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MUNDARIJA

TEXNIKA FANLARI

IJTIMOIY FANLAR

MATEMATIKA VA FIZIKA FANLARI

TABIIY TILNI QAYTA ISHLASHDA QO‘LLANILADIGAN NLP MODELLARI TAHLILI

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Annotatsiya: So‘nggi yillarda Sun’iy intellekt (SI) texnologiyalari yuqori darajada rivojlandi va turli sohalarda, jumladan, banklarda, elektron pochta boshqaruvida, tibbiyotda va boshqa ko‘plab sohalarda qo‘llanilmoqda. NLP (Natural Language Processing - Tabiiy Tilni Qayta Ishlash) so‘zida ko‘plab modellarni o‘z ichiga oladi. Bu modellar, matnni tahlil qilish, tarjima qilish, dialog tizimi, mazmuni tahlil qilish va boshqa ko‘plab vazifalarni bajarish uchun ishlatiladi. Bu modellar katta matnlar va ko‘p maqsadli vazifalarni bajarishda muvaffaqiyatli natijalarga erishish uchun yaratilgan. Har bir modellarning o‘z xususiyatlari va foydalanish sohalari mavjud. Ushbu maqolada shunday modellarning bir nechtasining imkoniyatlari va o‘ziga xos xususiyatlari bo‘yicha ma’lumotlar keltirilgan.

Kalit so‘zlar: tabiiy til, matn, NLP, RNN, Word2vec, GloVe, FastText.

ANALYSIS OF NLP MODELS USED IN NATURAL LANGUAGE PROCESSING

Abstract: In recent years, Artificial Intelligence (AI) technologies have advanced greatly and are being used in various fields, including banking, email management, medicine, and many others. The term NLP (Natural Language Processing) includes many models. These models are used for text analysis, translation, dialog system, content analysis and many other tasks. These models are designed for successful results on large texts and multi-purpose tasks. Each model has its own characteristics and areas of use. This article provides information on the capabilities and characteristics of several such models.

Keywords: natural language, text, NLP, RNN, Word2vec, GloVe, FastText.

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Kirish

Tilni modellashtirishning vazifalaridan biri oldingi matnni bilish asosida keyingi so‘zni bashorat qilishdir. Bu matn terish xatolarini tuzatish, avtoto‘ldirish, chatbotlar va boshqalar uchun zarurdir. Internetda tabiiy tilni qayta ishlash modellari haqida juda ko‘p tarqoq ma’lumotlarni topishingiz mumkin.

Tilni modellashtirishda alohida so‘zlar va so‘zlar guruhlari vektorlarga, ya’ni semantik munosabatlarni saqlaydigan ma’lum sonli tasvirlarga ko‘rsatiladi. So‘zning siqilgan vektor ko‘rinishi embedding deb ataladi. Bunday model oldingi n ta so‘zning kirish vektor ko‘rinishini oladi va jumlaning semantikasini "tushunish"ga harakat qiladi. Model treningi uzluksiz so‘zlar algoritmiga asoslangan. Kontekstli (qo‘shni) so‘zlar markaziy so‘zni bashorat qiladigan neyron tarmoqning kirishiga beriladi.

Asosiy qism

A bag of words (so‘zlar sumkasi) bu matnni vektor (so‘zlar to‘plami) sifatida ifodalash uchun qo‘llaniladigan modellardan biridir. Bunda matndagi har bir so‘z uning paydo bo‘lish soni bilan bog‘liq holda ifodalanadi.

Recurrent neural network (RNN)

Elementlar orasidagi yo‘naltirilgan aloqalarga ega neyron tarmoqlar. Neyronning chiqishi kirishga qaytarilishi mumkin. Ushbu tuzilma sizga o‘ziga xos "xotira" ga ega bo‘lish va ma’lumotlar ketma-ketligini, masalan, tabiiy tildagi matnlarni qayta ishlash imkonini beradi [3].

Hammamizga ma’lum Google ko‘pgina tillar uchun oldindan o‘qitilgan ochiq kodli modellardan foydalanadi. Model inglizcha Google News 200B korpusida o‘qitilgan va 128 o‘lchovli o‘rnatishni hosil qiluvchi, oldinga uzatiladigan neyron tarmog‘ining uchta yashirin qatlamidan foydalanadi. Bunday yechim quyidagi afzalliklarga ega:

- Oddiylik. Model tezda o‘rgatadi va o‘rnatishlarni yaratadi, bu ko‘pchilik oddiy ilovalar uchun yetarli hisoblanadi.
- Ko‘plab tillarda oldindan tayyorlangan versiyalar mavjud.

Shu bilan birga bunday yechim quyidagi kamchiliklarga ham ega:

- Uzoq muddatli bog‘lanishlarni hisobga olmaydi.
- Oddiylik foydalanish imkoniyatlarini cheklaydi.
- Yangi embedding modellar ancha kuchliroq imkoniyatga ega.

Word2vec

2013 yilda Google kompaniyasidan Tomas Mikolov so‘zlarning vektor ko‘rinishini o‘rganish uchun yanada samarali modelni taklif qildi - Word2vec. Usul ko‘pincha bir xil kontekstda uchraydigan so‘zlar o‘xshash ma’noga ega degan taxminga asoslangan edi. Bu NLP til modellarini ishlab chiqishda keskin burilish yasadi. Word2Vec modeli uzluksiz so‘zlarni to‘plash algoritmi o‘rniga Skip-gramdan foydalanadi. Ushbu modelning maqsadi avvalgi modelga mutlaqo ziddir - markaziy so‘zlarga asoslanib, atrofdagi so‘zlarni bashorat qilish.

Skip-gram modeli, bir so‘zning boshqa so‘zlar bilan hamkorlik qilishi mumkinligini aniqlash uchun so‘zlar orasidagi aloqalar tahlilini bajaradi. Bu model uchun kiritish qatorining uchinchi jihati so‘zlar va ularning konteksti bo‘lishi mumkin bo‘lgan qatorlarning ko‘p ma’lumotlaridan foydalaniladi. Bu ma’lumotlar bilan model o‘rganadi va so‘zlarning xususiyatlari (embedding) ni yaratadi. Natijada, har bir so‘z uchun bir qator kontekst so‘zlar haqiqiy joyda joylashishi va ularning ma’nolari bo‘yicha o‘rganiladi [2]. Skip-gram modeli, bu

so‘zlarning vektor koordinatalarini olish orqali amaliyotlarda o‘zlashtirish imkonini beradi. Bu vektorlar, so‘zlarning aynan ularning kontekstida uchun ma’nolarga yaqinlik va uzoqliklarini ifodalaydi [1]. Ma’lumotlar tahlili, matematik va tarqalgan texnologiyalar yordamida bu vektorlar ustida amalga oshiriladi. Bu vektorlar, ko‘p yo‘nalishli ma’lumotlar tahlili, matematik va yadroli ustama ma’lumotlar tahlili (NLP) uchun muhimdir.

Afzalliklar

- Oddiy arxitektura: oldinga uzatish, 1 kirish, 1 yashirin qatlam, 1 chiqish.
- Model tezda o‘rganadi va o‘rnatishlarni yaratadi (hatto o‘zingiz ham).
- O‘rnatishlar ma’noga ega, bahsli fikrlarni hal qilish mumkin.
- Metodologiya boshqa ko‘plab sohalarga kengaytirilishi mumkin (masalan, Lda2vec).

Kamchiliklar

- So‘z darajasida o‘rganish: so‘z ishlatilgan jumla yoki kontekst haqida hech qanday ma’lumot yo‘q.
- Birgalikda yuzaga kelishi e’tiborga olinmaydi. Model so‘zning qo‘llanish kontekstiga qarab turli xil ma’nolarga ega bo‘lishi mumkinligini hisobga olmaydi. Bu GloVe-ni odatda Word2Vec-dan afzal ko‘rishining asosiy sababidir.
- Noma’lum yoki kam uchraydigan so‘zlarni to‘liq qayta ishlamaydi.

GloVe (Global Vectors)

GloVe Word2Vec bilan chambarchas bog‘liq: algoritmlar bir vaqtning o‘zida paydo bo‘lgan va so‘z vektorlarining talqin qilinishiga tayanadi. GloVe modeli hit statistikasidan samarali foydalanish muammosini hal qilishga harakat qiladi. GloVe so‘z vektorlarining mahsuloti va stoxastik gradient tushishidan foydalangan holda ularning birgalikda paydo bo‘lish ehtimoli logarifmi o‘rtasidagi farqni minimallashtiradi. Olingan tasvirlar so‘zlarning vektor fazosining muhim chiziqli quyi tuzilmalarini aks ettiradi: bitta sayyoraning turli sun’iy yo‘ldoshlarini yoki shaharning pochta indeksini uning nomi bilan bog‘lash mumkin[5].

Word2Vec-da so‘zlarning birgalikda paydo bo‘lish chastotasi unchalik muhim emas, bu faqat qo‘shimcha o‘quv namunalarini yaratishga yordam beradi. GloVe faqat kontekstli statistik ma’lumotlarga tayanishdan ko‘ra, birgalikdagi hodisalarni hisobga oladi. So‘z vektorlari global o‘xshashlik asosida guruhlanadi.

Afzalliklar

- Neyron tarmog‘isiz oddiy arxitektura.
- Model tez va oddiy ilovalar uchun yetarli bo‘lishi mumkin.
- GloVe Word2Vec imkoniyatlarini to‘ldiradi. U so‘z chastotasini qo‘shadi va ko‘pgina mezonlarda Word2Vec-dan ustun turadi.

Kamchiliklar

- Birgalikda sodir bo‘lish matritsasi global ma’lumotni taqdim etsa-da, GloVe so‘z darajasida o‘qitilgan bo‘lib qoladi va jumla va so‘z ishlatiladigan kontekst haqida kam ma’lumot beradi.
- Noma’lum va kam uchraydigan so‘zlarni sifatsiz qayta ishlash.

FastText

Facebook tomonidan yaratilgan fastText kutubxonasi tabiiy til modellarini ishlab chiqishda yana bir jiddiy qadam bo‘ldi. Uni ishlab chiqishda bizga Word2Vec-dan tanish bo‘lgan Tomas Mikolov ishtirok etdi. So‘zlarni vektorlashtirish uchun bir vaqtning o‘zida skip-gram, salbiy namuna olish va uzluksiz sumka algoritmidan foydalaniladi[4].

Asosiy Word2Vec modeliga ramziy n-gramm modeli qo‘shildi. Har bir so‘z ma’lum

uzunlikdagi bir nechta belgilar ketma-ketligidan iborat kompozitsiya sifatida ifodalanadi. Klassifikator natijalari kam uchraydigan so‘zlar uchun juda mos keladi, chunki ular n-grammga bo‘lingan. Word2Vec va Glove-dan farqli o‘laroq, model noma’lum so‘zlar uchun qo‘shimchalar yaratish imkoniyatiga ega.

Afzalliklar

- Nisbatan oddiy arxitektura: oldinga o‘tish, 1 kirish, 1 yashirin qatlam, bitta chiqish
- N-grammlar tufayli u kam uchraydigan va eskirgan so‘zlarda yaxshi ishlaydi.

Kamchiliklar

- So‘z darajasida o‘rganish: so‘z ishlatilgan jumla yoki kontekst haqida hech qanday ma’lumot bo‘lmaydi.
- Birgalikda paydo bo‘lish e’tiborga olinmaydi, ya’ni model turli kontekstlarda so‘zning turli ma’nolarini hisobga olmaydi.

Xulosa

Zamonaviy texnologiyalarning jadal rivojlanib borayotganligini hisobga olsak, NLP sohasida yangiliklar doimiy ravishda paydo bo‘lishi mumkin. Mavjud modellar o‘zlarini yanada rivojlantirish uchun ko‘plab sohalarga qo‘llanilmoqda va yangi modellar ham paydo bo‘lmoqda. Masalan, GPT modellari ketma-ketlikda rivojlanmoqda, va yangi generativ modellar, masalan, DALL-E so‘z va tasvirlar kombinatsiyasini yaratishda muvaffaqiyat qozonmoqda. Bunday modellar, turli sohalar uchun yangi imkoniyatlar eshigini ochadi.

Shuningdek, ko‘p kompaniyalar xizmatlarida NLP ni qo‘llashga qodir modellar ishlab chiqishga qaratilgan. Bu modellar, avtomatlashtirilgan savollar va javoblar, muloqot botlari va tizimlarini yaratishda ishlatiladi. Muloqot botlari, onlayn do‘konlarda xizmat ko‘rsatish, ma’lumotlarni topish va foydalanuvchilarga yordam berishda keng qo‘llanilmoqda. NLP sohasida nufuzli tadqiqotchilar va kompaniyalar ham butun jihatlarini rivojlantirish va yangiliklarni ko‘rsatish bilan shug‘ullanmoqda. Ushbu soha, kiber xavfsizlik, tibbiyot, ta’lim, avtomatizatsiya va boshqa sohalar uchun e’tiboringizni jalb etuvchi yuqori potensialga ega.

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UZASSISTANT: REVOLUTIONIZING CUSTOMER SERVICE IN UZBEKISTAN WITH AI

Abstract: This paper introduces UzAssistant, an innovative artificial intelligence system designed to automate customer service interactions in Uzbek. By utilizing state-of-the-art speech recognition and synthesis technologies, UzAssistant aims to significantly enhance service efficiency and accessibility, addressing the linguistic needs of the Uzbek-speaking population. Preliminary results demonstrate high accuracy in voice recognition and naturalistic speech synthesis, promising substantial improvements in customer experience and operational efficiency.

Keywords: Speech technologies, call center, Uzbek language, speech-to-text, text-to-speech, speech recognition, speech synthesis.

Introduction

The advent of intelligent personal assistants has transformed customer service, offering 24/7 support across various sectors. However, the availability of these technologies in languages other than English remains limited. UzAssistant emerges as a groundbreaking solution, offering comprehensive customer service automation in the Uzbek language, thus filling a significant gap in the market [1-6].

Methodology

Our methodology was meticulously designed to optimize results and achieve our set goals. The project was divided into four principal segments: speech recognition, text summarization, sentence similarity analysis, and text-to-speech (TTS) conversion [7]. For the speech recognition part, we utilized an advanced deep learning framework suitable for this purpose (Deep Speech 2). Text summarization was handled using the seq2seq model, while the doc2vec model was instrumental in assessing sentence similarity. Lastly, for converting text into spoken words, we employed TTS technology, specifically using the WaveNet deep learning framework, which is known for its high-quality speech synthesis capabilities[8].

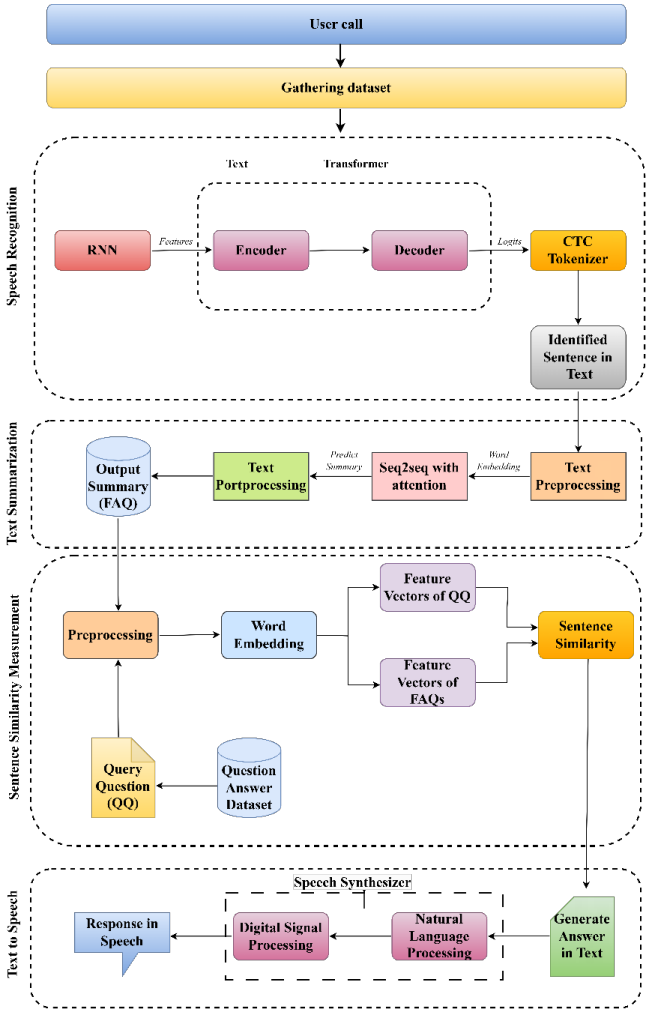

Figure 1. System Architecture of UzAssistant

The system was trained using the Uzbek Bank Speech Corpus, a comprehensive dataset containing thousands of hours of customer service calls in Uzbek. Data preprocessing involved noise reduction, normalization, and the extraction of Mel-Frequency Cepstral Coefficients

(MFCCs) to serve as input features for the neural network.

The RNN-based models were trained on the preprocessed dataset, with hyperparameter tuning conducted to optimize performance. Validation was performed using a separate set of data to ensure the model's generalizability [9].

Results

UzAssistant achieved a speech recognition accuracy of 96.4%, surpassing benchmarks set by existing systems in other languages. This high accuracy rate is pivotal for understanding customer queries accurately and providing relevant responses.

During the experiments, the Deep Speech 2 model demonstrated superior performance in terms of Word Error Rate (WER) and Character Error Rate (CER). On a test set comprising 5,474 samples, the Deep Speech 2 model achieved a WER of 13.8% and a CER of 5.22%, indicating its effectiveness in accurately processing and transcribing speech.

Table 1. Comparison of Speech Recognition Accuracy

Model	LM	AN	SP	SA	Valid		Test	
					CER	**WER**	**CER**	**WER**
E2E-BLSTM	×	×	×	×	13.9	43.2	15.1	44.7
	✓	×	×	×	14.8	30.1	15.2	31.9
	✓	✓	×	×	13.8	27.7	15.5	31.2
	✓	✓	✓	×	12.7	24.8	12.3	27.8
	✓	✓	✓	✓	10.6	22.6	11.5	23.9
DNN-CTC	×	×	×	×	13.1	35.1	10.9	32.7
	✓	×	×	×	10.9	21.3	9.0	25.4
	✓	✓	×	×	7.3	19.4	8.1	23.9
	✓	✓	✓	×	7.2	20.2	8.7	25.4
	✓	✓	✓	✓	6.0	17.1	6.5	21.9
E2E-Conformer	×	×	×	×	9.3	40.5	12.6	44.2
	✓	×	×	×	8.2	32.6	10.3	28.6
	✓	✓	×	×	8.1	30.3	9.9	27.2
	✓	✓	✓	×	7.9	24.1	9.2	24.4
	✓	✓	✓	✓	7.6	23.1	8.9	22.3
Deep Speech 2	×	×	×	×	12.0	36.7	10.2	34.6
	✓	×	×	×	11.3	26.4	9.3	25.9
	✓	✓	×	×	8.9	20.6	7.1	20.7
	✓	✓	✓	×	7.2	17.5	5.9	16.9
	✓	✓	✓	✓	**5.4**	**15.1**	**5.22**	**13.8**

The TTS component was rated highly for naturalness and intelligibility in a survey conducted with native Uzbek speakers, indicating UzAssistant's capability to generate responses that are both clear and engaging.

Discussion

The integration of UzAssistant in call centers is anticipated to not only improve customer satisfaction through efficient and accurate query handling but also reduce operational costs by automating routine interactions. Future work will focus on expanding UzAssistant’s domain of knowledge and exploring its application in other industries.

Conclusion

UzAssistant represents a significant advancement in the field of AI-driven customer service, specifically addressing the needs of the Uzbek-speaking population. Its successful deployment could serve as a model for developing similar technologies for other underrepresented languages, promoting inclusivity and accessibility in digital services.

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ENHANCED DIAGNOSIS OF CATTLE DISEASES USING FUZZY LOGIC ALGORITHMS

Abstract. Cattle illnesses can greatly affect both animal health and the economic stability of farmers. Prompt and precise diagnosis is crucial for effective management and treatment of these diseases. This study explores the development of diagnostic models and algorithms for cattle diseases using Sugeno's fuzzy inference system. It includes an analytical review of mathematical methods for animal disease diagnosis and soft computing approaches for tackling classification challenges. The study proposes an algorithm to create a knowledge base from the clinical signs of diseases, enhancing the reliability of informative features. Utilizing this algorithm, a software program was developed to diagnose cattle diseases. A computational experiment was conducted, and its results now serve as additional decision-making tools for diagnosing diseases in cattle. Using the program, a Sugeno fuzzy logic model was constructed and its results' adequacy analyzed. The study also evaluates the performance of this model by comparing it with existing algorithms and addresses various classification and evaluation challenges. The outcomes facilitate quick diagnosis and timely intervention, reducing data analysis time and improving the diagnostic process's efficiency. The scientific innovation of this research lies in the development of a knowledge base construction algorithm and enhancements to the Sugeno fuzzy logic model for cattle disease diagnosis. The findings have significant implications for veterinary medicine, particularly in the diagnosis of cattle diseases and supporting decision-making in intelligent systems.

Keywords: osteodystrophy, secondary, steodystrophy, ketosis, hypomicroselementosis, decision making, expert systems, fuzzy sets.

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Introduction

Diagnosing cattle diseases presents a significant challenge due to the overlapping symptoms among various conditions. Currently, the integration of artificial intelligence (AI) with mathematical approaches utilizing fuzzy sets is proving critical for the accurate diagnosis and prediction of animal diseases. Research has shown promising results in the development of computer-based diagnostic and prognostic systems, enhancing the quality of treatments through early detection of disease types and causes, and enabling targeted interventions. However, continual improvements to these systems are necessary to facilitate the early diagnosis of animal diseases effectively.

One such disease, osteodystrophy in cattle, encompasses a range of metabolic bone diseases marked by abnormal bone growth and mineralization. This condition can stem from several factors including mineral imbalances, hormonal disorders, and genetic predispositions. Common symptoms observed in affected cattle include lameness, stiffness, and a reduction in milk production.

Another prevalent metabolic disorder is ketosis, or ketotic hypoglycemia, which arises when cattle metabolize fats instead of carbohydrates as the primary energy source. This shift can result from high-fat diets, stress, or heightened energy demands. Symptoms typically include a decrease in appetite, weight loss, and reduced milk production.

Microelementosis, also known as trace mineral deficiency, occurs when cattle diets lack essential trace elements like copper, zinc, selenium, and iodine. This deficiency can trigger a variety of health issues, including immune dysfunction, reproductive failures, and poor growth. Affected cattle often exhibit symptoms such as anemia, deteriorated coat quality, and decreased milk output.

Methods

The methodology involved developing a fuzzy logic-based system using Sugeno's inference techniques. The system was designed to interpret clinical signs and laboratory data to diagnose diseases such as osteodystrophy, ketosis, and hypomicroelementosis in cattle. Parameters were converted into fuzzy sets, allowing for handling uncertainties inherent in clinical symptoms. The system integrates over 450 rules derived from veterinary expertise and validated against historical diagnostic data.

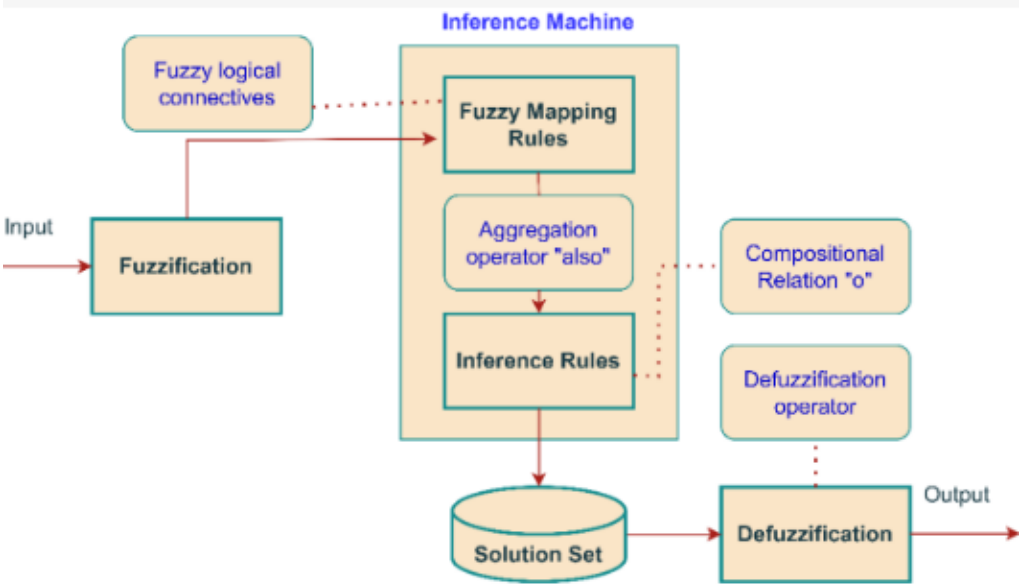

Figure 1. Fuzzy inference mechanism on the expert and control systems

The developed functional diagram for diagnosing diseases in cattle is presented in Figure 2.

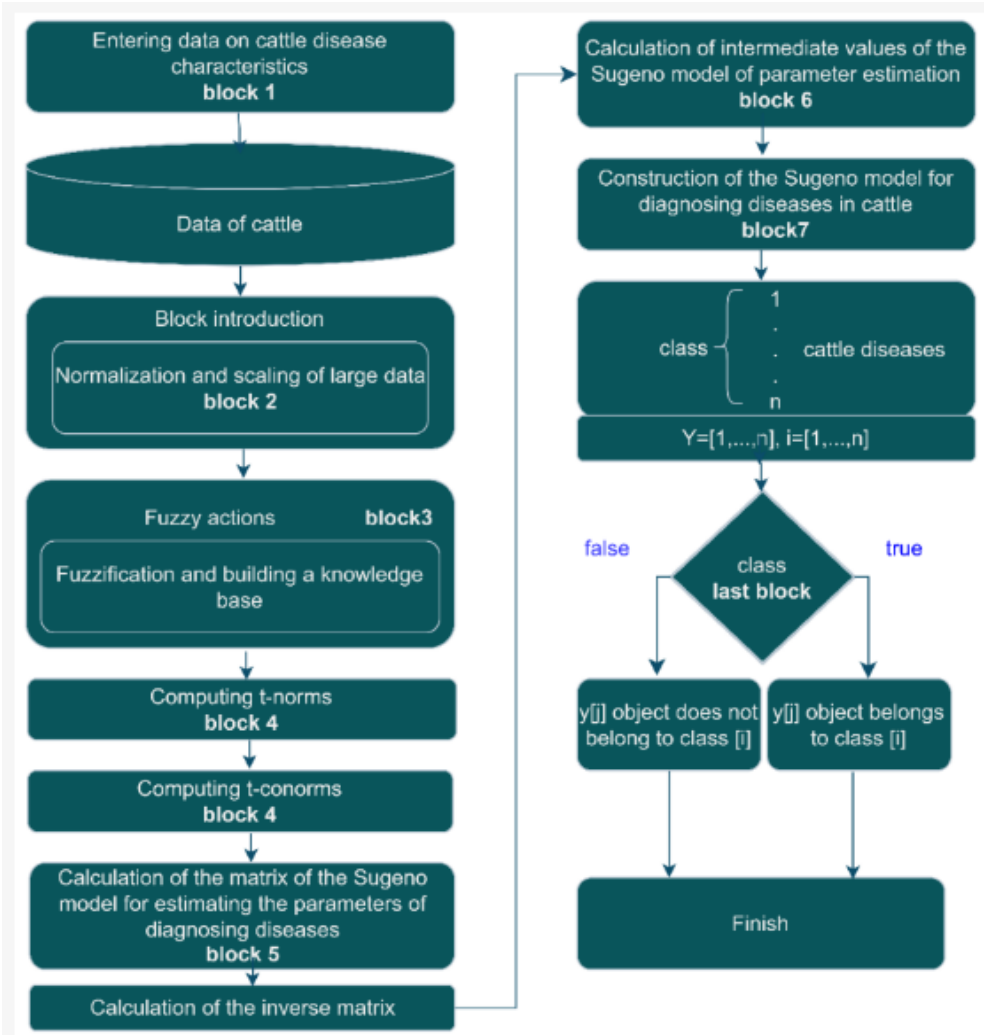

Figure 2. Functional scheme for diagnosing diseases in cattle.

Results

The implemented fuzzy logic system was tested through a series of computational experiments. The system demonstrated significant improvements in diagnosing cattle diseases, with increased accuracy and reduced time compared to traditional methods. Specifically, the system could accurately identify disease conditions from clinical signs and symptoms with a reliability of over 98%, as evidenced by validation tests involving real case scenarios from veterinary practices.

Conclusion

The study confirms the potential of fuzzy logic systems to revolutionize veterinary diagnostics by providing quick, accurate, and reliable disease diagnosis. Future research will focus on expanding the database of symptoms and conditions to cover a wider range of diseases and integrating real-time data acquisition systems for continuous monitoring and diagnosis. Further development will also explore the integration of these systems into mobile platforms for use in field conditions.

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THE USE OF INNOVATIVE AND DIGITAL TECHNOLOGIES IN TEACHING PROGRAMMABLE DIGITAL DEVICES

Abstract: In all types of production - industrial, radio equipment, construction, agricultural - the design of various kinds of objects is carried out. Computer-aided design systems ensure the implementation of functionally complete design tasks with the receipt of appropriate design solutions and design documents. Programs of this class solve the problem of automating all stages of designing systems of varying degrees of complexity: from the production technology of a single part to the design of an entire production line. The article describes the FPGA programming algorithm and presents the modeling of digital devices based on the VHDL programming language. An important advantage of FPGAs is their versatility and the ability to program them to perform the functions of almost any digital device. The practical significance of the work is to study the basics of FPGA programming in Verilog. Introducing the Quartus II compiler is the primary design environment for Intel FPGAs, easily adaptable to the requirements of a specific project. The Quartus II package includes all the utilities needed to work with FPGA chips. The light version of CAD is free and publicly available, which is very convenient for learning the basics.

Key words: VHDL programming language, digital devices, DMIS(FPGA), integrated circuits, macrocell, module interface, logic elements, circuits, converters.

Introduction

In recent years, programmable logic devices (PLDs) have virtually replaced special-purpose logic devices such as counters, multiplexers, etc. A PLD is a chip that can be programmed one or more times to perform multiple logical functions. The difference between hardware and software has gradually disappeared in recent years. Currently, engineers create the bulk of a digital circuit in programming languages such as VHDL and Verilog [2].

The main goal for using programmable logic is to reduce overall costs. One of the most important advantages of development using PLD is that it occurs much faster, thereby reducing the time required to bring a product to market. Programmable devices also reduce the risks associated with product development because they allow last-minute changes to be made without the need for a complete board redesign. Since FPGAs often replace several other special-purpose devices, the design typically has fewer components. This reduces PCB size, installation, testing and repair costs. Using FPGAs also requires fewer parts to be kept in stock, which reduces storage costs. Since most of the logic is integrated into each chip, the number of interconnections is significantly reduced, which increases product reliability. A programmable logic integrated circuit (FPGA) is an electronic component used to create digital integrated circuits. The operating logic of the FPGA is not determined during manufacturing, but is set by the developers through programming. For programming, debugging environments are used that allow you to set the desired structure of a digital device in the form of a circuit diagram or a program in special languages VHDL, Verilog, etc [1].

Literature review and Methodology

The subject of FPGA technology is always changing, influencing digital technology and computer science. You can see how FPGA is breaking down barriers and promoting innovation to create significant improvements in a variety of disciplines, including artificial intelligence (AI), quantum computing, and edge computing, among others, by observing the present trends and forecasts for the future.

Xilinx Inc. initially presented the idea of FPGA in the 1980s. The phrase was created by the business to characterize the novel type of semiconductors they were working on.

Table 1. Quick History of FPGA

1984	Xilinx releases XC2064, the first commercially-viable FPGA
1990	First FPGA with embedded system functions
2000	First FPGA with over one million system gates
Present	Modern FPGAs now include features like high-speed communication interfaces, integrated processors, and large memory blocks

The architecture of the FPGA largely supports programming in addition to influencing its flexibility and performance. The first step in building an FPGA is to use a Hardware Descriptive Language (HDL), such Verilog or VHDL, to describe the needed digital operations. Writing software code is not as similar to this early stage as drawing a building layout is. Synthesis tools subsequently translate this hardware description into a gate-level representation of the desired digital functionalities. Subsequently, the synthesized design is placed into the FPGA fabric using placement and routing algorithms, which also determine how to connect everything via programmable interconnects. The enormous sea of FPGA gates, which may be programmed and

coupled in countless ways, come into play here.

The method of designing FPGAs differs greatly from that of designing standard software. Rather than creating software, FPGA design primarily entails creating digital circuits to carry out particular functions. The first step in the design process is to specify the system's functionality using a high-level hardware description language (HDL), like Verilog or VHDL.

The system description in Verilog or VHDL is simply the start of the FPGA design process. Several steps are taken with the HDL code, such as bitstream generation, synthesis, placement, and routing, in order to produce a configuration file that can be loaded onto the FPGA.

Synthesis: Here, the HDL code is converted into a gate-level representation that corresponds to the basic building blocks of the FPGA, such as memory units and logic blocks.

Placement: Every gate or primitive specified in the synthesis process is allocated to a particular position (logic block) on the FPGA chip during placement.

Routing: The routing stage establishes the path that signals will follow to link the gates that have been installed through the programmable interconnects.

Bitstream Generation: In this last phase, the inserted and routed design information is encoded into a bitstream file that can be imported and used to setup the FPGA chip.

The main findings and Results

FPGA programming is done using Verilog and VHDL hardware description languages. At a high level, these languages are very similar -the hardware model is described in the form of interacting blocks (modules), and the interface and implementation are defined for each of them.

Programmable logic chips are one of the most powerful and flexible tools for building digital circuits. Convenient and accessible design systems allow the developer to create their own devices and devices with minimal time and money, and it allows students to master the Altera Quartus II CAD system and gain skills in designing digital devices and systems, as well as writing programs for FPGA-based processors in modern project environment [5].

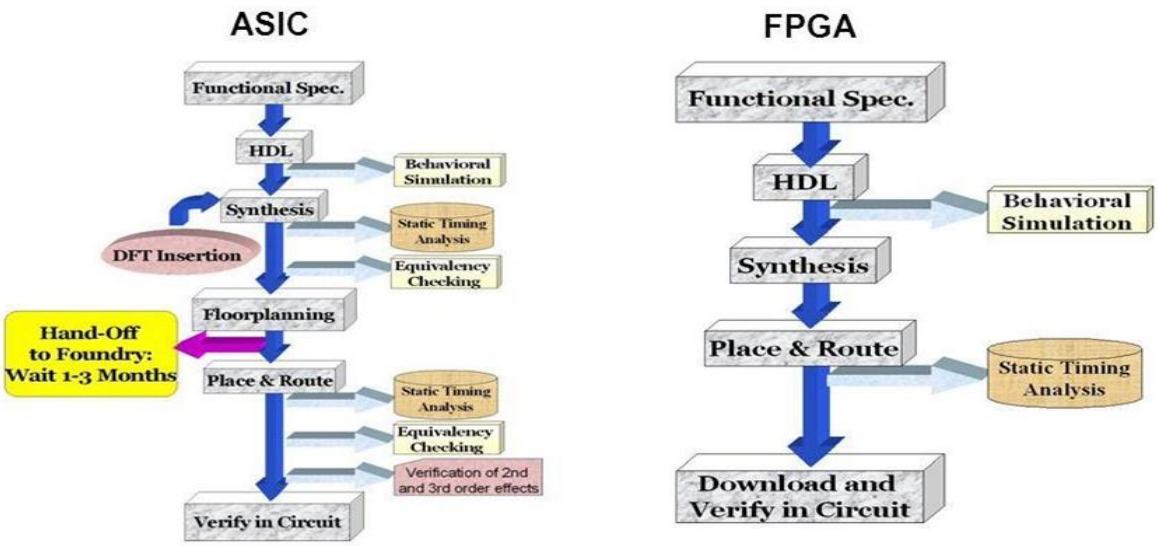
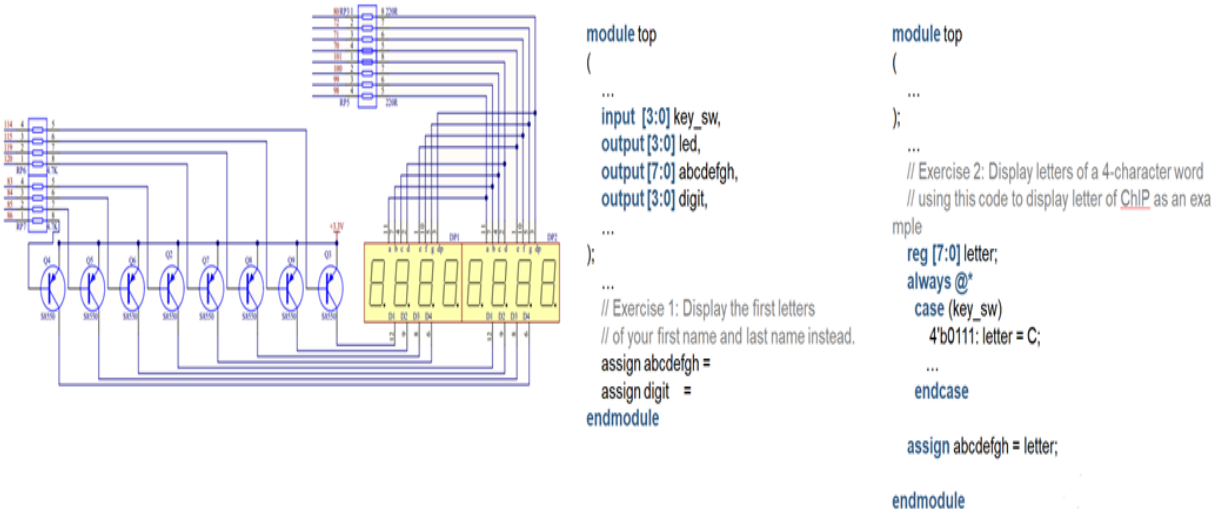


Figure 1. Design route



```
module top
(
  ...
  input  [3:0] key_sw,
  output [3:0] led,
  output [7:0] abcdefgh,
  output [3:0] digit,
  ...
);
  ...
  // Exercise 1: Display the first letters
  // of your first name and last name instead.
  assign abcdefgh =
  assign digit   =
endmodule
```

```
module top
(
  ...
);
  ...
  // Exercise 2: Display letters of a 4-character word
  // using this code to display letter of ChIP as an exa
mple
  reg [7:0] letter;
  always @*
   case (key_sw)
     4'b0111: letter = C;
     ...
   endcase

  assign abcdefgh = letter;

endmodule
```

Figure 2. Seven-segment indicator and Verilog program

Advantages and disadvantages of technology. Designing with FPGAs requires additional hardware and software development tools, which are often very expensive. Staff training may be required to master new development tools. In addition, components must be programmed before they are assembled into the final product [9]. Despite these disadvantages, programmable logic usually has economic advantages, with the exception of very simple (gates, some decoders) very complex (central processor) or very fast circuits (DRAM controller). Compared to ASICs (standard circuit or logic trica) PLD offers reduced costs for one-time costs for design and implementation in production (Non-Recurring Engineering cost), fast (1 hour versus several weeks) full development cycle, lower risk and simpler design tools. On the other hand, ASICs operate at higher speeds and are less expensive in large volumes (usually several thousand batches) [7].

CPLDs are complex programmable logic devices. For most practical purposes, CPLDs can be treated as multiple PLD devices (and some programmable interconnects) on a single chip. The larger CPLD size allows for more logic gates or more complex designs to be implemented. Unlike programmable interconnects within a PLD, the matrix switcher within a CPLD may or may not be fully interconnected. In other words, some of the theoretically possible connections between a logic block of inputs and outputs may not actually be supported in a given CPLD. The effect of this is to make full use of macrocells difficult to implement. Some hardware designs simply will not fit into this CPLD [5]. Some hardware designs simply will not comply with this CPLD even though there are enough logic gates and flip-flops. Because CPLD can accommodate larger projects than PLD, its potential use is much broader [10]. They are still used for simple applications like address decoding, but more often contain highly efficient logic devices or complex machines.

FPGA - user programmable gate array (FPGA). FPGA can be used for implementation in almost any hardware project. Typically used for even more complex devices with flexible architecture. The main advantage of the PPMV is that it can be changed at any time during operation. It consists of several configurable modules. In a digital circuit they implement binary operations OR, AND, XOR, NAND, etc. [6].

PPMV are ideal for projects that require a large amount of logic, since it is possible to

combine several storage registers, arithmetic and logical circuits, controllers, etc. on one device. One of the disadvantages of FPGAs is relatively large propagation delays. These delays are difficult to predict until the circuit design is completed. This is due to the need to route signals through several levels of logic and interconnection blocks. Another disadvantage is the expensive ($3000 or more) and slow software [8].

Module interfaces describe the input, output, and bidirectional ports through which modules connect to each other to exchange data and control signals. The implementation defines the elements of the internal state and the procedure for calculating the values of the output interfaces based on this state and the values of the input ports, as well as the rules for updating the internal state. Overview of the Digital Device Design Route The design of FPGA-based devices is carried out using special ALT systems. Designing with such ALT systems involves consistent use of the software tools provided. In ALT terminology, this process is called the modeling path. Modeling is traditionally divided into stages: systematic, structural, algorithmic, technological and functional.

Conclusion

To conclude, programmable logic integrated circuits (FPGA) are used in the development of digital devices. An important advantage of FPGAs is their versatility and ability to be quickly programmed to perform the functions of almost any digital device. FPGA is a semi-finished product, based on which a developer with a personal computer can design a digital device in record time. The main problems at all stages of VLSI design are to ensure defect-freeness and reduce design time. Module interfaces describe the input, output, and bidirectional ports through which modules connect to each other to exchange data and control signals.

An introduction to FPGA architecture, design flow, programming languages such as Verilog and VHDL, and methods for optimizing implementations and typical function implementations were given in this article. FPGAs are perfect for developing and implementing sophisticated digital systems in a variety of industries, including networking, video processing, aerospace, defense, and more, due to their performance and versatility. The era of parallel computing is seeing an expansion of applications to keep up with Moore's Law due to continuous advancements in FPGA density, speed, and programming tools.

Future developments in new fields are expected to be significantly impacted by FPGA technology. FPGA is making contributions to AI-based data centers, automotive systems, and even quantum computing, among other interesting new technologies. FPGAs, with their versatility and high-speed operation, continuously pushing the boundaries of what's possible in computer science and digital technology, continually revealing greater opportunities and problems. This can be used to refine existing concepts or to tread uncharted technological territory.

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VAZIYATGA SEZGIR AQLLI MUHITNING NAMUNAVIY ARXITEKTURASI

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Annotatsiya: Ushbu maqola, zamonaviy texnologiyalar yordamida yaratilayotgan vaziyatga sezgir aqlli muhitlarning asosiy arxitekturaviy yechimlariga bag'ishlangan. Maqolada aqlli muhitlar uchun ishlatiladigan arxitekturaning asosiy komponentlari va ularning vazifalari batafsil tahlil qilinadi. Sensorlar, ma'lumotlar bazasi,, bilim bazasi, kontekstni tahlil qilish, faoliyatni tanib olish, qaror qabul qilish va ijro etish kabi tarkibiy qismlar yoritilgan. Shuningdek, maqola aqlli muhitlarning ishlash prinsipi va ularning kundalik hayotimizdagi ahamiyati haqida ma'lumot beradi. Aqlli muhitlarning kelajakdagi rivojlanish istiqbollari va ularning foydalanuvchilarga taqdim etishi mumkin bo'lgan imkoniyatlar ko'rib chiqiladi.

Kalit so'zlar: aqlli muhitlar, arxitektura, sensorlar, ma'lumotlar bazasi, bilim bazasi, kontekstni tahlil etish, faoliyatni tanib olish, qaror qabul qilish, ijro etish komponentlari, texnologik integratsiya.

A MODEL ARCHITECTURE OF A SITUATION-SENSITIVE INTELLIGENT ENVIRONMENT

Abstract: This article is devoted to the main architectural solutions of situation-sensitive smart environments created with the help of modern technologies. The article analyzes in detail the main components of the architecture used for smart environments and their functions. Components such as sensors, database, knowledge base, context analysis, activity recognition, decision making and execution are covered. Also, the article provides information about the principle of operation of smart environments and their importance in our daily life. Prospects of future development of smart environments and the opportunities they can provide to users are considered.

Keywords: intelligent environments, architecture, sensors, database, knowledge base, context analysis, activity recognition, decision making, execution components, technological integration.

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Kirish

Hozirgi kunda axborot texnologiyalari rivojlanishi bilan “aqlli uy”, “aqlli bino”, “aqlli shahar”, “aqlli transport” va “aqlli muhit” kabi tushunchalar kirib kelmoqda va amaliyotga joriy etilmoqda. Ushbu tushunchalar ichidan eng imkoniyati kengrog‘i, keng qamrovlisi va har tomonlama mukammalrog‘i “aqlli muhit” hisoblanadi. Aqlli muhit tizimlarining atrofdagi muhit vaziyatini qabul qilib, shunga muvofiq qaror qabul qilish qobiliyati, foydalanuvchilarga kengroq imkoniyat va qulaylik yaratish va o‘z ongini kengaytirishga yordam berishga imkon beruvchi beqiyos vosita ekanligi isbotlandi. Shuning uchun, so‘nggi yillarda ishlab chiqarishda ko‘plab aqlli muhit yechimlari chiqmoqda va sanoat miqyosida eng so‘nggi keng tarqalgan kompyuter texnologiyalaridagi ilmiy yutuqlar qo‘llanilmoqda.

Vaziyatga sezgir aqlli muhit taqdim etayotgan xizmatlar ko‘lami kengdir. Kelib chiqish tarixiga yuzlanadigan bo‘lsak, 1992-yildagi “Active Badge” tizimi orqali qabul qiluvchi joylashgan xonaga qo‘ng‘iroqni yo‘naltiradigan telefonlardan, siz uyg‘ongan vaqtingizga mos keladigan tabingizdagi qahva tayyorlash vaqtini belgilash imkoniyatiga ega oddiy qahva mashinalaridan tortib, murakkab xulq-atvor qoidalari va rejalashtirish texnikalari bilan to‘liq binolarni avtomatlashtirish tizimlarigacha cho‘ziladi. Bu tizimlar sizning ko‘zingizni qisishingizni kutib, murakkab sun’iy intellekt qarorlarini ishga tushirish uchun, sizning ovozsiz xatti harakatingizni tushunib bajarishga tayyor bo‘ladi.

Shuningdek, yaqin tarixda aqlli muhitlar faqat shaxsiy va ijtimoiy miqyosda emas, balki katta shahar infrastrukturasida ham muhim ahamiyatga ega. Ba’zan butun mahallalar aqlli muhitlar sifatida ko‘rib chiqilishi mumkin, bu ko‘plab “Aqlli to‘r” (Smart Grid) imkoniyatlarini beruvchi loyihalar [1] tomonidan ko‘rsatilgan. Kichik miqyosdagi energiya ishlab chiqarish inshootlari, masalan, shamol generatorlari yoki quyosh panellari joriy etish orqali, ayrim binolar ma’lum vaqtlarda iste’mol qiladigan elektr energiyasidan ko‘ra ko‘proq energiya ishlab chiqarishlari mumkin. Bu qimmatli energiyani (bu "yashil" energiya, barqaror manbaga ega bo‘lganligi sababli yanada qimmatli hisoblanadi) energiyani yo‘qotib qo‘ymaslik uchun, binalar o‘rtasida to‘liq avtomatlashtirilgan texnikalari bilan jihozlangan, bir binodan boshqa qo‘shni binoga ortiqcha energiyani sotish imkonini beruvchi nuqta-nuqta (peyer-to-peyer) kabi energiya uzatish tizimlari joriy etiladi. Gollandiyaning “PowerMatching City” loyihasi kabi birinchi sinov loyihasida 25 ta o‘zaro bog‘langan xonadonlar mavjud bo’lib, bunday energiya arzon narxda keladi va "uzatish ortiqcha xarajati" ham keskin kamayadi, chunki endi o‘rtacha energiya uzatish masofasi ancha qisqaradi [2].

Aqlli muhitlar

Vaziyatga sezgir aqlli muhitlar - bu atrof-muhit, foydalanuvchi va tizim o'rtasidagi o'zaro ta'sirni yaxshilashga qaratilgan texnologiyalardir. Bu muhitlar sensorlar, aloqa tarmoqlari, ma'lumotlar bazasi va sun'iy aql komponentlaridan foydalangan holda atrof-muhitdagi o'zgarishlarni sezadi va mos ravishda javob qaytaradi.

Aqlli muhitlar bo‘yicha o‘tgan yillarda aqlli bino avtomatlashtirishiga bag‘ishlangan ko‘plab loyihalar amalga oshirildi. Ushbu loyihalar orqali ko‘rish mumkinki, aqlli muhitlar turli xil ko‘rinishlarda va turli o‘lchamlarda mavjud, lekin ularning har biri o‘z navbatida aqlli avtomatlashtirish va foydalanuvchilarning hayot sifatini yaxshilash maqsadida yaratilgan.

Ko‘rib chiqilganidek, vaziyatga (kontekstga) sezgir aqlli muhitlar ko‘plab turli shakllarda va miqyosda mavjud bo‘lishi mumkin, lekin asosiy g‘oya bir xil qoladi ya’ni, tizim o‘z kontekstini, ya’ni atrofdagi muhitni biladi, u aqlli, oldindan belgilangan, o‘rganilgan yoki avtomatik xulosalar chiqarish orqali mos ravishda harakat qila oladi va foydalanuvchilariga

murojaat qila oladi.

Shu tariqa ularning qulaylik va xabardorlik darajasini ham oshiradi. Seng Loke o‘z kitobida (Loke, 2006) vaziyatga (kontekstga) sezgir keng tarqalgan tizimning uch asosiy elementini aniqlaydi [3]:

- sezish;
- o‘ylash;
- harakat qilish.

Aqlli muhitlar birinchi tanishtirilganidan bir necha yil o‘tib, ushbu mavzu juda qiziqarli bo‘lib qoldi va ko‘plab loyihalar, ilmiy tadqiqotlar va ishlab chiqarishdagi yutuqlar aynan shu sohaga bag‘ishlandi. Ko‘plab boshqa tadqiqot sohalarida bo‘lgani kabi, turli tadqiqot guruhlari va sanoat kompaniyalari bir xil mavzuda alohida ish boshlaganda, vaziyatga (kontekstga) sezgir muhitlar sohasida guruhlar duch keladigan muammolar ko‘p jihatdan o‘xshash bo‘ladi, va ularning ba’zilari bir necha marta, ba’zan o‘xshash usullar bilan hal qilindi.

Bunday muammolardan biri va muhimlari, kontekstga sezgir aqlli tizimlarning yuqori darajadagi arxitektura loyihasi hisoblanadi. 2000-yillarning boshidan beri ko‘plab loyihalarda aqlli muhit tizimlarini arxitektura loyihasini taqdim qilishga harakat qilishgan. Biroq, bu tizimlarning arxitekturasiga tubdan qaraganda, ular orasida ko‘plab o‘xshashliklarni payqash mumkin. Asosiy tuzilish bir xil bo‘lgani bilan, eng katta farqlar odatda alohida komponentlar darajasida paydo bo‘ladi va ular turli yakuniy darajadagi talablarni qondirishga qaratilgan.

Shunday qilib, bunday aqlli muhit loyihalarining arxitektura namunasini yagona standartlashtirish g‘oyasi tabiiy ravishda paydo bo‘ldi. Ko‘plab muvaffaqiyatli va davom etayotgan loyihalarni namuna sifatida olib, biz umumiy tuzilish, umumiy namuna va bir gap bilan aytganda “eng yaxshi amaliyotlar”ni topishga harakat qildik. Bu kelajakdagi loyihalarga umumiy tizim arxitekturasi bo‘lib xizmat qilishiga va har bir loyihadagi noyob talablarga ko‘proq e’tibor qaratishga yordam beradi. Preuveneyers va Novaisning tadqiqotiga ko‘ra talablar muhandisligi, kontekst modeli, ishlab chiqarishni tezlashtirish va kodni qayta ishlatish kabi turli darajalardagi aqlli keng tarqalgan ilovalar bo‘yicha eng yaxshi arxitektura namunasini topish va o‘rganishga qaratilgan o‘xshash tadqiqotlarni ko‘rib chiqiladi [5]. Bu maqolada esa, biz aqlli muhit tizimlarining arxitekturasi uchun umumiy namunaga e’tibor qaratamiz.

Biz aqlli muhit loyihalarida umumiy bo‘lgan arxitekturaning bir nechta pog‘onasini tanishtiramiz va bu pog‘ona qismlari bo‘lishi mumkin bo‘lgan potensial komponentlar haqida muhokama qilamiz. Keyin, shunday arxitektura ichida umumiy ma’lumot oqimlarini muhokama qilamiz va eng muhim muammolarni, masalan, ko‘lamni kengaytirish va xatolarga bardoshlilikni tilga olamiz. Oxir-oqibat, bir nechta namunalarni, muvaffaqiyatli davom etayotgan aqlli bino loyihalarini taqdim etamiz va ko‘rsatilgan namuna ularning arxitekturalarida osonlik bilan moslashtirilishi mumkinligini ko‘rsatamiz.

2008-yilda Italiyaning Rim shahrida "Hamma uchun Aqlli Uylar" (SM4All) loyihasi doirasida aqlli kvartira quriladi. Loyiha murakkab sun’iy intellekt (AI) rejalashtirish texnikalaridan foydalanadi, bu esa har qanday vaziyatda foydalanuvchining ehtiyojlariga moslashish uchun bir qator harakatlarni ishlab chiqaradi.

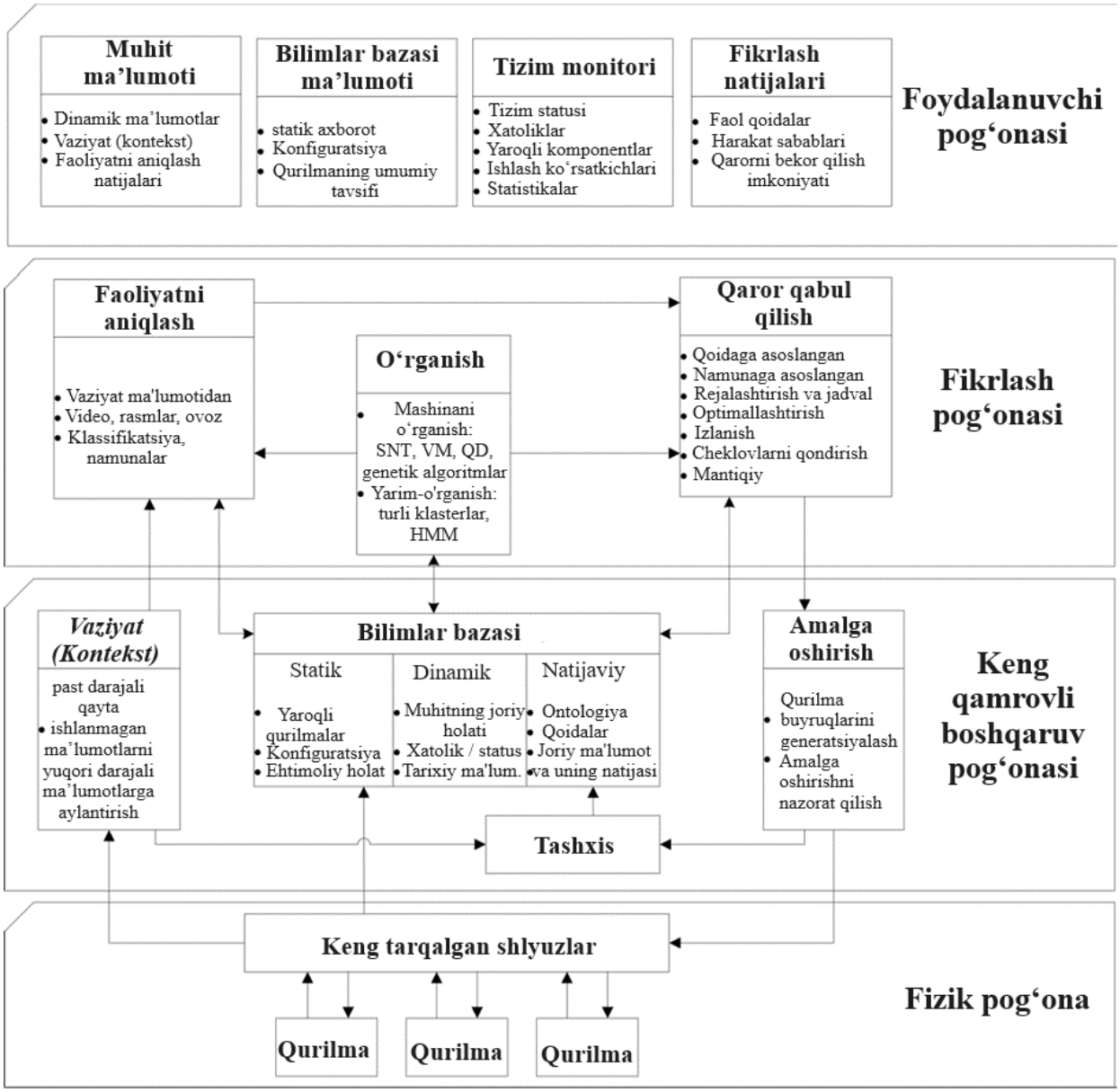
Shuningdek ushbu loyihalar qatoriga “e-Diana” loyihasi (2009-yil), “GreyenerBuildings” loyihasi (2013-yil), “ThinkHome” loyihasi (2013-yil) va boshqa yirik loyihalarni misol keltirishimiz mumkin.

Ushbu loyihalar foydalanuvchilarning odatlarini o‘rganish, ularning xatti-harakatlarini

avtomatik ravishda bashorat qilish va tegishli muhitni yaratish orqali shaxsiy qulaylikni oshirishga qaratilgan. Endi biz loyihalarda umumiy bo‘lgan komponentlarni batafsil taqdim etamiz.

Umumiy arxitektura

Endi esa aqlli muhit uchun vaziyatga (kontekstga) sezgir umumiy arxitektura namunasini taqdim etamiz. Arxitektura namunasi 1-rasmda ko‘rsatilgan. Biz to‘liq arxitekturani to‘rtta pog‘onaga bo‘lish mumkinligini va har bir pog‘onada bir nechta farqli komponentlar mavjudligini ko‘rsatamiz. Ko‘pgina komponent namunalari barcha kontekstga sezgir aqlli muhitlar uchun umumiy bo‘lgan talablarga ko‘ra arxitektura loyihasi o‘xshashliklaridan kelib chiqadi.



1-rasm. Vaziyatga sezgir aqlli muhit arxitekturasi.

Quyida tavsiflanadigan komponentlar tizimga komponentlarning mavjudligi jihatidan to‘liq mos kelmasligini ta’kidlash muhimdir. Bu yerda keltirilgan komponentlar asosiydir, lekin ko‘pincha amaliyotda ba’zi bir yordamchi komponentlar talab qilinadi, bu komponentlar

boshqa komponentlar o‘rtasida aloqani o‘rnatadi yoki kuzatuvchi, proksi, monitor kabi vazifalarni bajaradi. Shuningdek, agar tizim ma’lum bir maxsus qobiliyatga ega bo‘lsa, masalan, isitish mexanizmlarini maxsus boshqarish yoki nogiron foydalanuvchilar uchun maxsus qo‘llab-quvvatlash tizimi kabi, ko‘pincha bu alohida komponentni talab qiladi. Shunday qilib, bu maqolada tavsiflanadigan tizim zarurat tug‘ilganda ko‘proq komponentlarni ulash imkoniyati bilan kengaytirilishi mumkin deb qaralishi kerak. Aksincha, ba’zi taqdim etilgan komponentlar va oqimlar ba’zan kichikroq miqyosdagi loyihalarda soddalashtiriladi, birlashtiriladi yoki umuman olib tashlanadi. Bu imkoniyat komponentlar darajasida ta’kidlanadi.

Fizik pog‘ona tizimning barcha apparat qismlarini o‘z ichiga oladi, bu esa barcha simli va simsiz sensorlar, harakatlantiruvchilar, tarmoq sxemasi, ular bilan bog‘liq past darajadagi protokollar va boshqalarni o‘z ichiga oladi. Fizik pog‘onaning asosiy vazifalaridan biri muhit haqida ma’lumotni to‘plash va uni yuqori pog‘onalarga uzatishdir. Past darajadagi protokollar bir xil shlyuzni ta’minlash uchun amalga oshirilishi mumkin, bu esa interfeyslarni birlashtirish, maxsus apparat farqlarini yashirish yoki ma’lumotni birlashtirish orqali tarmoq talablarini kamaytirish imkonini beradi. Fizik pog‘onaning ikkinchi asosiy vazifasi yuqori pog‘onalardan yuborilgan buyruqlarga asosan muhitdagi harakatlantiruvchilarni ishga tushirishdir.

Yuqorida tasvirlangan aqlli muhit arxitekturasi namunasining har bir pog‘onasi alohida komponentlarga ega. Har bir komponent esa bir nechta aniq vazifalarga ega. Avvalo, bu pog‘ona tizimning ma’lumotlar saqlash joyini o‘z ichiga oladi, ya’ni muhit, tizim konfiguratsiyasi, tizim imkoniyatlari, foydalanuvchi uchun imkoniyatlar va boshqalar haqidagi hozirgi va tarixiy barcha ma’lumotlarni to‘playdi va saqlaydi.

Shuningdek ushbu pog‘ona, oddiy sensor xatolari yoki nosozliklarni aniqlay oladigan, past darajali sensor qiymatlarini muhitning yuqori darajali mantiqiy holatiga o‘zgartiradigan va boshqalar kabi ma’lumotlarni qayta ishlash komponentini o‘z ichiga olishi kerak.

Fikrlash pog‘onasida tizimning mantig‘i joylashgan. Bu pog‘ona tizimning harakatlariga qaror qilish uchun javobgar bo‘lgan barcha komponentlarni o‘z ichiga oladi, bu oddiy mantiq qat’iy “agar – unda” (if-then) qoidalar orqali belgilangan bo‘lishi mumkin yoki rejalashtirish yoki harakatlarni jadvalga kiritish kabi murakkab AI texnikalari bo‘lishi mumkin. Shuningdek ushbu pog‘ona, faoliyatni tanish yoki o‘rganish komponentlarini o‘z ichiga olishi mumkin, bu esa avtomatlashtirilgan tizimning javobini yaxshilashi kerak.

Foydalanuvchi pog‘onasi tizim haqida ma’lumotlarni uning foydalanuvchilariga taqdim etadi. U ikki asosiy qismdan iborat. Birinchisi muhit haqida, hozirgi foydalanuvchi uchun yaratilgan qulayliklari, tizimning ma’lum qarorlari uchun sabablar haqida ma’lumot beradi va foydalanuvchiga o‘z ehtiyojlariga muvofiq tizim konfiguratsiyasini o‘zgartirish, yangi ijro qoidalarini kiritish yoki tizimning qarorlarini bekor qilish imkoniyatini beradi. Ikkinchi qism o‘zi tizim haqida meta-ma’lumotlarni taqdim etadi, masalan, barcha komponentlarning holati, ular to‘g‘ri ishlayotganligi, statistika, resurslarni iste’mol qilish va boshqalar. Endi har bir pog‘onani batafsil tavsiflaymiz.

Fizik pog‘ona

Fizik pog‘onaing asosiy qismi, nomidan ko‘rinib turibdiki, apparat qismdir, ya’ni muhitga o‘rnatiladigan qurilmalar. Aqlli uy muhitini amalga oshirishni rejalashtirgan barcha guruhlar dastlabki bosqichdan boshlab oldindan hal qilinadigan muammo bilan to‘qnash keladi. Masalan, ular foydalanmoqchi bo‘lgan qurilmalarning xilma-xilligi. Hozirgi vaqtda ba’zi kompaniyalar sensorlar va harakatlantirgichlar kombinatsiyasini taqdim etishga ixtisoslashgan bo‘lsa-da, hanuz ko‘plab maxsus ehtiyojlarga mo‘ljallangan, turli xil va ehtimol

monopoliya asosidagi interfeys va aloqa protokollari bilan ta’minlangan maxsus qurilmalar mavjud.

Shuning uchun interfeys va ma’lumotlarni yig‘ishni tizimga yanada chuqurroq yuborishdan oldin unifikatsiya qilish muhimdir. Bunday unifikatsiya quyi bog‘lanish arxitektura qoidasiga rioya qilishdan tashqari, qurilmalarni alohida va butun bir tur sifatida qo‘shish, olib tashlash yoki o‘zgartirishni osonlashtiradi. Tizimning boshqa qurilma qismlarini faolsizlantiradi va uning dastur shaklida qurilmani almashtirishda tizimning fizik pog‘onasidan tashqarida birorta ham kod satrini o‘zgartirishni talab qilmaydi.

Shuning uchun fizik pog‘onaning muhim qismi - bu shlyuz hisoblanadi. Bu komponent dastlab qurilmalardan ma’lumotlarni yig‘adi va uni tizimning ichida bir xil usulda yuborish uchun past darajali transformatsiyani qo‘llab-quvvatlaydi. Shlyuz juda ko‘p qurilmaga bog‘liq bo‘lib, qurilma turlaridagi har qanday o‘zgarishda o‘zgartirishlarni talab qiladi.

Albatta, konseptual jihatdan ba’zi boshqa qismlar ham, ayniqsa ma’lumot beruvchi qurilmalar sifatida va fizik qurilmalar sifatida ko‘rib chiqilishi mumkin, masalan, shaxsning kun tartibi, VoIP orqali qo‘ng‘iroq qilish jarayoni yoki tizimdan tashqaridan kelgan elektron xabar. Tez-tez bunday voqealar dastlab “yuqori”dan, ya’ni foydalanuvchi pog‘onasidan yoki hatto keng qamrovli boshqaruv pog‘onasi yoki fikrlash pog‘onasiga to‘g‘ridan-to‘g‘ri kirish nuqtasi orqali tizimga kiritiladi va qayta ishlanadi.

Keng qamrovli boshqaruv pog‘onasi

Keng qamrovli boshqaruv pog‘onasi butun tizimning boshqaruvchisi hisoblanib, boshqa barcha komponentlarning asosiy qo‘llab-quvvatlovchisidir. Shuningdek, u asosiy ma’lumot oqimlari va ma’lumot saqlash kanallarini o‘z ichiga oladi va ba’zi jihatdan ushbu pog‘ona ikki xil infrastrukturani (masalan, fizik va fikrlash pog‘onasi komponentlarini) birlashtiradi va ularni tushunishda yordam beradi.

Bu pog‘onaning bir nechta asosiy komponentlari mavjud va ularning har biri bir aqlli muhit tizimida deyarli muqarrar mavjud bo‘ladi.

Bilimlar bazasi. Bilim bazasi komponentining vazifasini tahlil etamiz. Tizimning ma’lumotlar bazasi ushbu komponentga tegishli bo‘lib, ba’zi tizimlar uchun ushbu komponent ma’lumotlar bazasi bilan sinonim bo‘ladi. Bilimlar bazasida 3 xil ko‘rinishdagi ma’lumotlar saqlanadi:

- Statik ma’lumotlar;
- Dinamik ma’lumotlar;
- Natijaviy (qayta ishlangan) ma’lumotlar

Birinchi tur - bu qurilmalar haqida statik ma’lumotlar. Bu tizimda mavjud bo‘lgan qurilmalar turlari, ularning aloqa protokollari, ular sensorlar yoki harakatlantirgichlar ekanligi, ular taqdim etadigan vazifalar tuzilishi yoki ularga o‘rnatilishi mumkin bo‘lgan holatlar kiradi.

Bilimlar bazasining ikkinchi turdagi ma’lumoti dinamikdir va bu yuqori chastotada o‘zgaradigan ma’lumotlarni, masalan, muhitning joriy holati, qurilmalar yoki bajarilgan buyruqlarni anglatadi. Ko‘plab tizimlar ushbu turdagi ma’lumotlarni to‘g‘ridan-to‘g‘ri tegishli komponentlarga yuborishni afzal ko‘rishadi. Shuningdek, dinamik ma’lumotlarni uzatish uchun to‘g‘ridan-to‘g‘ri aloqa bilimlar bazasidan tashqarida bo‘lsa ham, ma’lumotlarni saqlash va keyinchalik qayta olish va qayta ishlash uchun bilimlar bazasiga ham yuboradigan dublikat aloqa bo‘lishi kerak.

Nihoyat, bilimlar bazasidagi oxirgi turdagi ma’lumotlar deyarli eksklyuziv tarzda fikrlash

pog‘onasida ishlatiladi, chunki bu yerda yuqori darajadagi fikrlash uchun zarur bo‘lgan barcha ma’lumotlar mavjud. Bu yerda ma’lumotlar bazasi tizim qanday vaziyatdan foydalanishiga katta darajada bog‘liq. Masalan, ontologiyaga asoslangan tizimlar uchun, ThinkHome (Reinisch, Kofler, & Kastner, 2010) kabi, bu tizim va muhitning ontologiyasini yaratadi.

Vaziyat (Kontekst). Keng qamrovli boshqaruv pog‘onasining keyingi komponenti kontekst hisoblanadi. Kontekstning asosiy vazifasi qurilmalardan yig‘ilgan past darajali qayta ishlanmagan ma’lumotlarni yuqori darajali ma’lumotlarga aylantirishdir, bu esa fikrlash pog‘onasida foydalanish uchun mos keladi.

Bunday qayta ishlashning bir turi ma’lumotlarni inkapsulyatsiyalashdir. Masalan, akustik sensor kabi ba’zi sensorlar juda yuqori chastotada ma’lumot yuboradi. Yuqori darajadagi komponentlar bunday batafsil ma’lumotlarga muhtoj bo‘lmasligi mumkin. Ayrim soddalashtirilgan tizimlar faqat tovush borligi yoki yo‘qligi yoki tovush darajasini bilishni xohlashi mumkin, shuning uchun ko‘p miqdordagi ma’lumot uzatishlarni vaziyat (kontekst) bosqichida ma’lumotlarni birlashtirish orqali va faqat natijalarni tizimning yuqori qismiga yuborish orqali amalga oshirish mumkin. Bu esa tizim resurslaridan oqilona foydalanish qoidasiga to‘g‘ri keladi va tizim xotirasidan imkon qadar kam joy egallaydi.

Amalga oshirish. Ijro komponenti ma’lum ma’noda kontekstning to‘liq teskarisi hisoblanadi. Ijroning vazifasi fikrlash pog‘onasidan qabul qilingan harakat maqsadlarini qurilmalarga yuborilishi mumkin bo‘lgan ijro etiladigan harakatlarga aylantirishdir. Vazifaga qo‘shimcha tarzda qurilmalar tomonidan buyruqlarning to‘g‘ri bajarilishini nazorat qilish ham yuklanadi.

Tashxis. Nihoyat, keng qamrovli boshqaruv pog‘onasining oxirgi komponenti tashxis komponentidir. Bu komponent ixtiyoriy hisoblanadi, ya’ni ba’zi tizimlar uni aniq amalga oshirishni tanlamaydilar, ayniqsa aqlli muhitni rivojlantirishning dastlabki bosqichlarida. Komponentning vazifasi sensorlardan ma’lumotlarni o‘qishni va ijro natijalarini kuzatish, qurilmalarning to‘g‘riligini tekshirish va iloji boricha har qanday xatolik va vaziyatlarni aniqlashdir. Masalan, ko‘plab batareyali qurilmalar batareya quvvati past bo‘lganda noto‘g‘ri ma’lumotlar yuborish ehtimoliga ega. Agar erta aniqlanmasa, bu fikrlash darajasida katta muammolarga olib kelishi mumkin.

Fikrlash pog‘onasi

Fikrlash pog‘onasi tizimning domen darajasidagi mantig‘ni o‘z ichiga oladi. Har bir aqlli muhit loyihasi muhit qanday vaziyat va harakatlarni amalga oshirish haqida qaror qabul qilishi kerakligi to‘g‘risida o‘z g‘oyalariga ega bo‘lishi kerak.

Vaziyatga sezgir tizimlar tadqiqotlarining ko‘plab yillari davomida domen darajasidagi ma’lumotlarni modellashtirishning turli usullari ishlab chiqildi, ba’zilari umumiy, ba’zilari esa tizim hal qilishga mo‘ljallangan aniq vazifaga qaratilgan.

Turli vaziyatga sezgir tizim modellarining batafsil tahlili va misoli (Bettini va boshqalar, 2010)da taqdim etilgan. Vaziyatni tasvirlash modelini aniq tanlash, tizimning o‘rganish, faoliyatni tanish va qaror qabul qilish qobiliyatlariga katta ta’sir ko‘rsatadi, shuning uchun bu aqlli muhit tizimining dastlabki loyihasida qilinadigan eng muhim tanlovlardan biridir.

Biz bu pog‘onani uch komponentga ajratdik, ammo kelajakdagi aqlli muhit loyihalari bu komponentlarning har qanday kombinatsiyasini turli usullarda o‘z ichiga olishi mumkin.

O‘rganish. O‘rganish komponenti kirish ma’lumotlariga asoslanib, eng yaxshi qarorlar va harakatlarni avtomatik ravishda o‘rganishga javobgardir, bu real vaqt ma’lumotlari yoki oldin yig‘ilgan statik ma’lumotlar bo‘lishi mumkin.

O‘rganish komponenti tizimdagi boshqa barcha komponentlar orasida biroz maxsus o‘rinni egallaydi. Bir tomondan, bu komponent ixtiyoriydir, ya’ni masalan, u qoida asosidagi tizim bo‘lsa, hech qanday o‘rganishni qo‘shmasdan aqlli muhit tizimini qurish mumkin. Boshqa tomondan, agar komponent mavjud bo‘lsa, u tizimdagi eng muhim markaziy o‘rinlardan birini egallaydi.

Ushbu komponentning asosiy vazifasi mashinani o‘rganishdir. Mashinani o‘rganish, sun’iy neyron tarmoqlari, vektor mashinalarini qo‘llab-quvvatlash, qarorlar daraxtlari, genetik algoritmlar, kuchaytirilgan o‘rganish, turli klasterlash texnikalari orqali aqlli muhit tizimlarini aqliy jihatdan rivojlantirib yanada intellektual qiladi.

Faoliyatni aniqlash. Faoliyatni aniqlash komponenti kontekstdan joriy holat haqida ma’lumot oladi va muhit haqida ko‘proq yuqori darajadagi ma’lumotni tasniflash va aniqlash uchun ichki bilimni qo‘llaydi. Masalan, kontekst xonada harakat borligini ko‘rsatuvchi harakat sensorining o‘qishini yuborgan bo‘lsa ham, faoliyatni aniqlash bu xonada biror kishining mavjudligiga mos kelishini tekshiradi. Faoliyatni aniqlash ovoz, video yoki tasvirni tanishni o‘z ichiga olishi mumkin. Ko‘pincha u faoliyatni tasniflash va tanish uchun o‘rganish komponentidan olingan natijalardan foydalanadi.

Qaror qabul qilish. Qaror qabul qilish komponenti aqlli muhitni jim kuzatuvchidan qat’iy harakat qiluvchiga aylantiradi. U berilgan bilimlar bilan berilgan vaziyatda qanday harakatlar bajarilishi kerakligini hal qiladi.

Faoliyatni aniqlash va o‘rganish komponentlari singari, qaror qabul qilish komponenti ko‘plab turli shakllarda qo‘llaniladi. Foydalanilishi mumkin bo‘lgan usullar orasida optimallashtirish nazariyasi, rejalashtirish va jadval tuzish, cheklovlarni qondirish, qidiruv texnikalari, mantiqiy fikrlash, ontologik fikrlash, noto‘g‘ri fikrlash va boshqalar bor.

Foydalanuvchi pog‘onasi

Ko‘plab loyihalar foydalanuvchilar uchun alohida maxsus e’tiborni qaratmasdan, o‘z arxitekturalarida ular uchun faqatgina komponentning bir qismi sifatida foydalanuvchi interfeysi belgilab qo‘yilgan. Biz buni namunaviy arxitekturada alohida bag‘ishlangan pog‘ona sifatida ko‘rib chiqish kerakligini ta’kidlaymiz.

Foydalanuvchi pog‘onasi tizimni foydalanuvchiga ko‘rsatadi va tizimni o‘zgartirish va sozlash, xatolarni tuzatish, tizimning qarorlarini bekor qilish va boshqa ko‘plab imkoniyatlarni beradi.

Pog‘onaning birinchi komponenti muhit ma’lumotidir. Bu kuzatuvchi komponent bo‘lib, o‘z ma’lumotlarini 3 ta manbadan oladi:

- Dinamik ma’lumotlardan;
- Vaziyatdan (kontekstdan);
- Faoliyatni aniqlash natijalaridan.

Foydalanuvchi pog‘onasining ikkinchi komponenti bilimlar bazasi ma’lumotidir. Qurilmalar holati va ularning konfiguratsiyasi, mumkin bo‘lgan harakatlar haqida statik ma’lumotlar foydalanuvchi uchun asosiy qimmatli ma’lumot sanaladi. Bilimlar bazasi ma’lumoti asosan statik axborot, qurilma konfiguratsiyalari va qurilmaning umumiy tavsifi kabi ma’lumotlar bilan boyitiladi.

Foydalanuvchi pog‘onasining navbatdagi komponenti bu tizim monitori hisoblanadi. Barcha oldingi komponentlardan farqli ravishda, bu komponent domen va muhit haqida emas, balki o‘z tizimi haqida ma’lumot ko‘rsatadi. Masalan, komponentlarning yaroqlilik holati,

ularning ishlash koʻrsatkichlari, aniqlangan holat oʻzgarishlari yoki xatolar, va hokazolar. Bu, shuningdek, qurilmalardagi aniqlangan xatolarni oʻz ichiga oladi. Bunda qurilma toʻgʻri ishlayotganini yoki rostdan ham oʻzgartirilishi yoki ta’mirlanishi kerakligini tekshirish uchun foydalanuvchining aralashuvini talab qilishi mumkin.

Foydalanuvchi pogʻonasining oxirgi komponenti fikrlash natijalari hisoblanadi. Ushbu komponent orqali ma’lum bir qaror tizim tomonidan nima uchun qabul qilinganini koʻrsatadi. Masalan, agar tizim ma’lum bir harakatni bajarishga qaror qilsa, bu komponent qaysi qoidalar aniq faollashtirilganini koʻrsatadi. Bu yerda fikrlash pogʻonasining barcha komponentlaridagi ma’lumotlarni, jumladan qaror qabul qilish, oʻrganish va hatto faoliyatni aniqlash komponentlaridan ma’lumotlarni qayta ishlaydi. Fikrlash natijasi komponenti qaror qanday va nega qabul qilinganini foydalanuvchiga tushuntiradi. Ushbu komponent asosan foydalanuvchi uchun faol algoritm va qoidalar, bajarilgan harakatlarning sabablari yoki qarorni bekor qilish imkoniyatini beradi.

Adabiyotlar

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A COMPARATIVE ANALYSIS OF TRADITIONAL AND DEEP LEARNING-BASED APPROACHES FOR FACE DETECTION: PERFORMANCE, ADVANCEMENTS, AND CHALLENGES

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Abstract: This thesis presents a comprehensive survey and analysis of various neural network architectures utilized in the domain of face detection, focusing specifically on their effectiveness in handling occlusion. The research investigates the challenges posed by occlusion in face detection and examines state-of-the-art neural network models designed to address this issue. The study explores the strengths, limitations, and advancements made in these architectures concerning occlusion handling.

Keyword: Face detection, traditional approaches, deep learning, Viola-Jones, CNN, HOG.

Introduction

Face detection, a pivotal component of computer vision technology, plays a fundamental role in identifying and localizing human faces within images or video frames. Its ubiquitous relevance spans across diverse domains such as security surveillance, entertainment applications, healthcare diagnostics, personalized marketing, and human-computer interaction. While the significance of accurate face detection cannot be overstated in these realms, the efficacy of this technology encounters numerous hurdles, especially in scenarios where faces are partially obscured or occluded.

The evolution of face detection algorithms has significantly enhanced the precision and efficiency of identifying faces in varying environmental conditions and contexts. Despite these advancements, the detection of faces under occlusion remains a persistent challenge, impeding the technology's reliability in real-world applications. Occlusion, stemming from varied factors like objects, hands, facial accessories, or even natural facial expressions, poses a substantial obstacle to accurate face detection. Addressing occlusion in face detection is imperative for the technology's robustness and practical utility across domains. Overcoming occlusion demands the development and deployment of sophisticated algorithms and neural network architectures capable of discerning and reconstructing obscured or partially visible facial features.

This survey paper endeavors to comprehensively explore the landscape of face detection under occlusion. It aims to analyze and evaluate a spectrum of neural network architectures and methodologies specifically designed to mitigate the challenges posed by occlusion. By synthesizing existing research and advancements, this paper aims to provide insights into the strengths, limitations, and future directions in the quest for more effective face detection under occlusion.

Exploring Face Detection Techniques

2.1 Traditional approaches

The Viola-Jones algorithm, pioneered by Paul Viola and Michael Jones, stands out for its adeptness in object detection [1]. It functions through the utilization of Haar-like features, which are rectangular filters designed to detect pixel intensity variations across various sections of an image. These features collectively form a potent classifier capable of efficiently distinguishing between facial and non-facial elements. Employing a cascade of classifiers, the algorithm strategically narrows down regions likely to contain faces, thus notably decreasing computation time.

The HOG (histogram oriented gradient) algorithm, developed by Navneet Dalal and Bill Triggs, relies on the distribution of gradient orientations in localized regions of an image. It computes histograms of gradient orientations, which are representations of the local edge directions, and then creates a descriptor capturing the distribution of these gradients. HOG is robust to changes in illumination and background clutter, making it effective for face detection [2].

Each of these traditional algorithms has its strengths. Viola-Jones is known for its speed, HOG for its robustness against variations in lighting and background, and Haar-like features for their simplicity and effectiveness in identifying distinctive patterns in an image. However, they also have limitations. Viola-Jones can sometimes struggle with pose variations and complex backgrounds. HOG, while robust, might not perform as well with extreme variations in facial expressions or occlusions. Haar-like features might oversimplify certain facial characteristics,

limiting their accuracy in complex scenarios.

These traditional techniques laid the groundwork for more advanced and robust face detection methods by providing insights into feature extraction and classification. Modern approaches often integrate deep learning models, leveraging convolutional neural networks (CNNs) and other sophisticated architectures to achieve higher accuracy and adaptability in various conditions.

2.2 Neural networks based approaches

Multi-Scale Fully Convolutional Network (MS-CNN). This is a specialized neural network architecture tailored for precise face detection across multiple scales within an image canvas. This architecture's core strength lies in its ability to handle faces appearing at various sizes and resolutions. By employing a fully convolutional structure, the MS-CNN operates on different scales of the input image, allowing it to detect faces at varying sizes simultaneously. This network architecture is designed to extract hierarchical features from different layers, capturing facial characteristics at multiple levels of abstraction. This comprehensive feature extraction process enables the network to discern faces amidst diverse scales and complexities. Notably, the MS-CNN integrates contextual information from these varied scales, improving its accuracy even in scenarios involving cluttered backgrounds or occlusions that might obscure parts of the face [3].

Typically leveraging an anchor-based approach, the MS-CNN predicts bounding boxes at different scales and aspect ratios across the image, aiding in precisely localizing potential face regions. During training, the network learns to optimize its parameters by minimizing the disparity between predicted bounding boxes and annotated face locations within labeled datasets. MS-CNN has demonstrated promising performance in face detection tasks, exhibiting high accuracy across various benchmarks. Its multi-scale approach addresses the challenge of identifying faces regardless of their sizes or orientations, making it suitable for real-world applications where faces exhibit diverse perspectives and appearances. This architecture represents a significant stride in advancing the accuracy, efficiency, and adaptability of face detection models under varied conditions.

Face Detection Algorithm Based on Double-Channel CNN. In literature [4] proposed a model architecture based on VGGNet and residual network. The main reason for choosing VGGNet in this paper is its excellent performance in image feature extraction, and it is easy to modify and train. Residual network is used because it is easy to optimize and can extract face features well with a simple modification. The overall framework of the model is shown in Figure 1. The occlusion perceptron network is used to extract facial features in fewer occlusion regions. The main function of the Region Decision Unit (RD-Unit) is to determine whether the occlusion ratio of the subregion exceeds the set value. When the occlusion of a certain area exceeds the set proportion, the feature vector of the area is discarded. Several regional occlusion judgment units are integrated into the VGG16 network to screen out the subregions with less occlusion. Therefore, the occlusion perceptron network can extract the face related features in fewer occlusion areas. Residual neural network (RNN) is applied to extract full-face features. The output of the two networks is fused with feature vectors by the single-factor weighting method, and the fused feature vectors will be used for face detection.

Multi-task Cascaded Convolutional Networks (MTCNN) is a popular deep learning-based algorithm used for face detection. It's a multi-stage framework designed to detect faces in images while handling variations in pose, scale, and lighting conditions. MTCNN consists of three stages, each focusing on a specific aspect of face detection [5]:

Stage 1: Proposal Network (P-Net). In this stage generates candidate facial regions likely to contain faces. It employs a fully convolutional network to scan the image at multiple scales, detecting faces of different sizes. Utilizes a sliding window technique to propose candidate bounding boxes with associated probabilities for face regions. Works efficiently in identifying potential face locations but might produce false positives;

Stage 2: Refinement Network (R-Net). In this stage refines the candidate face regions obtained from the first stage. Filters out false positives by performing more precise bounding box regression. Evaluates the proposed regions, discarding inaccurate regions and further narrowing down potential face regions. Improves the accuracy of face localization by refining the bounding boxes;

Stage 3: Output Network (O-Net). The final stage performs further refinement and detailed facial feature extraction. Detects facial landmarks (such as eyes, nose, and mouth) within the bounding boxes identified by the previous stages. Outputs the final bounding boxes for faces along with the precise facial landmarks.

MTCNN is widely used in applications requiring accurate and robust face detection, such as facial recognition systems, surveillance, and biometric authentication. However, the choice of a face detection algorithm depends on factors like accuracy, speed, and resource constraints specific to the intended application.

Conclusion

In the domain of face detection, traditional methods like Viola-Jones and Histogram of Oriented Gradients (HOG) offer simplicity and speed but struggle with handling diverse conditions. Contrastingly, neural network-based algorithms such as Multi-Stage Cascaded Convolutional Networks (MTCNN), Double-Channel CNN, and Multi-Scale Convolutional Neural Network (MS-CNN) provide robustness and accuracy, leveraging deep learning techniques to address variations in scale, pose, and lighting. However, their effectiveness often comes at the cost of computational intensity and the need for substantial labeled datasets for training. Each approach presents a trade-off between speed, accuracy, and resource requirements, catering to specific application needs within face detection tasks.

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GISTOLOGIK TASVIRLARDAGI MAVJUD SOHALARNI O'LCHASH USULI

Annotatsiya: Mazkur ishda gistologik tasvirlarni segmentlash va ularda mavjud sohalarni belgilab, ularning o'lchamlarini aniqlash usullari tadqiq qilingan. Gistologik tasvirlarni bo'sag'aviy segmentlash usuli tadqiq qilinib, tasvir chegaralarida bo'lgan va tasvirda to'liq nomoyon bo'lmagan sohalarni olib tashlash usuli taklif etilgan. Tasvirdagi sohalarga nishonlar qo'yish, ularni turli ranglarga bo'yash, o'lchamlarini turli xarakteristikalar bo'yicha aniqlash usuli keltirilgan.

Kalit so'zlar: gistologik tasvir, tasvirlarga raqamli ishlov berish, segmentlash, bo'sag'aviy funksiya, sinflararo dispersiya.

METHOD OF MEASURING AVAILABLE AREAS IN HISTOLOGICAL IMAGES

Abstract: In this work, the methods of segmenting histological images and determining the areas present in them and determining their sizes are studied. The method of threshold segmentation of histological images is studied, and a method of removing areas that are on the borders of the image and are not completely visible in the image is proposed. There is a method of marking areas in the image, coloring them in different colors, and determining their size according to various characteristics.

Key words: histological image, digital image processing, segmentation, threshold function, interclass dispersion.

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Kirish

Zamonaviy tibbiy tasvirlarga ishlov berish usullari tashxis aniqligi va samaradorligini oshirishda, ayniqsa gistologiya sohasida muhim rol o‘ynaydi [1]. Hozirgi tibbiy diagnostikada bemorlarning to‘qimalari va hujayralari haqida ma’lumot olish uchun gistologik tasvirlar keng qo‘llaniladi. Tibbiyot sohasida tasvirlarni olishning raqamli gistologiya kabi yuqori texnologiyali usullari paydo bo‘lishi bilan olingan ma’lumotlarni qayta ishlash va tahlil qilishning avtomatlashtirilgan usullariga ehtiyoj ortdi [2,3]. Ushbu sohadagi asosiy muammolardan biri gistologik tasvirlarda biologik tuzilmalar hajmi va chegaralarini avtomatlashtirilgan tarzda aniqlashdir. Gistologik tasvirlarda sohalarning o‘lchamini aniqlash ma’lumotlarni tahlil qilish jarayonidagi asosiy qadam bo‘lib, uni avtomatlashtirish tibbiy tadqiqotlarning aniqligi va samaradorligini sezilarli darajada oshirishi mumkin. Biroq, gistologik tasvirlarda biologik sohalarning aniq va samarali o‘lchamlarini aniqlash diagnostika va davolashni rejalashtirish uchun aniqroq ma’lumotlarni taqdim etish uchun muhim masala bo‘lib qolmoqda.

Masalaning qo‘yilishi

Gistologik tasvirni $M \times N$ o‘lchamdagi I matritsa shaklida olib, bunda har bir I_{ij} element pikselning (i, j) - pozitsiyasidagi intensivligini ifodalaydi. B - tasvirni bo‘sag‘aviy segmentlash orqali olingan binar tasvir bo‘lsin, bunda B_{ij} ning har bir elementi piksel tanlangan sohaga tegishli bo‘lsa 1 ga, aks holda 0 ga teng.

Sohalarning o‘lchamlarini aniqlash uchun quyidagi belgilashlarni kiritamiz:

1. R bo‘sag‘aviy segmentlash bilan aniqlangan sohalar to‘plami bo‘lsin. Har bir $r \in R$ soha B binar tasviridagi piksellar to‘plamini ifodalaydi.

$$B_{ij}=\begin{cases}1, \text{agar } I_{ij} \geq T\\ 0, \text{agar } I_{ij} < T\end{cases} \quad (1)$$

2. Har bir $r \in R$ soha uchun piksellar soni, ya’ni uning A_r o‘lchamini aniqlash kerak bo‘lsin:

$$A_{r_i} = \sum_{(i,j)\in r_i} B_{ij},$$

Maqsad $R = \{r_1, r_2, \dots, r_k\}$ to‘plamning gistologik tasvirdagi o‘lchamlari biologik tuzilmalarga mos keladigan sohalarini o‘z ichiga olishini ta’minlaydigan T bo‘sag‘aviy qiymatni topishdan iboratdir.

Taklif etilayotgan usullar

Bo‘sag‘aviy segmentatsiya

Bo‘sag‘aviy segmentatsiyaning asosiy g‘oyasi yorqinlik yoki rang qiymati uchun shunday bo‘sag‘aviy qiymatni belgilashdan iborat bo‘ladiki, unda piksel u yoki bu sinfga tegishli deb hisoblanadi [4]. Zamonaviy masalalarda tasvirni binarizatsiya qilish uchun optimal bo‘sag‘aviy qiymatini avtomatik ravishda hisoblash kerak bo‘ladi. Bunday masalalarda tasvirni binarlashtirishning bo‘sag‘aviy qiymatini avtomatik hisoblash uchun Otsu usuli keng qo‘llaniladi [5]. Otsu piksellarning ikkita sinfi: fon va ob’ekt (yoki fon va old fon) o‘rtasidagi ajratishni maksimal darajada oshiradigan mezonni taklif qildi [6]. Matematik jihatdan u sinf ichidagi dispersiyani minimallashtirish va sinflararo dispersiyani maksimallashtirishga asoslanadi va uni quyidagi bosqichlar bilan tavsiflash mumkin:

1. Har bir yorqinlik darajasining paydo bo‘lish ehtimoli p(i)ni hisoblash:

$$p(i) = \frac{n_i}{N}, \quad (2)$$

bunda n_i - yorqinlik darajasi i bo‘lgan piksellar soni, N - tasvirdagi piksellarning umumiy soni.

2. Ikki $w_0(t)$ va $w_1(t)$ sinflar uchun umumiy ehtimollikni hisoblash:

$$w_0(t) = \sum_{i=0}^{t} p(i),\ w_1(t) = \sum_{i=t+1}^{L-1} p(i), \quad (3)$$

bunda $w_0(t)$ - yorqinlik darajasi t dan kam bo‘lgan barcha piksellarning umumiy ehtimoli, $w_1(t)$ - yorqinlik darajasi t dan katta bo‘lgan barcha piksellarning umumiy ehtimoli, L - yorqinlik darajalarining umumiy miqdori.

3. Ikki $\mu_0(t)$ va $\mu_1(t)$ sinf uchun o‘rtacha qiymatlarni hisoblash:

$$\mu_0(t) = \frac{1}{w_0(t)} \sum_{i=0}^{t} i \cdot p(i),\ \mu_1(t) = \frac{1}{w_1(t)} \sum_{i=t+1}^{L-1} i \cdot p(i) \quad (4)$$

4. Ikki $\sigma_0^2(t)$ va $\sigma_1^2(t)$ sinf uchun sinf ichidagi dispersiyani hisoblash:

$$\sigma_0^2(t) = \frac{1}{w_0(t)} \sum_{i=0}^{t} (i - \mu_0(t))^2 \cdot p(i),$$

$$\sigma_1^2(t) = \frac{1}{w_1(t)} \sum_{i=t+1}^{L-1} (i - \mu_1(t))^2 \cdot p(i). \quad (5)$$

5. Sinflararo dispersiyani hisoblash $\sigma^2(t)$:

$$\sigma^2(t) = w_0(t) \cdot w_1(t) \cdot (\mu_0(t) - \mu_1(t))^2 \quad (6)$$

6. Otsu mezoniga ko‘ra bo‘sag‘aviy qiymatni tanlash:

$$t^* = \arg\max_t \sigma^2(t) \quad (7)$$

6 - qadamda olingan t^* bo‘sag‘aviy qiymat tasvirni binarizatsiya qilish uchun optimal bo‘sag‘aviy qiymat bo‘ladi. Yorqinlik darajasi t^* dan kam yoki unga teng bo‘lgan piksellar bir sinf, yorqinligi darajasi t^*dan kattaroq piksellar boshqa sinf hisoblanadi.

Gistologik tasvirlar murakkab tarkibga ega bo‘lganligi va to‘qimalarning mikroskopik tasvirlarini ifodalaganligi sababli, bunday tasvirlarda ba’zi artefaktlar, shovqinlar, tasvirga to‘liq yoki qisman kirmagan ob’ektlarning sohalari, shuningdek, tasvirning chegaralarga tegib qolgan sohalar bo‘lishi mumkin [7]. Noaniqliklarga yo‘l qo‘ymaslik uchun odatda bunday sohalarni olib tashlash tavsiya etiladi. Bunday sohalarni olib tashlash uchun quyidagi usuldan foydalanish mumkin.

Tasvir chegarasiga tegib turgan sohalarni olib tashlash usuli

Faraz qilaylik Z tasvir berilgan bo‘lib, $A \times B$ uning o‘lchamlari bo‘lsin, unda Z_{ij} pikselning (i,j) pozitsiyadagi intensivligini ifodalasin. Intensivlik qiymatlari [0, 1] oraliqda deb qabul qilinadi, bunda 0 qora (fon), 1 oq (ob’ekt).

Tasvir chegarasiga tegib turgan sohalarni olib tashlash usuli quyidagi bosqichlarda amalga oshiriladi:

- Chegaradagi sohalarni aniqlash:Binar tasvirni belgilab chiqamiz, ya’ni piksel sohaga tegishli bo‘lsa, V_{ij}=1 deb olinadi, aks holda V_{ij}=0 ga teng.

$$V_{ij} = \begin{cases} 1, \text{agar } Z_{ij} = 1 \text{ va } i = 0 \text{ yoki } i = A - 1 \text{ yoki } j = 0 \text{ yoki } j = B - 1 \\ 0, \text{aks holda.} \end{cases}$$

- Sohalarni olib tashlash:Bunga ushbu sohalarning piksel qiymatlarini 0 ga tenglashtirish orqali erishish mumkin.

$$Z_{ij} = \begin{cases} 0, \text{agar } V_{ij} = 1 \\ Z_{ij}, \text{aks holda.} \end{cases} \quad (8)$$

Shunday qilib, matematik jihatdan, bu usul tasvir chegarasidagi sohalarga tegishli piksellar qiymatlarini nolga tenglashtirish uchun binar niqob [9] bilan elementlarni ko‘paytirish operatsiyasi qo‘llanadi.

Mavjud sohalarni nishonlash (belgilash) usuli

Rasmning chetidagi sohalar olib tashlangandan so‘ng, tasvirdagi qolgan sohalarni nishonlash(belgilash)ni boshlash mumkin. "Nishonlash" har bir sohaga noyob yorliq (butun son) belgilashni anglatadi. Buni amalga oshirish uchun quyidagi usuldan foydalanish mumkin.

Q binar tasvir berilgan bo‘lib, har bir piksel $Q_{i,j}$ bilan belgilangan bo‘lsin, bunda i va j piksel koordinatalari.Shuningdek, ikkita funktsiya kiritamiz: $Y_{i,j}$ - (i, j) piksel nishonini (butun son) ifodalovchi funksiya va $H(i, j)$ - (i, j) pikselning qo‘shni piksellar to‘plamini saqlovchi funksiya bo‘lsin.

O‘zaro bog‘langan komponentlarni aniqlash:Piksellar qiymati 1 ga teng bo‘lib (sohaga tegishli), umumiy chegaraga ega bo‘lsa, ular o’zaro bog‘langan hisoblanadi.

Nishonlarni aniqlash:Nishonlash algoritmi o’zaro bog‘langan komponentlarga unikal nishonlar tayinlaydi. Har bir pikselning nishonini $Y_{i,j}$ bilan belgilaymiz.

Nishonlash algoritmi:$Y_{i,j} = 0 \; \forall \; (i, j) \in Q$ (barcha piksellar uchun).

Tasvir bo‘ylab yurish:Q dagi har bir (i, j) piksel uchun: Agar $Q_{i,j} = 1$ (piksel sohaga tegishli bo‘lsa) va $Y_{i,j} = 0$,Yangi nishonni o‘rnatish: $Y_{i,j} =$ yangi nishon.

Nishonlar interpolyatsiyasi: $H(i, j) \cap H(p, q) = \emptyset$ bo‘lgan har bir qo‘shni (p, q) piksel uchun:Agar $Q_{p,q} = 1$ va $Y_{p,q} \neq 0$ bo‘lsa, unda $Y_{i,j} = Y_{p,q}$ deb olinsin.

Takrorlashlar barcha piksellar ko‘rib chiqilgunga qadar takrorlanadi.

Natijada har bir sohasi noyob nishon bilan belgilangan yangi Y tasvirga ega bo‘lamiz.

Sohalarning turli xarakteristikalarini ajratib olish usuli

Nishonlangandan so‘ng, tasvirdagi sohalarning turli xarakteristikalarini ajratib olish mumkin. Ushbu ishda nishonlangan sohalardan quyidagi xarakteristikalar olinadi:

1. Soha yuzasi:S sohaning yuzasi - bu sohadagi piksellar soni.

$$S = \sum_{i,j} Z_{i,j}, \tag{9}$$

bunda $Z_{i,j}$ - (i, j) - pozitsiyasidagi piksel qiymati.

2. Sohaning massa markazi:Sohaning massa markazi C sohadagi barcha piksellar koordinatalarining o‘rtacha qiymati sifatida hisoblanishi mumkin.

$$C = \left(\frac{\sum_{i,j} i \cdot Z_{i,j}}{\sum_{i,j} Z_{i,j}}, \frac{\sum_{i,j} j \cdot Z_{i,j}}{\sum_{i,j} Z_{i,j}} \right) \tag{10}$$

3. Ekvivalent diametr:Ekvivalent diametr E ni soha bilan bir xil yuzaga ega bo‘lgan doira diametri sifatida hisoblash mumkin.

$$E = 2 \cdot \sqrt{\frac{S}{\pi}} \tag{11}$$

4. O‘rtacha intensivlik:O‘rtacha intensivlikni sohadagi barcha piksellarning o‘rtacha yorqinligi qiymati sifatida hisoblash mumkin.

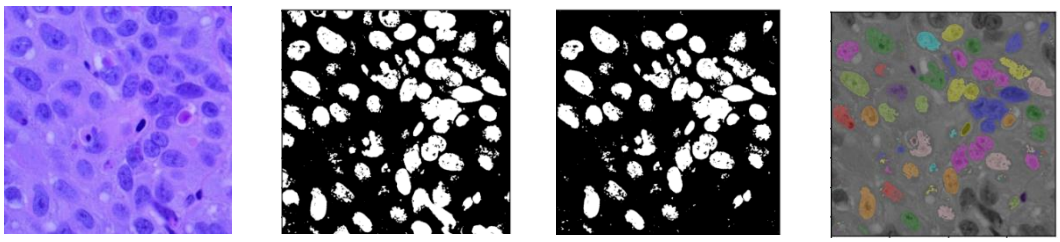
$$T = \frac{\sum_{i,j} Z_{i,j}}{S} \tag{12}$$

5. O‘xshashlik:O‘xshashlik D sohaning qavariq ko‘pburchakka qanchalik o‘xshashligini aniqlaydi [10]. O‘xshashlik soha yuzasi S ning, uning qavariq ko‘pburchagi yuzasi $\mathbb{S}$ ga nisbatiga teng.

$$D = \frac{S}{\mathbb{S}} \quad (13)$$

Natijalar

Yuqoridagi usullarning ishlashi amalda eksperimental tadqiqotlar bilan tasdiqlangan. Eksperimental tadqiqot ob’ektlari sifatida inson o‘pkasining gistologik tasvirlari tanlangan(1-rasm).



1-rasm. Inson o‘pkasining gistologik tasviri:
(a) - rangli tasvir, (b) – segmentlangan tasvir, (c) - chegaraga tegib turgan sohalarni olib tashlanganidan keyin natija, (d) - sohalarini nishonlash natijasi .

1b-rasmda (2-7) formulalar yordamida ushbu tasvirning bo‘sag‘aviy segmentatsiyasi natijasi ko‘rsatilgan. Rasm segmentatsiyasidan so‘ng, yuqoridagi usul va (8) formuladan foydalanib, tasvir chegaralariga tegib turgan sohalarni olib tashlash mumkin. Olib tashlash natijasi 1c-rasmda ko‘rsatilgan.

Shundan so‘ng sohalarni nishonlashni boshlash mumkin, ya’ni har bir mintaqaga noyob nishon (butun son) belgilash mumkin. Buning uchun yuqorida tavsiflangan usuldan foydalanib, tasvir bo‘ylab to‘liq o‘tiladi va mavjud sohalarga nishonlar tayinlanadi, shu bilan birga ular turli xil ranglar bilan bo‘yaladi. Rasm sohalarini nishonlash natijasi 1d-rasmda ko‘rsatilgan.

Nishonlangandan so‘ng sohalardan, xarakteristikalar ajratilgan. 1-jadvalda birinchi va oxirgi beshta sohalarning xarakteristikalari ko‘rsatilgan.

1-jadval

Nishon	Soha o‘lchami(piksel)	Ekvivalent diametr	O‘rtacha intensivlik	O‘xshashlik
1	5	2.52	126.00	1.00
2	8	3.19	124.75	1.00
3	27	5.86	126.19	0.82
4	1	1.13	127.00	1.00
5	7	2.99	126.00	0.88
...	...	...	...	...
300	4	2.26	126.75	1.00

301	3	1.95	126.33	1.00
302	2	1.59	127.00	1.00
303	2	1.59	127.00	1.00
304	1	1.13	125.00	1.00

1-jadvaldan ko‘rinib turibdiki, tanlangan tasvirni tahlil qilishda usul uch yuzdan ortiq sohalarni aniqladi va nishonladi. Shuningdek, har bir sohaqadagi piksellar sonini (soha o‘lchami ustuni), soha bilan bir xil yuzaga ega bo‘lgan doira diametrini (ekvivalent diametr ustuni), soha ichidagi piksellarning o‘rtacha intensivligini (o’rtacha intensivlik ustuni) aniqlandi va o‘xshashlik (o‘xshashlik ustuni) bu sohaning qavariq shaklga qanchalik o‘xshashligini bildiradi, bunda 1 qiymati soha butunlay qavariq ekanligini bildiradi. Yuqoridagi usullardan foydalanishni avtomatlashtirish uchun Pythonda dasturiy vosita yaratildi, u yordamida tasvirlarni ochish, segmentlash, chegaralardagi sohalarni o‘chirish va sohalar haqidagi ma’lumotlarni filtrlash uchun ba’zi qiymatlarni o‘rnatish mumkin.

Xulosa

Ushbu ishda gistologik tasvirlardan sohalarni segmentlash va bu sohalardan ba’zi xarakteristikalarini ajratib olish masalasi ko‘rib chiqildi. Shu maqsadda keng qo‘llaniladigan va tibbiyot, biologiya va fan sohasidagi tadqiqotlar imkoniyatlarini kengaytiruvchi, to‘qimalar va hujayralar tuzilmalarini yanada chuqurroq o‘rganish imkonini beruvchi bo‘sag‘aviy segmentatsiya qo‘llanildi. Tasvirga to‘liq tushmagan yoki tasvir chegaralariga tegib turgan sohalarni olib tashlashning bosqichma-bosqich usuli tavsiflangan, shuningdek, segmentlangan sohalarni nishonlash va ulardan turli xil xarakteristikalarni olish usuli taklif etildi. Sohalarning olingan xarakteristikalari jadval shaklida keltirilgan. Ushbu usullardan foydalanishni avtomatlashtirish uchun gistologik tasvirlarni tahlil qilish uchun foydalaniladigan dasturiy vosita yaratildi.

Ta’riflangan segmentatsiya usullari, shuningdek, sohalarni nishonlash va ularning turli xarakteristikalarini olish uchun tavsiya etilgan usullar tibbiy diagnostika va ilmiy tadqiqotlarda muhim istiqbolga ega bo‘lgan tahlillarni avtomatlashtirish va aniqligini oshirishning muhim vositasi sifatida xizmat qilishi mumkin.

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CHUQUR O‘QITISH ALGORITMLARI ASOSIDA KO‘ZI OJIZ INSONLAR UCHUN AQLLI BOSH KIYIM ISHLAB CHIQISH

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Annotatsiya: So‘nggi yillarda Sun’iy intellekt (SI) texnologiyalari yuqori darajada rivojlandi va turli sohalarda, jumladan, banklarda, elektron pochta boshqaruvida, tibbiyotda va boshqa ko‘plab sohalarda qo‘llanilmoqda. Ushbu tadqiqotning asosiy maqsadi ko‘rish qobiliyati zaif (ko‘r) insonlarga SI texnologiyalaridan foydalangan holda yordam berishdir. Ko‘rlik tabiiy hodisa, ammo ko‘r insonlarning dunyoni ko‘rish qobiliyatiga ega bo‘lgan insonlarga o‘xshash his qilishlariga to‘sqinlik qilmasligi zarur. Har xil to‘siqlar ularning rivojlanishiga to‘sqinlik qilmasligi uchun ular shunday aniqlik bilan yurishi yoki kundalik vazifalarni bajarishlari kerak. Odatda, ko‘r inson to‘siqlarni aylanib o‘tish uchun oq tayoqdan foydalanadi. Texnologik taraqqiyot aqlli bosh kiyimlarni ishlab chiqish imkoniyatini taqdim etadi, bu ko‘zi ojiz insonlarga potensial xavflarni oldindan bilishga yordam beradi. Ushbu maqolada ko‘r insonlar yo‘llarni, obyektlarni va QR kodlarni aniqlashda duch keladigan qiyinchiliklar tahlil qilindi va olib borilayotgan tadqiqotlar taqdim etildi.

Kalit so‘zlar: ko‘zi ojiz inson, sun’iy intellekt, aqlli bosh kiyim, chuqur o‘qitish.

DEVELOPMENT OF SMART HEADWEAR FOR BLIND PEOPLE BASED ON DEEP LEARNING ALGORITHMS

Abstract: In recent years, Artificial Intelligence (AI) technologies have advanced greatly and are being used in various fields, including banking, email management, medicine, and many others. The main goal of this research is to help visually impaired (blind) people using SI technologies. Blindness is a natural phenomenon, but it should not prevent blind people from experiencing the world in the same way as sighted people. They need to walk or perform daily tasks with such precision that various obstacles do not hinder their development. Usually, a blind person uses a white cane to get around obstacles. Technological progress offers the possibility of developing smart headgear, which helps blind people to anticipate potential dangers. In this article, the difficulties faced by blind people in identifying roads, objects and QR codes were analyzed and ongoing research was presented.

Keywords: blind person, artificial intelligence, smart headgear, deep learning.

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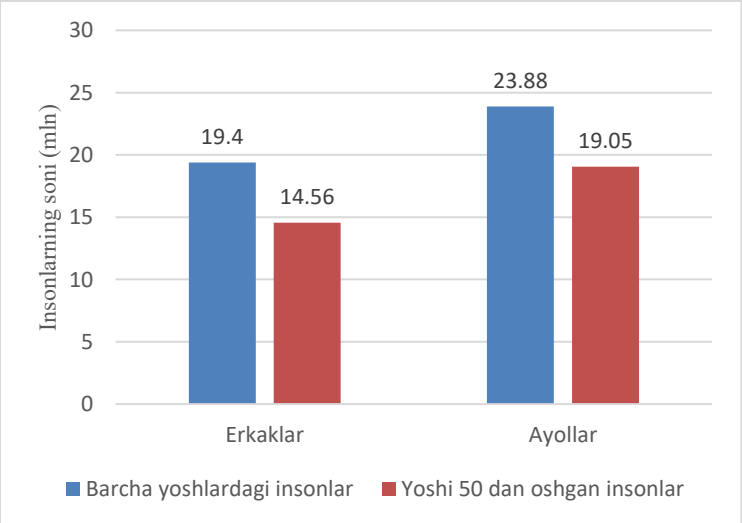
Kirish

Texnologiyalar bizning ishlash, yashash va muloqot qilish uslubimizni o‘zgartirdi. SI haqida to‘liq tushunchaga ega bo‘lmagan ko‘rish qobiliyati zaif insonlar ko‘plab veb-saytlarga kira olmaydi va mobil telefonlaridan foydalana olmaydi. Ko‘pgina Internet buyumlari ko‘rish qobiliyati zaif insonlar uchun mavjud emas [1]. SI hujjatlarni o‘qiy oladi va sarlavhalar, paragraflar va ro‘yxatlar kabi tizimli elementlarni tushuna oladi, shu bilan foydalanuvchilarga ovozli signallar yordamida hujjatlarni tezda boshqarish imkonini beradi. Shuningdek, u boshqa ilovalardagi fotosuratlarni ham taniy oladi [2].

Yigirma birinchi asrning eng e’tiborga molik yangiliklari orasida ko‘zi ojizlar insonlar uchun o‘zini bir joydan ikkinchi joyga ko‘chirish va texnik vositalardan mustaqil foydalanish imkonini beruvchi o‘zini o‘zi boshqaradigan va avtomatik transport vositalari muhim ahamiyatga ega. Xavfsizlik nuqtai nazaridan, sun’iy intellektga to‘liq ishonish mumkin emas, lekin u insonlarni qutqarish qobiliyatiga ega va to‘qnashuvlar hamda to‘siqlar oqibatlarini yumshatishga yordam beradi [3].

Foydali texnologiya jamiyat va insoniyatga foyda keltiradigan texnologiyadir. Ko‘zi ojiz insonlar kundalik vazifalarni bajarishda, ayniqsa harakatchanlik haqida gap ketganda, qiyinchiliklarga duch kelishadi, chunki ularning yo‘lida potensial xavfli to‘siqlar bo‘lishi mumkin. Odatda, ular yer yuzida harakat qilish va eng xavfsiz marshrutni topishga yordam berish uchun oq tayoqdan foydalanadilar. Oq tayoq foydali, ammo yaqin atrofdagi to‘siqlarni, masalan, ko‘cha to‘siqlarini aniqlash qiyin. Texnologiya insoniyat hayoti uchun tobora zarur bo‘lib borayotgan bugungi dunyoda oq tayoq ko‘rlar uchun funksiyasini yaxshilash uchun aqlli bo‘lishi mumkin.

Ko‘rishning buzilishi butun dunyo bo‘ylab ko‘plab insonlarga ta’sir ko‘rsatadigan muhim muammolar bo‘lib, Irlandiya Ko‘zi ojizlar Milliy Kengashi ma’lumotlariga ko‘ra, 1-rasmda ko‘rsatilganidek, millionlab ko‘r insonlar normal turmush tarzini olib bora olmaydilar. Ko‘rish qobiliyati zaif bemorlar jiddiy yordamga muhtoj. Zamonaviy texnologiyalar va sun’iy intellekt yordamida bu bemorlar o‘z hayotlarini yaxshilash uchun innovatsion yondashuvlarni ishlab chiqish uchun alohida ish va e'tibor talab qiladi. Ko‘zi ojiz insonlar tanish ko‘chalarda harakat qilishda qiynaladi va ular hayotni yaxshilaydigan texnologiyalarni talab qiladi. SIga asoslangan yechimlar ko‘rish qobiliyati zaif bemorlarning hayotini yaxshilashi mumkin. Ushbu tadqiqot ko‘r insonlarga yo‘lni kesib o‘tishga va aqlli shaharlardagi narsalarni aniqlashga yordam berish uchun aqlli bosh kiyimlardan foydalanishni taklif qiladi.



1-rasm. Dunyodagi ko‘zi ojiz bo‘lgan insonlar soni.

Aqlli shaharlar ko‘r insonlarning hayotini o‘zgartirishi mumkin. Jamoat joylaridan foydalanish imkoniyati ko‘zi ojizlar uchun aqlli shaharlarning muhim xususiyatidir. Taklif etilayotgan aqlli bosh kiyim texnologiyasi nogironlar uchun qulay muhit yaratishga yordam beradi. Ovoz signallari bilan aqlli svetoforlar ko‘r insonlarga gavjum chorrahalarni kesib o‘tishga yordam beradi va ko‘r insonlar aqlli jamoat transporti tarmoqlari uchun real vaqt rejimida avtobus va poezdlar jadvali yordamida sayohatlarini rejalashtirishlari mumkin.

Aqlli shaharlar ko‘rlarga ma’lumot beradi. Ko‘zi ojiz insonlar QR kodlarini skanerlash va raqamli ma’lumotlar bilan o‘zaro aloqada bo‘lish uchun aqlli bosh kiyimga ulanish uchun smartfonlaridan foydalanishlari mumkin. Bu ko‘r insonlarga aloqada bo‘lishga va ma’lumotlarga kirishga yordam beradi. Aqlli shaharlar, shuningdek, ko‘zi ojiz insonlarga ichki makonlarda harakat qilish imkonini beradi. Ko‘zi ojiz insonlar notanish binolarda ovoz bilan faollashtirilgan ichki navigatsiya tizimlarining audio yo‘nalishlari va tavsiflari bilan harakat qilishlari mumkin.

Tadqiqotlar tahlili

Ko’rishni buzilishi bu ko‘zga ta'sir qiladigan anatomik deformatsiyalar, kasalliklar yoki yaralar natijasidir [4]. Jahon sog‘liqni saqlash tashkiloti (JSST) ma’lumotlariga ko‘ra, nogironlik bu funksiyaning yo‘qolishiga olib keladigan va bemor uni normal bajara olmaydigan disfunksiyadir. Bu jismoniy, aqliy yoki ikkalasi ham bo‘lishi mumkin bo‘lgan cheklovdir [5]. Biroq, tadqiqotchilar ko‘rish qobiliyati zaif insonlar kundalik hayotini samarali boshqarishi mumkinligini aniqladilar.

Ko‘rish qobiliyati zaif bemorlarga hayotda duch keladigan to‘siqlarni yengib o‘tishda yordam berish uchun sun’iy intellektga asoslangan yechimlarni qabul qilish bo‘yicha ko‘plab olimlar tomonidan bir nechta tadqiqotlar o‘tkazildi. SI odatda inson aqlini talab qiladigan funksiyalarni bajara oladigan aqlli mashinalarni ishlab chiqish bilan shug‘ullanadigan kompyuter fanining katta sohasini ifodalaydi. Biroq, mashinali o‘qitish va chuqur o‘qitish evolyutsiyasi texnologiya sanoatining deyarli barcha sohalarida paradigma o‘zgarishiga olib keldi, shu bilan birga shifokorlar va bemorlarga bir vaqtning o‘zida yordam berdi [6]. Aksariyat insonlar sun’iy intellektning konventsiyasi va uning kundalik hayotimizni o‘zgartirish hamda osonlashtirish qobiliyati bilan yaxshi tanish emas. Nogironlar ko‘pincha qo‘rquv, rahm-shafqat, noqulaylik aybdorlik bilan munosabatda bo‘lishadi [7].

Smartfon ko‘rish qobiliyati zaif foydalanuvchilarga yordam berishga qodir kuchli vositadir. Masalan, hujjatlarni smartfon kamerasi ostiga qo‘yish orqali ko‘zi ojiz insonlar elektron pochta xabarlarini o‘qiy oladi. Misol uchun, Amazonning Alexa kabi virtual shaxsiy yordamchilari harakatchanligi cheklangan insonlarga faqat ovoz yordamida uyidagi hamma buyumlarni boshqarishda yordam berishi mumkin. “Seeing AI” bu ko‘r va zaif ko‘ruvchilar hamjamiyatiga mo‘ljallangan bepul ilova vositasi. Bu yaqin atrofdagi insonlar, obyektlar va matnlarni tasvirlash orqali vizual dunyoni ochish uchun sun’iy intellektdan foydalanadigan davom etayotgan tadqiqot loyihasining natijasidir. Ko‘rish qobiliyati cheklangan insonlarga yangi texnologiyalarni loyihalashda yordam berish uchun bir nechta yechimlar taqdim etilgan. Tadqiqotchilar yangi SI tizimlarini yaratishda ijtimoiy ishtirok, himoya, mustaqillik va navigatsiyani taklif qilishdi [8].

Boshqa tadqiqotda alohida ehtiyojli insonlarning imkoniyatlarini kengaytirish uchun axborot kommunikatsiya texnologiyalaridan foydalanish ko‘rib chiqildi [9]. SI, shuningdek, ko‘rish qobiliyati zaif insonlarga tasvirlarni tushuntirish orqali yordam beradi. Biroq, sun’iy intellektning nutq taraqqiyoti nafaqat ko‘rish imkoniyati cheklangan insonlarga tegishli.

Speech-to-text va text-to-speech texnologiyasi bemorlarga ko‘proq muloqot qilish imkonini beradi. Bir nechta sun’iy intellekt texnologiyalari ko‘rish qobiliyati zaif insonlarga belgilar va landshaft matnlarini tanib olishga va ko‘proq harakatchanlik bilan yanada qulayroq yashashga yordam beradi. Uy SI texnologiyasi xavfsizlikni yaxshilaydi va aqlli uylar kimdir qulab tushsa yoki favqulodda xabardor qilishi mumkin. Obyekt va tasvirni identifikatsiya qilish e’tiborni tortdi, tasvir va obyektni tanib olish muhimdir.

Metadologiya

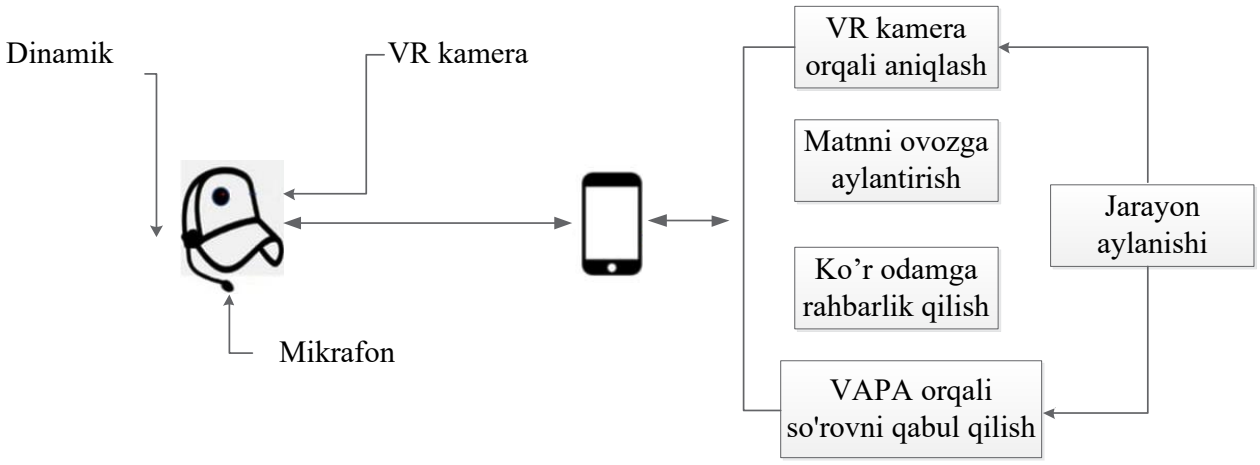
A. Ma’lumotlar to‘plami

Ushbu tadqiqot nogironlarga turli obyektlarni aniqlashga va real vaqt rejimida aqlli shaharlarning afzalliklaridan foydalanishga yordam berishga qaratilgan. Aqlli bosh kiyim VR texnologiyasini qo‘llab-quvvatlaydigan standart kamera, shuningdek, mikrofon va spiker bilan jihozlangan. Model Common Objects in Context (COCO) ma’lumotlar to‘plami bilan o‘qitildi va obyektlarni quyidagi uchta bosqichda aniqlash mumkin:

1. Kamera, mikrofon va spikerni ushbu funksiya uchun maxsus ishlab chiqilgan ilovaga ulash; VR kamerasi yuqori darajadagi ishonchni ta'minlagan YOLO algoritmi yordamida real vaqt rejimida obyektlarni suratga olishga va ularni aniqlashga muvaffaq bo‘ldi.

2. Dasturiy ta’minot obyektlarni aniqladi va matnni tanib olish va aylantirish uchun Text-to-Speech (TTS) algoritmidan foydalandi. TTS algoritmlari yozma matnni sinchkovlik bilan o‘rganish, tasniflash va talqin qilish uchun tabiiy tilni qayta ishlash (NLP) usullarini qo‘llaydi, so‘ngra matnning eshitish orqali ifodasini yaratish uchun nutq sintezidan foydalanadi.

3. Ovoz bilan faollashtirilgan shaxsiy yordamchilar (VAPA) ko‘zi ojiz insonlarga muloqot jarayonida yo‘l-yo‘riq ko‘rsatishi, ularni to‘g‘ri yo‘nalishga yo‘naltirish va qaror qabul qilishga yordam beradi, chunki ular oldida nima borligini aniqlashga harakat qiladi.



2-rasm. Taklif etilgan model

B. Jarayon

COCO ma’lumotlar to‘plami turli xil obyektlarning 50 dan ortiq tasvirlarini o‘z ichiga oladi. Quyidagi uchta sinf ko‘rib chiqiladi:

✓ Yo‘l harakati: Bu sinfda svetoforlar, yo‘lni kesib o‘tish belgilari va boshqalar kabi barcha yo‘l harakati yo‘riqnomalari mavjud.
✓ Obyektlar: Bu sinfda stol, stullar va boshqa turli xil obyektlar mavjud.
✓ Hayvonlar: Bu sinfda it, mushuk va boshqa hayvonlarning har xil turlari mavjud.

Ushbu turkumlash jarayoni COCO ma’lumotlar bazasida ko‘pchilik obyektlarni taqsimlash standartiga asoslanadi. Konvolyutsion neyron tarmog‘i (CNN) algoritmi tanib olingan tasvirni tasniflash va uni kelajakda olish uchun saqlashga qodir. Ular avtonom tarzda o‘rganish va tasvirlardan xususiyatlarni ajratib olish uchun mo‘ljallangan, ular keyinchalik tasvirlarni turli toifalarga belgilash uchun ishlatiladi. CNNlar bir nechta qatlamlarga ega, shu jumladan konvolyutsion qatlamlar, birlashtiruvchi qatlamlar va ularning asosiy tuzilishi sifatida to‘liq bog‘langan qatlamlar.

Tarmoq qirralar, burchaklar va teksturalar kabi xususiyatlarni ajratib olish uchun konvolyutsion qatlamdagi kirish tasviriga filtrlar to‘plamini qo‘llaydi. Keyin birlashtiruvchi qatlam o‘lchamlarini kamaytirish uchun xususiyat xaritalarini namuna oladi. To‘liq bog‘langan qatlamda tarmoq ushbu xususiyatlardan foydalangan holda tasvirni bir yoki bir nechta toifalarga ajratadi. Ushbu algoritm yordamida tasvirlarni tasniflash uchun CNN belgilangan tasvirlar to‘plamiga o‘rgatilgan bo‘lishi kerak. O‘quv jarayonida tarmoq turli toifalarga mos keladigan tasvir timsollarini aniqlashni o‘rganadi. O‘qitilgandan so‘ng, CNN yangi tasvirlarni tarmoq orqali o‘tkazish va chiqish asosida ularning toifalarini aniqlash orqali tasniflash uchun ishlatilishi mumkin. TensorFlow va Keras kabi chuqur o‘rganish tizimlarida CNNlarni amalga oshirishda ko‘plab kutubxonalar mavjud.

CNNni tenglama yordamida ifodalash mumkin (1):

$$y = f(W * x + b) \tag{1}$$

bu yerda y chiqish, x kirish, W vazn matritsasi, b egilish vektori va f faollashtirish funksiyasi. * operatori W va x o‘rtasidagi konvolyutsiyani ifodalaydi.

Oddiy CNN arxitekturasida bu tenglama turli darajadagi mavhumlikni o‘rganish uchun turli vazn matritsalari va moyilliklari bilan bir necha marta qo‘llaniladi. Yakuniy chiqish qatlami bashorat yoki tasnifni yaratmaguncha, bitta qatlamning chiqishi keyingi qatlam uchun kirish bo‘lib xizmat qiladi.

Natija va Mulohaza

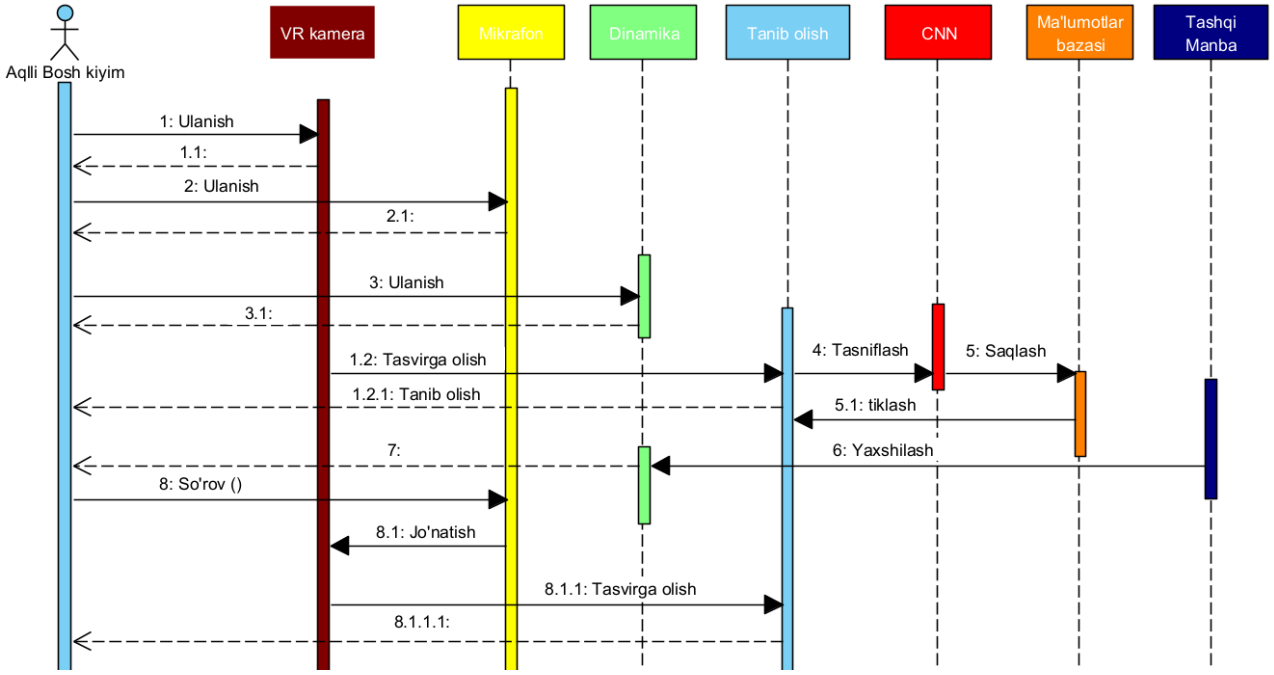
Tajribalar Python bilan uchta sinfga asoslangan turli obyektlarning integratsiyalashgan ma’lumotlar to‘plamidan foydalangan holda o‘tkazildi:

• Yo‘l harakati;

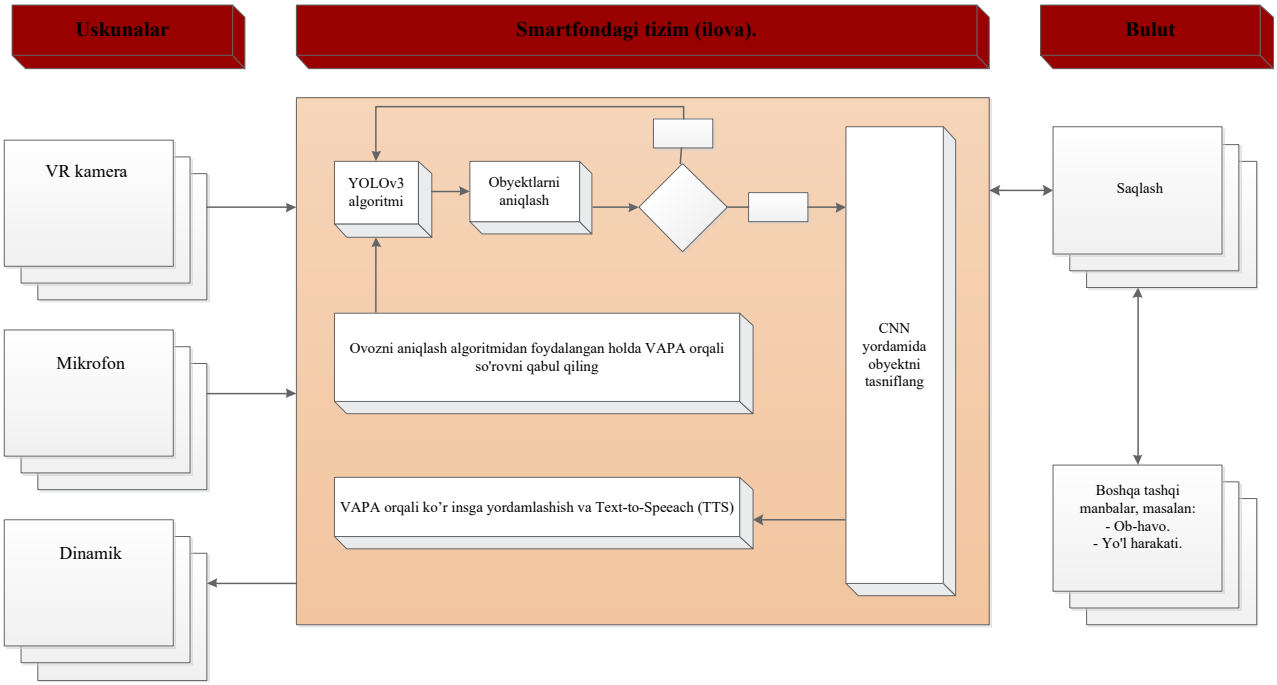
• Obyektlar;

• Hayvonlar.

Virtual reality (VR) kameralari texnologik dunyoda mashhurlik kasb etmoqda. Ular turli maqsadlarda, jumladan, o‘yin, turizm va ta’lim uchun ishlatilishi mumkin bo‘lgan 360 darajali yozuvlar va tasvirlarni olishlari mumkin. VR kameralarining eng diqqatga sazovor xususiyatlaridan biri bu turli obyektlarni ishonchli aniqlash qobiliyatidir. VR kameralarida obyektni aniqlash ilg‘or algoritmlar va mashinali o‘qitish usullari yordamida amalga oshiriladi.



3-rasm. Aqlli bosh kiyimning jarayonlari ketma-ketligi diagrammasi



4-rasm. Aqlli bosh kiyim arxitekturasi

3 va 4-rasmlarda, obyektlarni tanib olish uchun VR kamerasi YOLO algoritmi yordamida tasvirdan obyektlarni tanib uchun foydalanilgan. Mikrofon va kamerani o‘z ichiga olgan VAPA qurilmasi ko‘zi ojiz insonlarning so‘rovlari bilan ovozni aniqlash va TTS algoritmidan foydalanib, ularga o‘z vazifalarini bajarishda yordam berish uchun ishlatiladi.

1-jadval.

Turli obyektlarni aniqlash uchun ish vaqti natijalari

VR kamera orqali tasvirga olish va YOLO tomonidan aniqlangan	Vaqt/ishonch	Sinf
	4,5 soniya/Yuqori	Hayvonlar
	3,7 soniya/Yuqori	Yo‘l harakati
	3,2 soniya/Yuqori	Yo‘l harakati
	7,8 soniya/Yuqori	Obyektlar

Ushbu algoritmlar turli obyektlarning shakli, o‘lchami, rangi va tuzilishini aniqlash uchun to‘plangan tasvir va videolarni tahlil qiladi. Ularning aniqligini oshirish uchun algoritmlar obyektlar paydo bo‘ladigan konteksni ham hisobga oladi. ushbu tadqiqotda YOLO algoritmi nogironlarni normal hayotlarida baholash uchun qo‘llanildi.

VR kamerasi 1-jadvalda ko‘rsatilganidek, yuqori ishonch bilan obyektni aniqlaganda, obyekt qanday ko‘rinishda bo‘lishi ehtimoli yuqori. Ushbu yuqori darajadagi ishonch foydalanuvchilarga aniqlangan obyekt bilan turli yo‘llar bilan o‘zaro aloqa qilish imkonini beradi. Agar VR kamerasi xonadagi stulni aniqlasa, masalan, foydalanuvchilar unga o‘tirish yoki uni harakatlantirish orqali u bilan muloqot qilishlari mumkin.

VR qurilmalari bizning atrof-muhitni tasvirga olish va o‘zaro ta'sir qilish qobiliyatimizni inqilob qildi. Ularning turli obyektlarni ishonchli aniqlash qobiliyati yo’l harakati, obyektlar, hayvonlar va boshqa toifalar uchun yangi imkoniyatlar yaratdi. Umuman olganda, eksperimental natijalar shuni ko‘rsatdiki, CNN klassifikatori eng yaxshisi bo‘lib, turli obyektlarni to‘g‘ri sinfda tasniflash nuqtai nazaridan sezilarli ishonchlilik va ishlashni taklif qiladi. Bundan tashqari, natijalar shuni ko‘rsatdiki, YOLO algoritmining oldingi versiyasiga

nisbatan bir tasvirdagi turli obyektlarni tezroq aniqlashga qodir.

Xulosa

Ushbu maqola ko‘rish qobiliyati zaif insonlar aqlli shahar hududlarini samarali bosib o‘tishlari mumkin bo‘lgan vositalarni tushunishimizni kuchaytirishga qaratilgan. Obyektni tanib olish uchun tavsiya etilgan metodologiyaning samaradorligini tasdiqladi, bu nogironligi bo‘lgan insonlarga kundalik faoliyatini tabiiy va uzluksiz tarzda amalga oshirishga yordam beradi. Natijalar shuni ko‘rsatadiki, VAPA uskunasidan foydalangan holda CNN va YOLO kombinatsiyasi obyektlarni tanib, tez va ishonchli natijalarni taqdim etadi. Bu insonlarning o‘zaro ta'siri sohasida SIdan foydalanishni kengaytirishi mumkin.

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BARQAROR IQTISODIY O‘SISH SHAROITIDA AXBOROT-KOMMUNIKATSIYA TEXNOLOGIYA-LARINING O‘RNI

Annotatsiya: Ushbu maqolada bugungi kundagi barqaror rivojlanish sharoitida axborot-kommunikatsiya texnologiyalarining o‘rni ko‘rib chiqilgan va muxokama qilingan. Bugungi kunga kelib barqaror rivojlanish global davlatlar erishmoqchi bo‘lgan kun tartibi hisoblanib, unda Axborot-kommunikatsiya texnologiyalaridan (AKT) foydalanish mamlakatlarning barqaror rivojlanishiga asos bo‘lib xizmat qiladi. AKTning barqaror rivojlanishning har bir ko‘rsatkichlari bilan aloqasi boshqa o‘lchovlar mavjudligi bo‘yicha tahlillar shuni ko‘rsatmoqdaki, AKT mamlakatning barqaror rivojlanishi ko‘rsatkichlariga sezilarli darajada ijobiy ta’sir ko‘rsatadi. AKT iqtisodiy ko‘rsatkichlarga kuchli ta’sir ko‘rsatadi va iqtisodiy ko‘rsatkichlarga ta’siri orqali barqaror rivojlanishning ekologik va ijtimoiy o‘lchovini amalga oshirishga olib keladi. AKTning dunyoning eng chekka mamlakatlarga ham keng shaklda kirib borishi uning shu davlatning barqaror rivojlanishga erishishi uchun asosiy lakomativga aylanib kelmoqda. Shuningdek, barqaror rivojlanishning uch o‘lchovini muvozanatlash uchun katta hajmdagi ishlarni amalga oshirish talab etilmoqda.

Kalit so‘zlar: ICT, barqaror iqtisodiy o‘sish, iqtisod, ijtimoiy rivojlanish, atrof-muhit, konsepsiya.

THE ROLE OF INFORMATION AND COMMUNICATION TECHNOLOGIES IN SUSTAINABLE ECONOMIC GROWTH

Abstract: This article examines and discusses the role of information and communication technologies in today's sustainable development. To date, sustainable development is considered an agenda that global countries want to achieve, and the use of information and communication technologies (ICT) serves as the basis for sustainable development of countries. The analysis of the relationship of ICT with each of the indicators of sustainable development on the presence of other dimensions shows that ICT has a significant positive effect on the indicators of sustainable development of the country. ICT has a strong impact on economic performance and, through its impact on economic performance, leads to the realization of the environmental and social dimensions of sustainable development. The widespread penetration of ICT in the most remote countries of the world is becoming the main locomotive for the country's sustainable development. Also, a large amount of work is required to balance the three dimensions of sustainable development.

Keywords: ICT, sustainable economic growth, economy, social development, environment, concept.

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Kirish

Birlashgan Millatlar Tashkiloti (BMT) Bosh Assambleyasi 2015 yilning sentabr oyida 92 ta banddan iborat bo‘lgan 2030 yilgacha rivojlanish kun tartibini qabul qildi va uning 91-bandida 17 ta barqaror rivojlanish maqsadlari (BRM) hamda 169 ta boshqa tegishli maqsadlar belgilab olindi. Ushbu Nyu-Yorkda bo‘lib o‘tgan Birlashgan Millatlar Tashkilotining Barqaror rivojlanish sammitida 2030-yilgacha barqaror rivojlanish kun tartibi [1] tasdiqlandi. Ushbu sammit 2015 va 2030 yillar oralig‘ida barqaror rivojlanishga erishish uchun xalqaro hamkorlik uchun global va universal ko‘rsatkichlar bilan bog‘liq yangi ko‘rsatkichlar tizimini taklif qildi, shuningdek, ular jami 17 ta yangi Barqaror rivojlanish maqsadlarini (BRM) o‘z ichiga oladi (1-rasm).

Ushbu yangi kun tartibi haqiqatda 2000 yilda qabul qilingan Mingyillik Rivojlanish Maqsadlarini (MRM) davom ettiradi [2], ular asosiy guruhlar va fuqarolik jamiyatining keng ishtirokida a’zo davlat boshchiligidagi tartib orqali ishlab chiqilgan. Yangi BRM doirasida MRMni amalga oshirishdan olingan keng qamrovli tajribadan foydalanadi, shuningdek, qisman amalga oshirilmagan MRMlarni rivojlantirishga hizmat qiladi, shuningdek tenglik va shaxarlashtirish bo‘yicha yangi paydo bo‘layotgan muammolarni hal qilish orqali qo‘llab-quvvatlanadi.

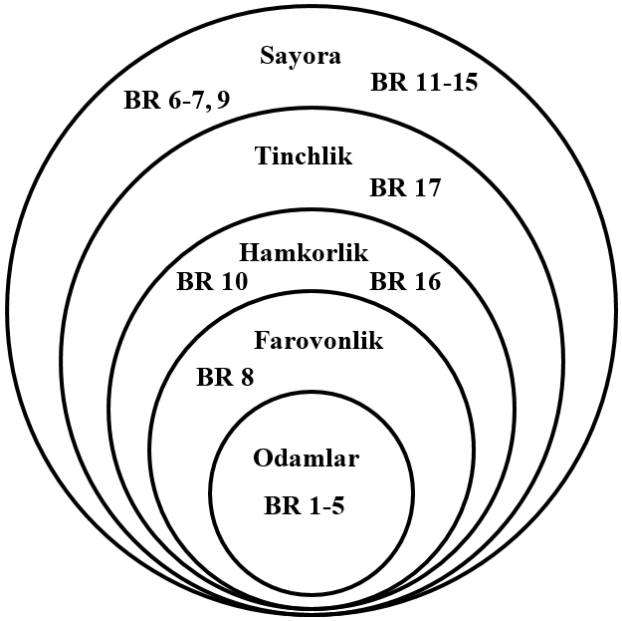
Ush jarayon global hamkorlikni yanada rivojlantiradi, shu bilan birga, MRMlarning uzluksizligi va konsolidatsiyasini aks ettiradi, shuningdek ekologik barqaror rivojlanishlarni mustahkamlash orqali yanada barqarorlikni oshirishga imkon beradi [3]. Garchi yuqorida keltirilgan 17 ta barqaror rivojlanishlarning hech biri, xususan, Axborot va kommunikatsiya texnologiyalariga (AKT) taalluqli bo‘lmasada shu bilan birga faqatgina bir nechta maqsadlarda AKT va tegishli texnologiyalar eslatib o‘tilgan bo‘lsada, Barqaror rivojlanish bo‘yicha 2030 kun tartibi hali ham AKT insoniyat taraqqiyotini sezilarli darajada tezlashtirishi mumkinligini alohida ta’kidlab o‘tgan [1].

Materiallar va usullar

Xalqaro elektraloqa ittifoqi (XEI) BMTning tegishli tashkilotlaridan biri bo‘lib, uning vazifasi butun dunyo bo‘ylab telekommunikatsiya xizmatlarini tashkil etishdan iborat. XEI barqaror rivojlanishni yaratishda AKTning muhim rolini namoyish qilish uchun katta kuch sarflamoqda.

1-rasm. 2030 yilgacha Barqaror rivojlanish kun tartibida qabul qilingan 17 ta rivojlanish maqsadlari [1]

XEI barqaror rivojlanishlarni o'lchash uchun foydalaniladigan ko'rsatkichlarni aniqlashda faol ishtirok etdi. Olingan 17 barqaror rivojlanish va 169 maqsad kelgusi yillarda insoniyat uchun ham, sayyoramiz uchun ham muhim bo'lgan ko'plab fanlar bo'yicha muhim harakatlarni rag'batlantiradi. Shuning uchun barqaror rivojlanish "5P" (Odamlar, Farovonlik, Hamkorlik, Tinchlik va Sayyora)ni o'z ichiga oladi (2-rasm).



2 – rasm. Barqaror rivojlanishning beshta asosi

AKT yuqoridagi barcha barqaror rivojlanish maqsadlarining asosiy lakomativi bo'lib va bu barqaror rivojlanishlarni amalga oshirish uchun juda muhimdir. AKT sohasidagi hozirgi tadqiqotlar va ishlanmalar ko'proq saqlash hajmi, hisoblash tezligi, hisoblash imkoniyatlari, aloqa va tarmoqlar kabi texnologik muammolarni o'rganishga qaratilgan. Barqaror rivojlanish yo'nalishidagi tadqiqot va ishlanmalar turli sohalar bo'yicha tadqiqotchilar o'rtasidagi hamkorlikni, shuningdek sanoat, hukumatlar va tashkilotlar bilan keng ko'lamli aloqa va hamkorlikni talab qiladi. Ushbu hamkorlik va aloqalar jamoaviy muhit, siyosat va qoidalarni o'rnatishga, shuningdek, yuqori samaradorlik bilan o'zaro ishonch, tan olish va bir-biriga majburiyat bo'lgan yangi tadqiqot madaniyatlarini yaratishga yordam berishi mumkin.

Barqaror rivojlanishda texnologik innovatsiyalar va rivojlanish uchun kuchli motivatsiyalar asosan 2015-yildan boshlab kuchli rivojlanishga olib kelib, unda yangi tadqiqot amalga oshirish va shuningdek, barcha mamlakatlada barqaror rivojlanishlarni qo'llab-quvvatlash uchun zarur bo'ladigan kengaytirilgan tadqiqotlarni moliyalashtirish imkoniyatlari kabi muhim afzalliklari sababli AKT sohalariga bo'lgan talab sezilarli darajada osha boshladi. Shundan kelib chiqib, ushbu 17 barqaror rivojlanishni qanday hal qilingani va nima yaxshi o'rganilmaganligini aniqlash uchun barqaror rivojlanishlarning AKTga aloqadorligi bo'yicha eng so'nggi yutuqlarni o'rganishga sabab bo'lmoqda. Yaxshi salomatlik (BR 3), Barqaror shaharlar (BR 11) va Iqlim harakati (BR 13) kabi AKTga tegishli bir qancha ishlar amalga oshorob kelinmoqda

Shuningdek, AKT butun iqtisod va jamiyatlarda o'zgarishlar uchun kuchli va keng tarqalgan kuch sifatida kirib kelmoqda va uni "Radio, televizor, uyali telefonlar, kompyuter va tarmoq apparat va dasturiy ta'minoti, sun'iy yo'ldoshni o'z ichiga olgan har qanday aloqa qurilmasi yoki ilovasini o'z ichiga olgan atamalar" orqali tushunishimiz mumkin [4]. Biroq, "AKT, Internet va barqaror rivojlanish" o'rtasidagi munosabatlar uchun "Yangi paradigma"

yo‘lida ishlashga intilishda [5]. “Barqaror rivojlanish va AKT/Internet davlat siyosati bilan shug‘ullanuvchi siyosatchilar va faollar o‘rtasida hayratlanarli darajada kam o‘zaro aloqalar bo‘lganini” ta’kidladi. Internetdagi davlat siyosati va muammolar turli tadqiqotlarda ko‘rib chiqilishi bilan bog‘liq bo‘lib, ular o‘rtasida juda oz almashinuv bo‘lgan [5]. Yevropa axborot texnologiyalari observatoriyasi (EITO) “AKTning jamiyat va madaniyatga tez kirib borishi natijasida barqaror rivojlanish uchun yaratilgan ta’sir va imkoniyatlarga” qiziqish ortib borayotganini ma’lum qildi.

Natijalar

Elektron Barqarorlik Global Tashabbusi AKT sanoatining bir qator muammolar, jumladan, iqlim o‘zgarishi bo‘yicha barqaror rivojlanishga qo‘shishi mumkin bo‘lgan hissasi haqida hisobot berib unda:

- chiqindilar va materiallardan foydalanish;

- AKTdan foydalanish;

- xodimlar bilan munosabatlar;

- iqtisodiy rivojlanishlar qayd etilgan [6].

AKT va barqaror rivojlanish o‘rtasidagi munosabatlarga analitik yondashuv uchun kontseptual asosni ishlab chiqish va “barqaror rivojlanishning me’yoriy kontseptsiyasi”ni ekologik, ijtimoiy va iqtisodiy o‘lchovlarga ajratish shu bilan birga AKT va barqaror rivojlanishni tahlil qilishni o‘z ichiga oladi [7]. Atrof-muhitga ta’sir darajasini rivojlanish uchun AKTning insoniy, ijtimoiy va ekologik muvofiqligini aniqlash. Ko‘plab o‘ziga xos muammolarga, shu jumladan aqlli barqaror shaharlarga e’tibor qaratuvchi “Ishlab chiqarish va iste’molning yanada barqaror modellarini rivojlantirish uchun AKTning transformatsion kuchidan” qanday foydalanish bo‘yicha quyidagilar mavjudligi ilgari surilgan [8]:

- ma’lumotlar markazlarining energiya talablari;

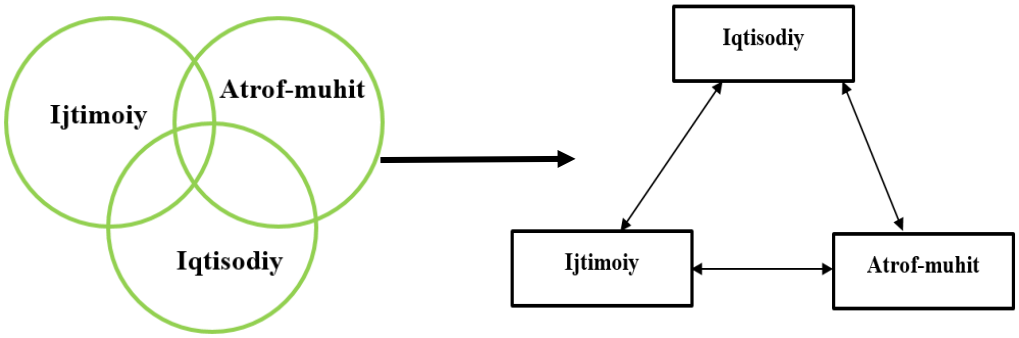
- ta’minot zanjirlari uchun dasturiy ta’minot;

- AKT uskunalarini qayta ishlash; internetning energiya intensivligi;

- energiya, axborot va o‘sishning o‘zaro bog‘liqligi.

Barqaror rivojlanish ustunlarining bir biriga bo‘lgan munosabatlari ikki tomonlama strelkalar yordamida tasvirlangan bo‘lib, ushbu tadqiqotda munosabatlar 3-rasmda tasvirlangan ta’sir yo‘nalishini ko‘rsatadigan o‘qlarga soddalashtirilgan.

Ushbu 3-rasm keltirilgan barqarorlikning uchta ustunining ta’siri iqtisodiyotdan atrof-muhitga, atrof-muhitdan ijtimoiy va ijtimoiydan iqtisodiygacha bo‘lishi mumkin yoki munosabatlar iqtisodiydan ijtimoiyga, ijtimoiydan atrof-muhitga va atrof-muhitdan iqtisodiygacha bo‘lishi mumkinligini ko‘rsatadi.



3-rasm. Barqaror rivojlanish kontseptsiyasi

Barqaror rivojlanishlar iqtisodiyot, jamiyat va atrof-muhitning turli jihatlariga aniq belgilangan ko‘rsatkichlarga ega bo‘lib so‘nggi olib borilayotgan tadqiqotlarda bir nechta toifalar ularni bir necha o‘lchovlarga tasniflash uchun ko‘rib chiqilmoqda [9, 10]. Shundan kelib chiqqan holda yuqorida keltirilgan yo‘nalishlarni aloxida ko‘rib chiqamiz:

Iqtisodiy o‘lchov: U iqtisodiy darajadagi barqaror rivojlanishga va shaxslarning farovonligi hamda ularni farovonligini hisobga olishga qaratilgan. Bu o‘lchov ikki nuqtai nazarga bo‘linadi:

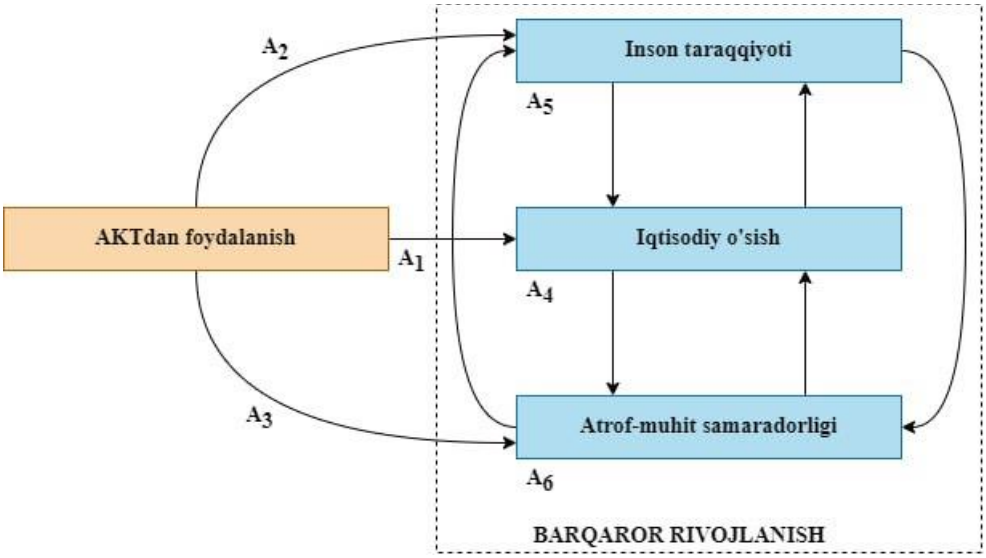
- qashshoqlikni qisqartirish, oziq-ovqat bilan ta’minlash va sog‘liq bilan bog‘liq hayot;

- iqtisodiy o‘sish, barqaror sanoatlashtirish va innovatsiyalar bilan bog‘liq iqtisodiy va texnologik rivojlanish.

Ijtimoiy o‘lchov: U jamiyatlarning tengligi, farovonligi va farovonligi nuqtai nazaridan barqaror rivojlanishga e’tibor qaratadi. Bu o‘lchov ikki istiqbolga bo‘linadi:

- barqaror jamiyatlar, tinchlik, adolat va global hamkorlik bilan bog‘liq ijtimoiy rivojlanish;

- ta’lim olish va ishga joylashishda tenglik, jins va boshqa omillar.



4-rasm. Barqaror rivojlanishga ta’sir etuvchi AKT kontseptual modeli

Atrof-muhit o‘lchovi: Bu barqarorlikni ta’minlash uchun atrof-muhitni saqlash va uning asosiy resurslarini boshqarish bilan bog‘liq. Bu o‘lchov ikki nuqtai nazarga bo‘linadi:

- resurslar, jumladan, suv, toza energiya, mas’uliyatli ishlab chiqarish va iste’mol;

- iqlim, quruqlik va suv osti ekotizimlariga asoslangan tabiiy muhit.

Barqaror rivojlanishni ikki tomonlama munosabatlar shaklida ko‘rib chiqiladi [11]. AKT ning hamma joyda mavjudligi uni barqaror rivojlanishga erishish yoki tezlashtirish vositasiga aylantiradi. Shuningdek, AKT barqaror rivojlanish ustunlaridan biriga ta’sir ko‘rsatishi mumkin va tarqalish effekti Barqaror rivojlanishning boshqa ustunlarida aks etadi. Shunday qilib, mamlakat uchun Barqaror rivojlanishga erishishda AKT iqtisodiy o‘sishga katta ta’sir ko‘rsatadi va barqaror rivojlanish ustunlari o‘rtasida o‘zaro bog‘liqlik mavjudligini aks ettiradi. Iqtisodiy o‘sish AKTning atrof-muhit ko‘rsatkichlariga yoki inson rivojlanishiga ta’sirida vositachilik qilishi mumkin. Yuqoridagi bayonotlarni hisobga olgan holda, AKT ning barqaror rivojlanishga ta’sirini ko‘rsatuvchi kontseptual model tasvirlangan (4-rasm). Barqaror rivojlanishning har bir ustunining AKT ning barqaror rivojlanishning boshqa ustunlari bilan ta’siri bo‘yicha vositachilik aloqalari quyidagicha faraz qilinadi:

A4: AKTdan foydalanish darajasi va mamlakatning iqtisodiy o‘sishi o‘rtasidagi bog‘liqlik mamlakatning atrof-muhit ko‘rsatkichlari yoki inson rivojlanishi bilan bog‘liq;

A5: AKTdan foydalanish darajasi va mamlakatning inson taraqqiyoti o‘rtasidagi bog‘liqlik vositachilik qiladi yoki mamlakatning ekologik ko‘rsatkichlari yoki iqtisodiy o‘sishga olib keladi;

A6: AKTdan foydalanish darajasi va mamlakatning atrof-muhit ko‘rsatkichlari o‘rtasidagi bog‘liqlik mamlakatning iqtisodiy o‘sishi yoki inson rivojlanishi bilan bog‘liq hisoblanadi.

Xulosa

Shunindek, barqaror rivojlanishda raqamli texnologiyalar innovatsion tabiati bilan ajralib turadi. Ushbu texnologiyalar tez rivojlanish va turli sohalarga moslashish qobiliyatiga egaligi, ularning umumiy asosi sifatida yangi biznes modellarini keltirib chiqaradi. Xususan, sun’iy intellekt (AI) va uning atrofidagi raqamli texnologiyalar, masalan, katta ma’lumotlar, blokcheyn, bulut, virtual va to‘ldirilgan reallik va boshqalar jamiyatimizni inqilob qilib, uni to‘rtinchi sanoat deb ataladigan hozirgi davrda o‘zgartirishga turtki bermoqda. Aslini olganda, ushbu texnologiyalar global miqyosda o‘zgarishlar uchun ijtimoiy va iqtisodiy dastak sifatida birlashishi kutilmoqda.

Adabiyotlar

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O‘ZBEKISTON AVTOMOBIL-LARINING DAVLAT RAQAMINI TANIB OLISH ALGORITMI ISHLAB CHIQISH

Mualliflar

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Annotatsiya: Ushbu maqolada avtomashina raqamlarini avtomatik aniqlash (RAA), avtrotransport vositalarining tasvirini oladigan ommaviy kuzatuv tizimi va ularning litsenziya raqamini taniydigan dastur haqida so‘z boradi. Maqsad - loyihalash tomonidan samarali avtomatik avtotransport vositasini identifikatsiya qilish tizimini ishlab chiqish hamda uni amaliyotga joriy qilinishidir. Bunda biz bir nechta mustaqil tadqiqotlar olib bordik va ushbu loyiha uchun O‘zbekiston avtomobil raqamidan foydalandik.

Kalit so‘zlar: RAA, Lokalizatsiya, Segmentatsiya, Sun’iy Neyron Tarmoq, belgilarni optik aniqlash.

DEVELOPMENT OF AN ALGORITHM FOR LICENSE NUMBER RECOGNITION OF UZBEKISTAN CARS

Abstract: This paper discusses automatic license plate recognition (RAA), a public tracking system that captures images of vehicles and software that recognizes their license plates. The goal is to design and implement an effective automatic vehicle identification system. In doing so, we conducted several independent studies and used the Uzbekistan license plate for this project.

Key words: RAA, Localization, Segmentation, Artificial Neural Network, optical character recognition.

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Kirish

Raqamni avtomatik aniqlash (RAA)[1] haqiqiy tizim bo‘lib, belgilarni optik aniqlashda foydalanadigan vaqt jarayonida o‘rnatilgan dasturdir. Transport vositalaridagi davlat raqamlarini o‘qish uchun ularning rasmli formatlaridan foydalangan holda uni yo‘l qoidalariga rioya qilish kameralar orqali amalga oshirilgan. O‘zbekistonda ishlab chiqilgan bu tizim turli YPXti tomonidan elektron usul sifatida ishnining aniq va tezligini ta’minlash, shuningdek yo‘llardagi qoidabuzarliklar sodir etilganda qo‘llanilgan pul mablag‘larining ham osongina yig‘ilishini maqsad qiladi. Ammo bu tizimning chegaralangan tomoni shunda ediki, litsenziya raqamlari standartlari faqat shu mamlakat ichki imkoniyatlarini inobatga olgan holda raqam belgilari, fon va old fon rangi uchun raqam belgisi chegarasi, raqam belgisi o‘lchami va boshqalar raqamlarni mahalliylashtirish orqali chegaralangan edi.

Masalaning o‘rganilganlik darajasi.Bu tizim xorij tajribasida yuzaga kelgan bo‘lishiga qaramay, ularning istisno hollari ham mavjud. Bugun bu borada sun’iy intellekt va raqamlashtirish texnologiyalarining keng ildiz otib borayotgani natijasida biz ham ushbu loyihani mamlakatimiz imkoniyatlari asosida o‘rganib chiqishga qaror qildik. Biz bugun yondashuvlarga emas, balki ularning metodologiyasi asosida kichik toifalar asosida sinflab chiqdik.

Ishlab chiqilgan tizimning mohiyati

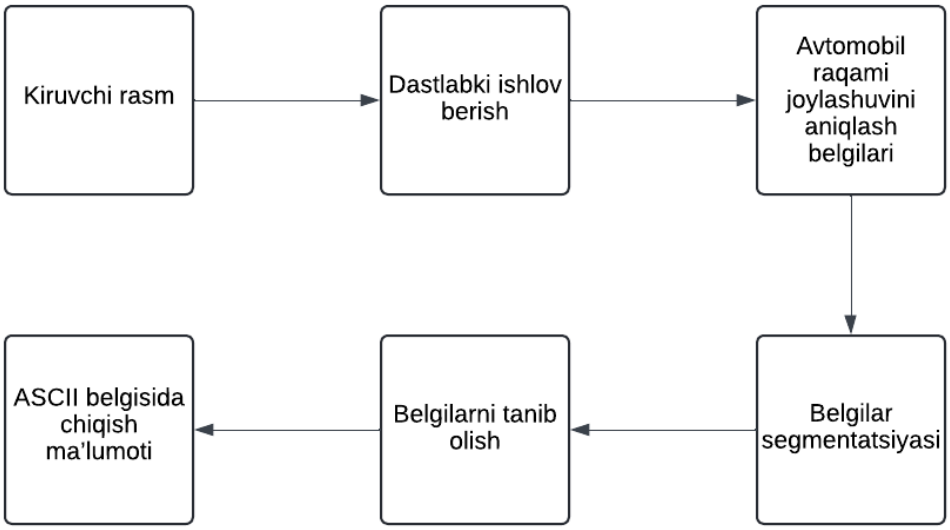
O‘zbekistonda raqam belgilarida RAA qilishda raqamlar va harflardan foydalanilgan va maxsus kodlashtirilgan. Natijada sonda keng farqlar yuzaga kelgan. RAA da mavjud shrift turi, belgilar o‘lchami va joylashuvi bo‘yicha plitalar raqam belgisi kiritilgan.[2],[3]O‘zbekistonda hozirgi paytda avtomobil raqamlari yangi formatdagi davlat raqamlari (1-rasm) bo‘lishi uchun quyidagilar kiritilgan:1.Viloyat kodeksi, 2. Birlamchi harf belgilari, 3.Raqam, 4. Ikkilamchi harf belgilari, 5. Mamlakat kodi.

1-rasm. Davlat raqami na’munasi

RAA tizimining algoritmida quyidagi bosqichlar inobatga olinadi:

1-qadam: Mashina tasvirini olish, tasvirni olish raqam belgisi, plastinka tasviridan belgini ajratib olish, raqam belgisini tanib olish va avtomobil raqami. Shu asosda avtotransport vositasi tasviri olinadi hamda turli xil algoritmlar bilan qayta ishlanadi.(2-rasm)

2-qadam: Ushbu plastinkani lokalizatsiya qilish algoritmiga asoslanadi. Avtomobil raqamining teksturaviy xususiyatlarini birlashtirgan va ichida o‘ziga xos shakllarga sezgir morfologik operatsiya yaxshi chegara qiymatiga ega bo‘lgan tasvirni kiritiladi shu asosida davlat raqami joylanib tegishli ma’lumotlar chiqib keladi. Lokalizatsiyalashda esa mamlakatning mavjud statistik ba’zasi litsenziya raqamlariga biriktiriladi.



2-rasm. Avtomobil raqamini tanib olish jarayoni.

3-qadam: Davlat raqami belgilarining segmentatsiyasi amalga oshirish. Davlat raqamining joylashuvi va binarizatsiyadan keyin segmentatsiya jarayoni litsenziya o‘rtasida asosiy vazifasini bajaradi. Plastinka lokalizatsiyasi va optik belgilarni aniqlash modullarining asosiy vazifasi - tanlangan belgilarni segmentlashdir. Har bir belgi yuborilishi mumkin bo‘lgan belgi tasvir uchun optik belgilarni aniqlash modullari alohida tanib olishi lozim.

4-qadam:Belgilarni tanib olish RAA ni aniqlashda yordam beradi va tasvir matnini tahrirlanadigan matnga aylantiradi. Ko‘pchilik kabi raqamlarni aniqlash algoritmlari bitta usuldan foydalanadi shuningdek shu avtotransport vositasi xarakterni tan oladi.

Ammo bu tizimning ham o‘ziga xos muammolari ko‘zga tashlanib qolgan edi. Avtotransport vositalarini raqamlashtirishdagi belgilar standart asosida emas va shrift turlari, script, o‘lcham hamda ranglar va raqamlardagi mutanosiblik yo‘q edi.

Ba’zi hollarda, boshqa raqam belgisiga kiruvchi bezaklar mavjud bo‘lib qolgan. Shunday bo‘lishiga qaramay, tizim O‘zbekiston raqamlari tanib olish jarayonini osonlashtiradi. Hozirda ham faqat qo‘lda yozish tizimlari va RAA ishlatiladi. RAA tizimi O‘zbekistonda tijorat maqsadida amalga oshirilmagan. Uning asosiy maqsadi loyiha sifatida amalda sinab ko‘rishdan iborat bo‘lgan. Biz ham bu borada raqamlarni tanib olish ular asosida avtotransport uchun xos xususiyatlar va imkoniyatlaridan kelib chiqqan holda guruhlash maqsadida ushbu loyiha ustida tadqiqotlar olib bordik va uni quyidagicha tartibli tarzda amalga oshirdik.

Avtomobil raqamini tasvirga olish

Bu jarayonda tizim amaliyoti yo‘lga qo‘yilishi mumkin bo‘lgan joylarga kuzatuv kameralarini o‘rnatish lozim. Bu har qanday ko‘rishga asoslangan tizimlarning birinchi bosqichidir.

Tasvirni qo‘lga kiritgandan so‘ng uni kulrang miqyosdagi (3-rasm) tasvir olinadi. Pseudo kod uchun rasmni kul rangga aylantirish amalga oshiriladi [4].Bunda esa raqamlashtirib yozilgan kodli vazifalar quyidagicha buyruqlar amalga oshiriladi.

1-qadam: Rasmni yuklash.

2-qadam: Tasvirning kenglik, balandlik kabi xususiyatlarini olish.

3-qadam: Jarayonga qadar kulrang rangga aylantirilgandan so‘ng tasvirni ko‘rsatish.

Olingan tasvirga oldindan ishlov beriladi.Oldindan ishlov berish uchun kirish kulrang shkalasi tasvir (4-rasm) hisoblanadi. Ushbu rasmda ham Otsu usuli yordamida ikkilik tasvirga moslashtirilgan. Bu usul bizning dasturimizga nisbatan ko‘proq mos keladi. Bu singari tasvirlarni aniqlashda Niblack usuli kabi boshqa adaptiv binarizatsiyadan o‘tkaziladi.

4-qadam: Binarizatsiyadan so‘ng o‘z ichiga olgan barcha obyektlarni olib tashlanadi. (Keltirilgan rasmning hajmi 30 pikseldan kam) Shovqinni olib tashlash uchun median filtridan foydalaniladi.

5-qadam: Tasvirning ulangan komponentlarini hisoblash tasvirni skanerlash, piksel (yuqoridan pastga va chapdan o‘ngga) bog‘langan piksel hududlarini aniqlanadi.

6-qadam: Tasvirdagi ulangan komponentlarni qidirish, ularning har biri ulangan komponentga tartibda maxsus yorliq beriladi va turli bog‘langan komponentlar farqlanadi

(5-rasm).

7-qadam: Har bir belgi o‘lchamini oldingi bosqichdan o‘zgartiriladi.Foydalanish uchun standart balandlik va kenglik belgilanadi va rasm ajratib olinadi.

8-qadam: Tasvir hududlarining xususiyatlarini chizmachilik orqali o‘lchash uchun alohida belgi va raqamlarni olish uchun chegaralovchi sirt olish jarayoni amalga oshiriladi(6-rasm).

Raqamli plita yoki lokalizatsiya

Lokalizatsiya jarayoni uchun bir qator algoritmlar taklif etiladi. Masalan Interlacing algoritmi, Furye domenni filtrlash va rangli tasvirni qayta ishlash bularga misol bo‘la oladi. Bu algoritmlar raqam belgilari o‘zbek tatqiqotchiligi uchun qoniqarli ishlamaydi.Har bir mamlakatning avtomobil raqamlarini mahalliylashtirish uchun quyidagi omillar inobatga olinishi lozim.

1. Plastinkaning o‘lchami: plastinka har xil o‘lchamda bo‘lishi mumkin .

2. Plastinkaning joylashuvi: plastinka har qanday joyda joylashgan bo‘lishi mumkin.

3. Plastinkaning foni: Plastinkaning foni har xil bo‘lishi mumkin.Ranglari va raqamlar avtomobil turiga qarab tanlanadi.. Masalan, hukumat avtomobil raqami jamoat transportlariga qaraganda turli fonga ega bo‘lishi mumkin.

4.Vint: Plastinkada vint bo‘lishi mumkin va bunda plastinka turli xil xarakter sifatida qaraladi.Navbatdagi bosqich median filtrlash va bog‘langan komponentlar hisoblanadi.

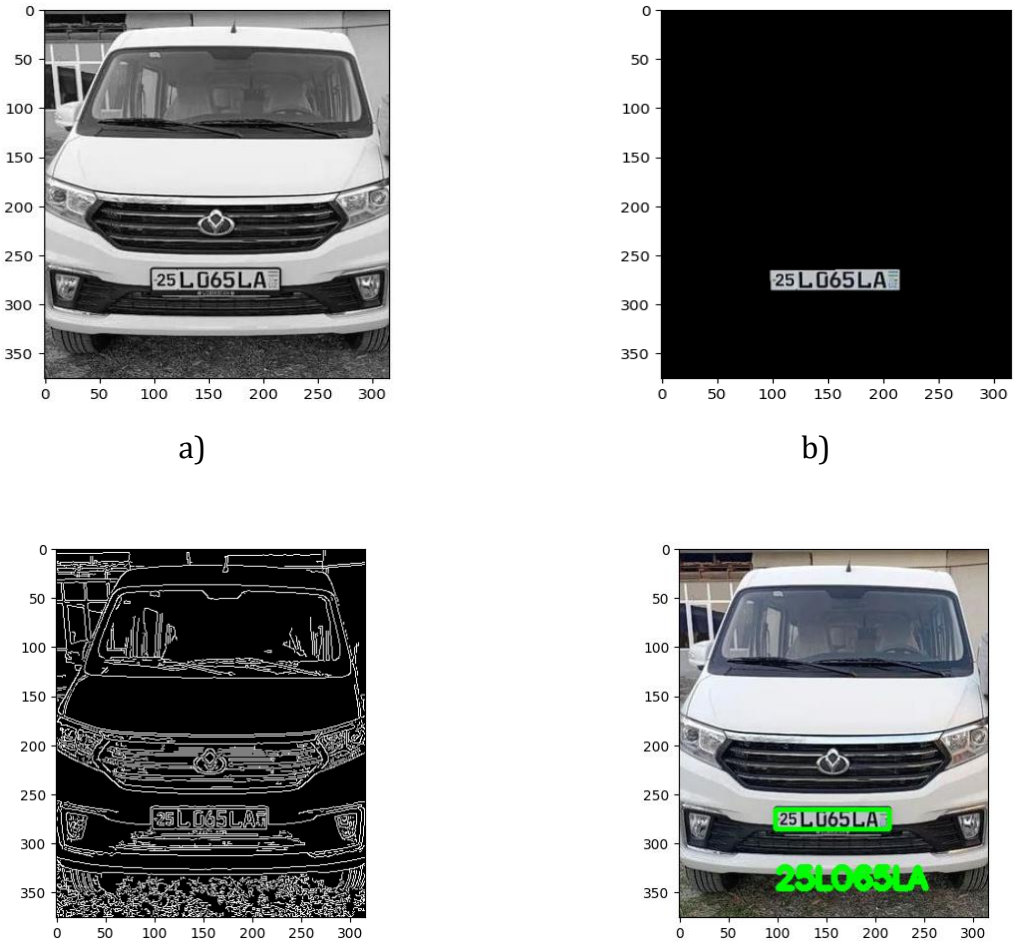
Bog‘langan komponentlar yorlig‘i tasvirni skanerlaydi va o‘z piksellarini piksel ulanishiga asoslangan komponentlarga guruhlaydi.Ya’ni ulangan komponentdagi barcha piksellar o‘xshash bo‘ladi. Piksel intensivligi xususiyatlar va qaysidir ma’noda bir-biri bilan bog‘liq bo‘ladi. Shundan keyin biz kiritgan raqam standart holga keltiriladi.

Davlat raqamini belgilarini segmentlashtirish

Belgilarni segmentatsiyalash jarayoni raqamini mahalliylashtirish va optik belgilarni aniqlash modullari o‘rtasida ko‘prik vazifasini bajaradi Uning asosiy vazifasi belgilarni qismlarga ajratishdir.Tanlangan belgilangan hududi har bir belgi optik belgilarni aniqlashga yuboriladi. Tanib olish uchun esa modul alohida bo‘ladi. Davlat raqami mahalliylashtirilgach uni individual belgilar olishga kirishamiz. Yuqorida aytib o‘tilganidek, davlat raqami mavjud yuqori intensivlikdagi o‘zgaruvchan hududlar mavjud. Bu uchun belgilar segmentatsiyasi asos bo‘ladi. Kuzatishlarimiz natijasida biz raqamlarning oq yoki qora ranglarda tanlanganini va

oxirgi bosqichda belgilarni tanitishga erishdik.

Taklif qilingan loyihada mamlakat tilini tanib olishi lozim va til belgilari bu borada muhim o‘ringa ega hisoblanadi. U obyektlarni aniqlash uchun ham ishlatilishi mumkin.Odatda yuzni aniqlash va tibbiy tasvirni qayta ishlashda keng qo‘llanilib kelinmoqda. U yana ikki qismga bo‘linadi: xususiyatga asoslangan moslashuv va shablonga asoslangan moslashtirish. Xususiyatga asoslangan yondashuv shablon tasviri kuchli xususiyatlarga ega bo‘lsa foydaliroq bo‘ladi. Statistikada 85% natijaga ga erishish uchun xususiyatni ajratib olish usuli qo‘llaniladi. Segmentatsiyadan so‘ng olingan rasm kulrang rangli tasvir hosil bo‘ladi. O‘qitish uchun ishlatiladigan dastlabki ishlov berish bosqichlarini amalga oshirish yetarli bo‘ladi.



a) b)

c) d)

3-rasm. Algoritm natijalari a) Kulrang tasvir,b) Otsu algoritmida olingan tasvir, c) Chegaralarni ajratish usulida olingan tasvir,d) Raqam aniqlangan tasvir

Xulosa

Ushbu taklif qilingan modelda oldindan ishlov berish va raqam belgisi mahalliylashtirish –“Otsu usullari” yordamida amalga oshirildi va mos ravishda “Xususiyatlarga asoslangan mahalliylashtirish usullari”dan foydalanildi. Bu tanlangan keng o‘zgarishlar binarizatsiya uchun qoniqarli natijalar berdi. Belgilar segmentatsiyasida yangi “Tasvir qaychi” algoritmidan foydalanildi. Bu optimallashtirishda ishonchlilik va vaqt beradi. Xarakterni qayta tashkil etish

uchun “Shablonlarni moslashtirish”dan foydalanildi. Algoritm natijasida umumiy aniqlik 80% foizni tashkil qildi. O‘ylaymizki, taklif qilingan bu dastur yaqin orada yurtimiz RAA tizimida sezilarli darajadagi qulayliklarni yuzaga keltiradi.

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RAQAMLI TEXNOLOGIYALAR: ASOSIY TUSHUNCHALAR, ZAMONAVIY DUNYOGA TA'SIRI VA MISOLLAR

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Annotatsiya: Maqolada raqamli texnologiyalar ning asosiy tushunchalari, ularning zamonaviy dunyoga ta'siri va misollar ko'rsatiladi. Raqamli texnologiyalar, ma'lumotlar va kommunikatsiya texnologiyalari, tizimlar va algoritmlar, internet, ishlab chiqarish va avtomatlashtirish, yashash muhiti va tibbiyot sohasida keng qo'llaniladi. Maqolada, raqamli texnologiyalar bilan bog'liq asosiy tushunchalar, ularning iqtisodiy, ijtimoiy, ma'naviy, o'quv-uslubiy va boshqa sohalardagi ta'sirini tahlil qilish uchun ilmiy manbalar va tadqiqotlardan foydalaniladi. Maqola zamonaviy dunyoda raqamli texnologiyalar ning o'rnini va rolini tushuntirish maqsadida yozilgan.

Kalit so'zlar: veb-sahifa, kompyuter, sun'iy intellekt, IoT, M2M, robototexnika, aqlli muhit, dronlar va boshqariladigan uskunalar.

DIGITAL TECHNOLOGIES: BASIC CONCEPTS, IMPACT ON THE MODERN WORLD AND EXAMPLES

Abstract: The article presents the main concepts of digital technologies, their impact on the modern world and examples. Widely used in digital technology, information and communication technology, systems and algorithms, internet, manufacturing and automation, environment and medicine. The article uses scientific sources and studies to analyze the main concepts related to digital technologies, their impact in economic, social, spiritual, educational and other fields. The article was written in order to explain the place and role of digital technologies in the modern world.

Keywords: web, computer, artificial intelligence, IoT, M2M, robotics, smart environment, drones and manned equipment.

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Kirish

Raqamli texnologiyalar faoliyatimizning barcha sohalariga kirib, hayotimizda tobora muhim rol o'ynamoqda. Ular bizga ma'lumot almashish, ishlash, ko'ngil ochish va yangi va qulay usullarda muloqot qilish imkonini beradi. Raqamli texnologiyalar, boshqaruv tizimlari, kompyuterlar, mobil qurilmalar va boshqa bir qancha texnik vositalar orqali yangi ma'lumotlarni kashf qilish, o'rganish va ularga murojaat qilish imkonini beradi. Raqamli texnologiyalar hayotning ko'plab sohalarida, shu jumladan biznes, ta'lim, tibbiyot, fan, o'yin-kulgi va boshqalarda keng qo'llaniladi.ular jarayonlarni avtomatlashtirish, ish samaradorligini oshirish, ma'lumot uzatishni tezlashtirish va katta hajmdagi ma'lumotlarga kirishni ta'minlash imkonini beradi [1]. Raqamli texnologiyalarning asosiy tamoyillari ikkilik sanoq tizimidan foydalanishni o'z ichiga oladi, bu erda ma'lumotlar nol va birlik sifatida taqdim etiladi va ma'lumotlarni qayta ishlash algoritmlari va dasturlaridan foydalaniladi. Raqamli texnologiyalarning asosiy turlariga Veb-saytlar, kompyuterlar, smartfonlar, planshetlar, ijtimoiy tarmoqlar, bulutli texnologiyalar, sun'iy intellekt, virtual va kengaytirilgan haqiqat, robototexnika va boshqalar kiradi [2].

Veb-sahifa. Internet o'zi raqamli texnologiyalarning bir nechta funktsiyasidir va veb-saytlar odamlar unga kirishning eng keng tarqalgan usullaridan biridir. Veb-saytlar bizga har xil ma'lumotlarni beradi va tobora interaktiv bo'lib bormoqda. Masalan, siz kinoteatr yoki televizorda sodir bo'layotgan har bir ko'rsatuvni veb-sayt orqali ko'rishingiz va chipta sotib olishingiz ham mumkin.

Kompyuter. Noutbuklar, planshetlar, ish stollari va boshqa turdagi kompyuterlar ishlash uchun raqamli texnologiyalarga bog'liq. Kompyuter texnologiyalari kompyuterlar va dasturiy ta'minot bilan ishlashning turli jihatlarini o'z ichiga oladi. Bunga dasturiy ta'minotni ishlab chiqish, ma'lumotlar bazalarini yaratish va boshqarish, operatsion tizimlar va tarmoqlar bilan ishlash kiradi.

Asosiy qism

Robototexnika. Raqamli robot texnologiyasi tobora takomillashib borishi bilan u keng qo'llanila boshlandi. Robot mashinalari allaqachon ishlab chiqarish sanoatida uchraydi. Ular, shuningdek, bomba aniqlash va zararsizlantirish kabi odamlar uchun xavfli bo'lgan vazifalarda ham qo'llaniladi. Shuningdek, olimlar tibbiy tekshiruvlar va protseduralarni amalga oshirish uchun inson tanasiga kiritilishi mumkin bo'lgan nanorobotlar, mayda robotlar ustida ishlashmoqda [3].

Sun'iy intelekt. Sun'iy intellekt (AI) raqamli texnologiyalar sohasi bo'lib, u intellektual qobiliyatlarni talab qiladigan vazifalarni bajarishga qodir kompyuter tizimlarini yaratishga qaratilgan. Bunga mashinani o'rganish, tabiiy tilni qayta ishlash, kompyuterni ko'rish va kompyuterlarga "o'ylash" va "qaror qabul qilish" imkonini beruvchi boshqa texnologiyalar kiradi. Bular raqamli texnologiyalarning asosiy turlaridan faqat bir nechtasi. Ularning har biri o'ziga xos xususiyatlarga va ilovalarga ega va ularning barchasi bizning zamonaviy hayotimizda muhim rol o'ynaydi [4].

Internet of Things (IoT). Internet of Things (IoT), raqamli texnologiyalar sohasidagi bir kontseptdir. IoT, ba'zi narsalar (qurilmalar, sensorlar, smart buyurtmalar, elektron vositalar va boshqalar) orqali ma'lumotlarni to'playdi, ularni o'zaro almashadi va ularga boshqa qurilmalar yoki tizimlar orqali aloqani ta'minlaydi. Bu, narsalararo aloqalar tarmog'ini o'rnatish orqali, narsalar o'rtasidagi ma'lumot almashishini, monitoringini va boshqarishini amalga oshiradi. IoT, narsalararo aloqa o'rnatish yordamida raqamli texnologiyalar bilan bog'liq bo'lib, narsalar

va sistemlar orasidagi ma'lumot almashishini, boshqarishini va avtomatlashtirishni osonlashtiradi [5].

Zamonaviy dunyoda raqamli texnologiyalarning roli. Zamonaviy dunyoda raqamli texnologiyalar, hayotimizning har bir sohasida katta o'zgarishlarni keltirib chiqarishda muhim bir rola ega. Quyidagi muhim sohalarda raqamli texnologiyalar o'z o'rnini topgan:

Kommunikatsiya. Raqamli texnologiyalar, global aloqalar va boshqa kommunikatsiya vositalari orqali insonlar, oilalar va do'stlar orasidagi aloqalarni kuchaytirishda muhim ahamiyatga ega. Telefonlar, internet, elektron pochta, ijtimoiy tarmoqlar va boshqa kommunikatsiya platformalari orqali, dunyo bo'ylab insonlar o'zaro habarlashish, ma'lumot almashish va aloqalarini o'rnatish imkonini topishdi [6].

Ish faoliyati. Raqamli texnologiyalar, ish faoliyati sohasini katta o'zgartirishga yordam berdi. Avtomatlashtirilgan tizimlar, ish uchun dasturlar, ma'lumotlar analizi, bulut xizmatlari va shaxsiy hisobotlash platformalari, ish muhitini samaraliroq qilish, ish jarayonlarini boshqarishni osonlashtirish va ishlar efektivligini oshirish imkonini berdi.

Transport. Zamonaviy avtoulovlarning asosiy qismida dvigatelni nazorat qilish va sozlash, xavfsizlik tizimlarini boshqarish, shuningdek qulaylik, qulaylik va xavfsizlik tizimlarini boshqarish uchun kompyuterlar mavjud. Qayiq va samolyot kabi boshqa transport vositalari o'zlarining ishlashi uchun kompyuterlarga yanada ko'proq ishonadilar. Texnologiya rivojlanishda davom etar ekan, o'z-o'zini boshqaradigan transport vositalarining odatiy holga kelishi vaqt masalasidir.

Tibbiyot. Raqamli texnologiyalar, tibbiyot sohasida katta o'zgarishlarni keltirib chiqardi. Teleradiologiya, telemeditsina, smart shifoxonalar, shaxsiy tibbiyot vositalari va mobil ilovalar orqali, ma'lumot almashish, tashhis qo'yish, monitoring va shifokorlar va mashinalar orasidagi aloqalarni o'rnatish imkonini berdi. Bu, tibbiyot sohasidagi xizmatlarni yanada yaxshilash, davolashni samaraliroq qilish va shifokorlar bilan foydalanuvchilar orasidagi aloqani kuchaytirishga yordam berdi.

Yashash muhiti. Raqamli texnologiyalar, yashash muhiti sohasida ham katta o'zgarishlarni keltirib chiqardi. Smart uy va smart energiya tizimlari, energiya boshqaruvini samaraliroq qilish va ishlatishni pasaytirish, resurslarni tejamli ishlatish va muhitni saqlash imkonini berdi. Smart avtomatiklar, smart oshxona uskunalari va boshqa smart qurilmalar, insonlarga yashash jarayonini qulayroq, xavfsizroq va mukammalroq qilish imkonini berdi.

Sog‘liqni saqlash. Raqamli texnologiyalar sog'liqni saqlashda muhim rol o'ynaydi. Ular kasalliklarni tashxislash, davolash va monitoringini yaxshilashga imkon beradi va tibbiy ma'lumotlarni yanada samarali boshqarishni ta'minlaydi. Ilovalarga misollar orasida teletibbiyotdan shifokorlar bilan masofadan maslahatlashish, bemorlarning sog'lig'ini kuzatish uchun tibbiy sensorlar va qurilmalardan foydalanish va tibbiy ma'lumotlarni tahlil qilish uchun sun'iy intellektdan foydalanish kiradi.

Ta’lim. Raqamli texnologiyalar ta'limda katta ahamiyatga ega bo‘ladi. Ta’lim olishingizda sizga ko‘plab qulayliklar yaratib beradi. Bularga misol sifatida: onlayn darsliklar, elektron platforma, darsni yaxshi o‘zlashita olmaganlar uchun soddalashtirilgan darsliklar, o‘zlashtirish uchun qulay darsliklar kabi ko‘plab imkoniyatlar yaratib beradi.

Dronlar va boshqariladigan uskunalar. Raqamli texnologiyalar uchun ko'plab harbiy maqsadlar mavjud. Dronlar (uchuvchisiz jangovar havo vositalari) va boshqariladigan raketalar samarali ishlash uchun raqamli texnologiyalarni o'z ichiga oladi. Uchuvchisiz samolyotlar odatda real vaqt rejimida uzoqdan qo'mondon tomonidan boshqariladi. Raketalar

raqamli texnologiyalarni boshqarish, nishonga olish va parvoz tizimlari uchun ishlatadi.

Jamiyatning turli sohalarida raqamli texnologiyalar muhim o'zgarishlarni keltirib chiqargani, insonlar orasidagi aloqalarni kuchaytirgan va har bir sohani yanada samarali va tezlashtirganligi bilan, zamonaviy dunyoda raqamli texnologiyalar hayotimiz uchun katta ahamiyatga ega.

Xulosa

Xulosa qilib aytganda, raqamli texnologiyalar bo'yicha umumiy tushunchalarni ta'riflash va tushuntirishga bag'ishlandi. Raqamli texnologiyalar, ma'lumotlar omborlari, matematik modellar, algoritmlar va boshqa raqamli qurilmalar orqali ma'lumotlarni saqlash, qayta ishlash va tarqatish uchun ishlatiladigan texnologiyalardir. Maqola, bu soha bo'yicha keng jihatdan ma'lumotlar beradi va qo'llanilgan misollar orqali umumiy tushunchalar ko'rsatadi.

Raqamli texnologiyalar umumiy tushunchalarni o'rganish uchun zamonaviy texnologiyalardan foydalaniladi va ularni o'rganuvchilar va so'nggi texnologiyalardan foydalanuvchilar uchun ma'lumotlarni oson tarqatishda yordam beradi. Maqola, bu sohaning asosiy ko'rsatuvchi tushunchalari, xususiyatlari va ularni amaliyotda qanday qo'llashni ta'riflaydi.

Shuni ta’kidlash kerakki raqamli texnologiyalar hayotimizda tobora muhim rol o'ynamoqda. Ular bizga ma'lumot almashish, ishlash, o'rganish va ko'ngil ochish imkonini beradi. Raqamli texnologiyalar tezlik, aniqlik va mavjudlik kabi ko'plab afzalliklarga ega. Shuningdek, ular bizga jarayonlarni avtomatlashtirish, hayot sifatini yaxshilash va yangi imkoniyatlar yaratish imkonini beradi. Kelajakda raqamli texnologiyalar rivojlanishda davom etadi va hayotimizning barcha sohalariga, sog'liqni saqlashdan tortib transportgacha kirib boradi. Shuning uchun zamonaviy dunyoda muvaffaqiyatli bo'lish uchun raqamli texnologiyalardan foydalanishga va o'zlashtirishga tayyor bo'lish muhimdir.

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ANALYSIS OF THE PROCESS OF DIGITAL TRANSFORMATION IN SMALL AND MEDIUM-SIZED ENTERPRISES

Abstract: This paper is based on the main impacts of the digital economy to small size business enterprises. And it is illustrates how increasing the role of ICT sector in among small to medium - sized business enterprises. Digital transformation (DT) is a critical driver of competitive advantage and operational efficiency for Small and Medium-Sized Enterprises (SMEs). This analysis examines the challenges, strategies, and outcomes associated with the DT process in SMEs. It integrates insights from academic literature, industry reports, and case studies to provide a comprehensive understanding of the phenomenon.

Keywords: digital transformation, digital economy, economy, enterprises, application, information communication technologies, global economy

Introduction

Beginning of the 21st century, the revolutionary impact of information and communication technologies manifested itself in a change in the way of life of people, in business, in a new approach to education, work, and in the interaction of government and civil society. Digital transformation (DT) is the process of redefining the entire business strategy by adopting the latest and emerging digital technology in driving the business through strategic plans and organizational change to augment the revenue and provide substantial value.

Digital transformation (DT) is the process of redefining the entire business strategy by adopting the latest and emerging digital technology in driving the business through strategic plans and organizational change to augment the revenue and provide substantial value.

Digital transformation has a growing impact on Small to Medium-sized Enterprises (SME) business and IT ecosystems and offers new and prolific opportunities to participate in the global economy. Enterprise Applications Providers, Technology and Infrastructure vendors have realized and capitalized on the power of innovative technologies like Cloud, Big Data, Mobile, Social, Sensors, etc., considering next-gen solutions are being developed with the nexus of these forces.

Expanding internet access and growing smartphone users are bound to change the future of the world economy. Yes, Digital transformation has brought a paramount shift to the traditional ways of manufacturing, handling, storing and transporting things.

Digital transformation lies in leveraging new technologies to ensure scalability and elasticity demanded by customers.

The most important objective of a business is revenue, the higher the revenue, the higher the growth of the business. A gigantic impact is seen in businesses after Digital transformation especially in terms of revenue. SMEs that adopted technology showed high profitability. It is proved that the profits of online businesses grew by 19% yearly and offline business revenue grew by 10% according to the KPMG report.

These stats clearly show that digital transformation has incentivized SMEs in terms of revenues.

Main part

Accessibility to Higher Customer Base

Having only the offline presence limits an enterprise form market reach. Customizing technology and having an online presence leads to remarkable opportunities for SMEs to grow and up their game in local and overseas markets.

Increased digital engagements allow SMEs to explore new markets, enabling them to compete with the top giants in the industry. E-Commerce platforms expand geographical boundaries by engaging in enhanced customer experience and provide support for better supply chain solutions. This allows companies to sell 24/7 and increase their customer base rapidly with limited operational costs.

An important observation is that 100% of India's high-web SMEs have e-commerce presence and 75% of the low-web SMEs have adopted online presence. A similar trend can be observed when drawing comparisons with other developing countries that can be seen in the below figure. This implies that even SMEs with a limited online presence and trifling in the developing markets are beginning to realize the potential of having an online presence.

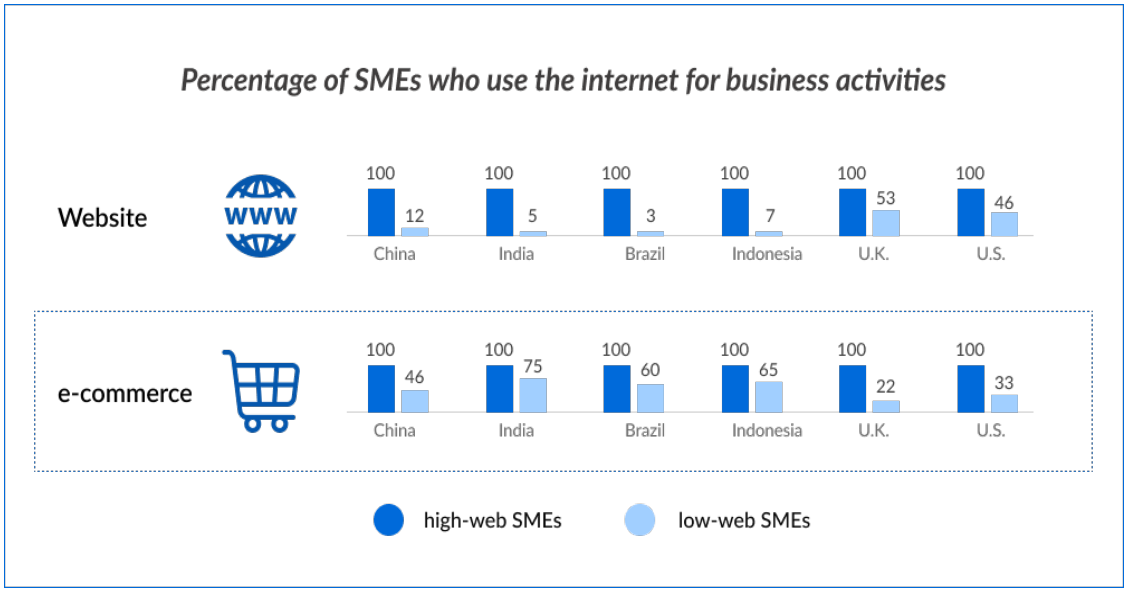

Figure 1. Percentage of SMEs who use the internet for business activities (Source: indianonlineseller.com)

True to the evidence! Forrester's Series report predicted that 2017 will see many organizations moving their focus on technology to enhance the customer experience. The report further added that the next wave of customer experience will impact companies, pointing to a clear correlation between customer experience and revenue growth. Cliff Condon, chief research and product officer at Forrester, once said "Our research shows that more than a third of all US online adults want new and engaging digital experiences. They will switch companies to find these experiences and being customer-obsessed can be your only competitive strategy."

A report by Tech Mahindra found that new digital technologies can reduce operational costs by 20 – 30 percent through improved capital and labour utilization.

Digital transformation allows SMEs to decrease overall expenditure by optimizing operational and marketing costs. IT-driven smart tools and techniques such as Information and Communication Technology (ICT), Digital Integrated Production Planning, Shop Floor Control, Supply Chain Solutions, Cloud-based ERP have increased the operational efficiency of SMEs in the current environment.

According to a Malaysian report on the “Digitalisation Survey of SMEs in 2018”, About 79.7% of the respondents realized the significance of ICT adoption and its role in improving business productivity and efficiency. The survey revealed that productivity is directly proportional to the utilization of digital tools. For example, SMEs that incorporated data management services to store, organize, store, display data of business operations, sales and customer information have seen productivity up to 60%, compared to SMEs that utilized e-business and social media initiatives that increased productivity to only about 27% and 26% respectively.

The figure below shows the usage of ICT among SMEs that mainly comes from personal devices, such as smartphones (91.4%), basic internet connection (90.1%) and computer or laptop (86.5%). The usage of back-end business processes, such as ERP and CRM are very low among SMEs.

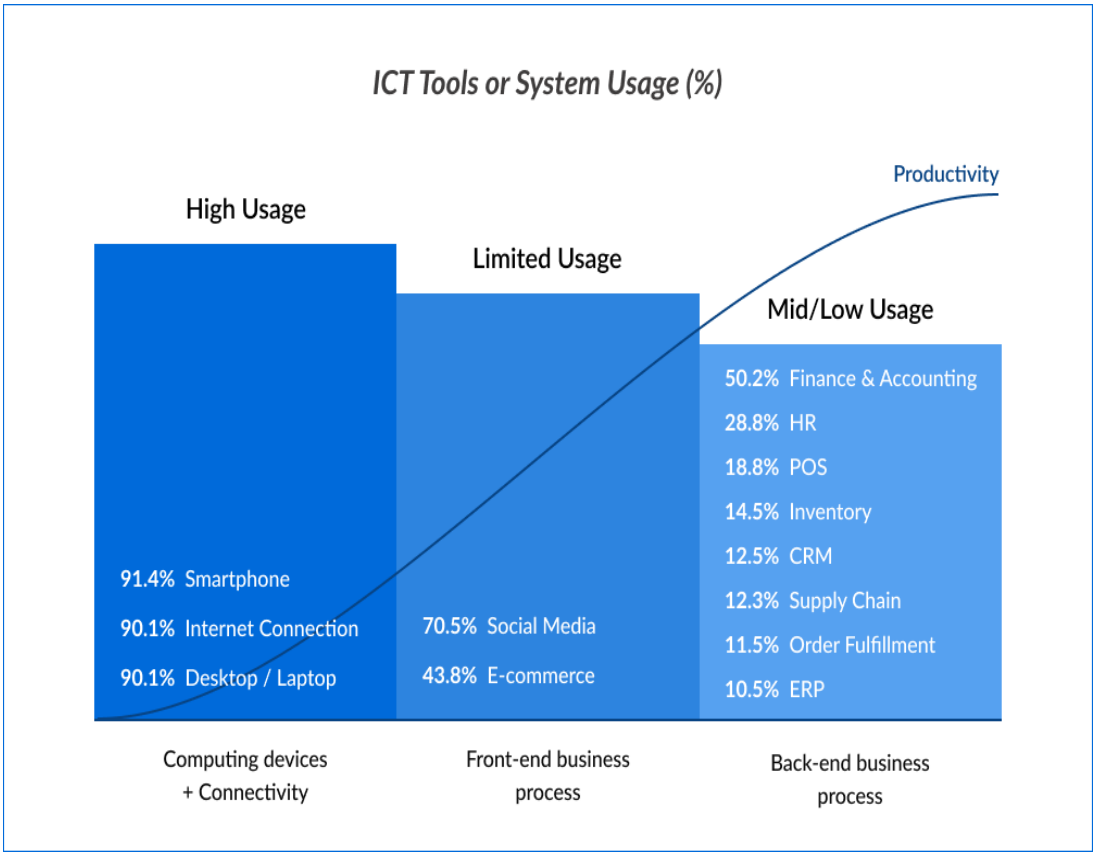

Figure 2. ICT Tools or System Usage (%) (Source: Digitalisation Survey of SMEs in 2018)

Business intelligence and data analytics have laid opportunities for SMEs to make better decisions by providing a deeper understanding of the customers. Using customer intelligence and insights to analyze and predict customer needs, designing new products that meet their requirements and clever delivery of the right products at the right time at a cost-effective price has revamped SMEs with next-generation customer engagement capabilities.

The advent of cloud-based solutions and freemium models, where basic software is provided for free, whereas functionality, virtual goods or proprietary functions may be charged; have enabled the SMEs to develop capabilities and enhance the customer experience.

SMEs play a vital role in the operations and profitability of E-Commerce platforms. Acknowledging this, E-Commerce giant Flipkart has signed MoU with the Federation of Indian Micro and Small and Medium Enterprises (FISME) and National Center for Design and Product Development (NCDPD) in 2014. This agreement allowed the website to provide infrastructural support in data analytics, marketing, and customer acquisition to help SMEs scale their business.

Nowadays, most of the young and talented entrepreneurs crave for innovation and are risk-takers. Many SME owners in recent times have entered the market with a dive into the online marketing methods with digital marketing as their primary source of acquisition as it promotes their business at a low cost. SMEs mainly use social media to promote their business. The ruling social media handlers that have helped businesses in the promotion are Facebook, Instagram, Google, etc. According to Statista, a market research report, about 65% of SMEs consider social media advertising effective and 51% of small enterprises rely on social media to grow their business.

“Digital marketing has made a huge impact on SMEs in terms of productivity”.

Some of the DM techniques that benefited SMEs:

Campaigns like CPC (Cost per Click) or PPC (Pay Per Click) modes can be utilized to achieve the desired results and to enhance profits for the SMEs.

Helped SMEs to search for flexible market potential in the global scenario which would directly affect their sales and make more profits.

Digital Marketing is considered to be the most cost-effective method to reach out to the targeted audience.

SMEs can also come in direct contact with the experts in this field who are in constant touch with the recent updates or advancements. By doing so, they can assure optimum ROI (Return on Investment).

With the use of effective DM techniques, SMEs are given the freedom to make the necessary changes in their ongoing online marketing campaigns as the need would arise.

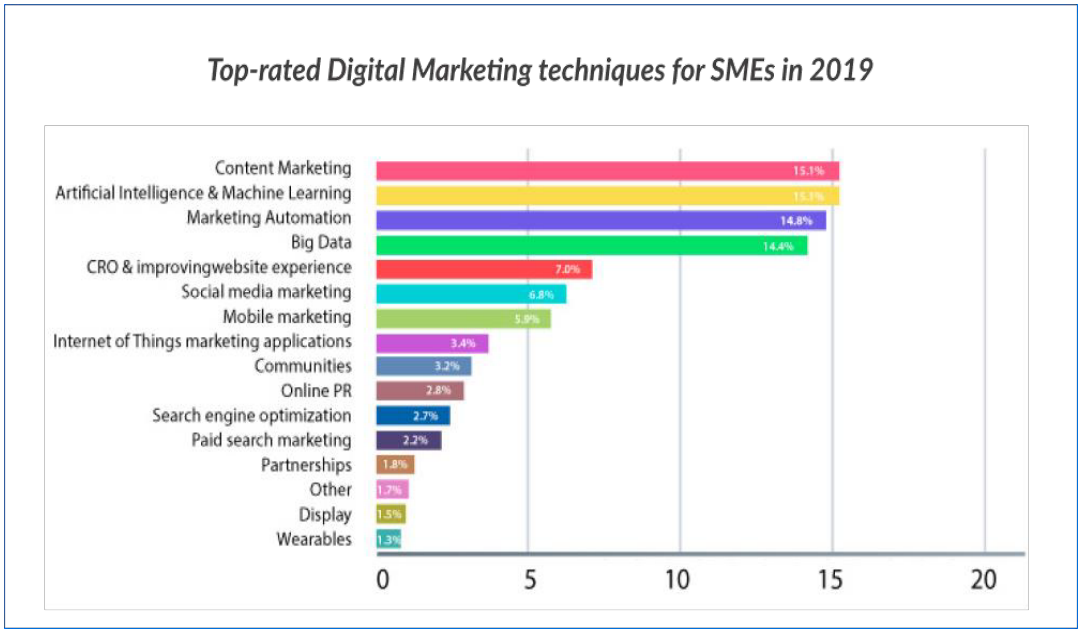

Figure 3. Top-rated Digital Marketing techniques for SMEs in 2009 (Source: smartinsights.com)

Conclusion

While digital transformation presents significant opportunities for SMEs, it requires careful planning and execution tailored to their unique constraints and capabilities. Developing a clear digital strategy, investing in digital skills, and ensuring robust cybersecurity measures are essential for SMEs to successfully navigate the DT journey.

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MODELS AND METHODOLOGIES SOFTWARE DEVELOPMENT

Abstract: Software development is a complex process that requires structured approaches to ensure the creation of high-quality and reliable software. Models and methodologies serve as frameworks to guide developers through the stages of software development, from initial requirements gathering to final deployment and maintenance. This abstract explores the key models and methodologies utilized in contemporary software development, highlighting their purposes, characteristics, and use cases.

Keywords: Software Development, Cascade model, V-shaped model, Spiral Model, DevOps, Model-Driven Development

Introduction

The life process of any system or software product can be described using a life cycle model consisting of stages. Models can be used to represent the entire life cycle from conception to retirement, or to represent a portion of the life cycle relevant to the current project. The life cycle model is represented as a sequence of stages that can overlap and/or repeat cyclically according to application, size, complexity, need for change, and capabilities. Each stage described wording goals and exits. Processes and life cycle activities are selected and executed at these stages to fully satisfy the purpose and results of each stage. Different organizations may use different stages within the life cycle. However, each stage is implemented by the organization responsible for that stage, with due consideration of the information available in life cycle plans and decisions made in previous stages. Similarly, the organization responsible for the current stage maintains records of decisions made and records of assumptions related to subsequent stages of that life cycle.

The software life cycle model is understood as a structure that defines the sequence of execution and relationships between processes, actions and tasks on throughout the life cycle. The life cycle model depends from specification, scale and difficulties project and specifications conditions, in which system is created and functioning. Model J C BY includes: stages, results of work at each stage, key events - points of completion of work and decision making. The life cycle model of any specific software determines the nature of the process of its creation, which is a set of works ordered in time, interconnected and combined into stages, the implementation of which is necessary and sufficient to create software that meets the specified requirements. A stage is understood as part of the creation process BY, limited certain temporary within ending with the release of a specific product (models, software components, documentation), determined by the requirements specified for this stage.

Methodologies

Cascade model

The first model to become widely known and truly structure the development process is the cascade (waterfall) model. Each stage of the waterfall model ends with some results that serve as input for the next stage. The requirements for the software being developed, determined at the stage of requirements formation, are strictly documented in the form of technical specifications and are recorded for the entire duration of the project development.

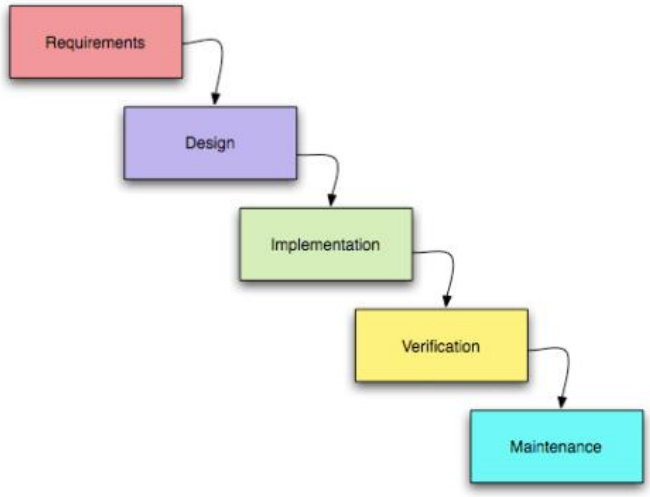

Figure 1. Standard waterfall model

Cascade model Maybe be used at creation BY, for which V himself began development Can enough exactly and fully formulate All requirements. IN That same time this an approach has a number of disadvantages, caused primarily by the fact that the actual creation process BY never fully Not was packing V such tough diagram.

A short time after its birth, the cascade model was modified by Winst Royce, taking into account the interdependence of the stages and the need to return to previous stages, What Maybe be caused by for example, incompleteness requirements or errors in the formation of the task. The process of creating software is usually iterative: the results of the next stage often cause changes in design solutions developed at earlier stages. Thus, there is a constant need to return to previous stages and clarify or revise previously made decisions. As a result, the real software creation process takes the form shown in Figure . 1 .

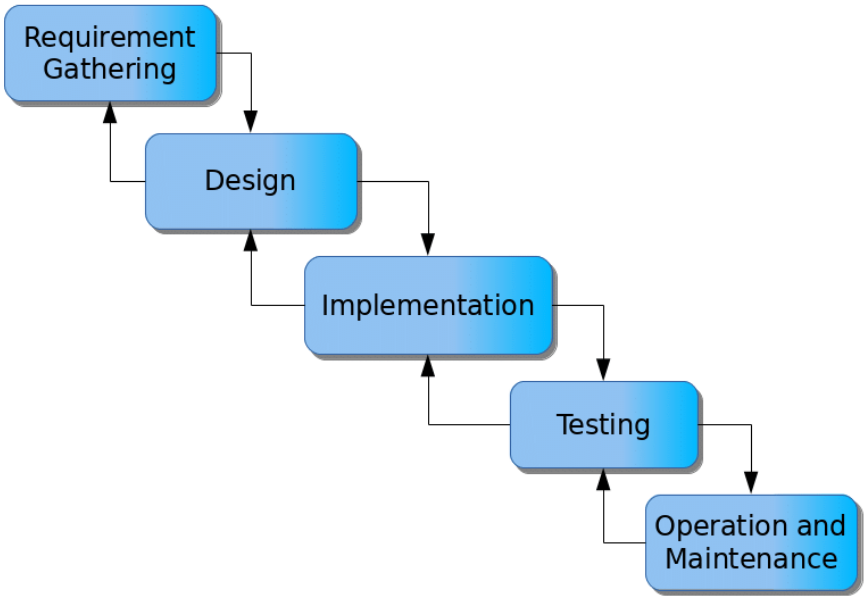

Figure 2. Modified waterfall model

The most common result of a waterfall approach to software development is late failure. Projects seem to be progressing Fine, but only before those since then Bye Work Not will enter in the final stage, And Then it turns out What consumers dissatisfied with the created product.

V-shaped model, How variety cascade model

The basic principle of the V-shape model is that the detail of a project increases from left to right along with the passage of time, and neither can be reversed. Iterations in the design are made horizontally, between the left and right sides of the letter.

V-model is a variation of the waterfall model , in which development tasks go from top to bottom along the left side of the letter V, and testing tasks go up along the right side of the letter V. Horizontal lines are drawn inside the V lines, showing How results each from development stages influence the development of the testing system at each testing stage. The model is based on the fact that acceptance testing is based primarily on requirements, system testing – on requirements And architecture, comprehensive testing - on requirements, architecture and interfaces, and component testing – on requirements, architecture, interfaces And algorithms.

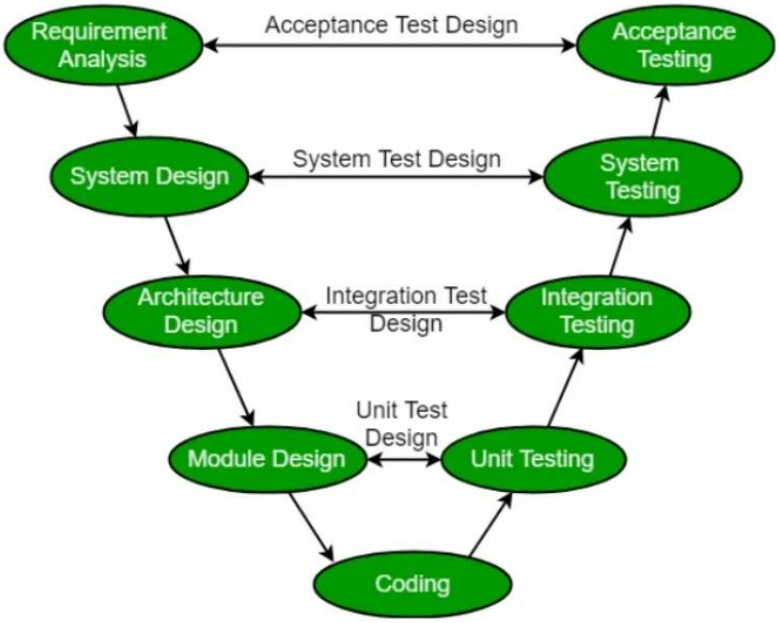

Figure 3. V-shaped model

A feature of this model is the division of stages into three logical stages: design (detailing requirements), implementation, testing. The V-Model provides guidance to organizations and project teams for executing and completing projects in a consistent and repeatable manner. Application of the principles of the V-model ensures that user requirements are identified and captured. The approved requirements can be translated into functions of the finished application, (And) application reflects requirements users.

Iterative model

The iterative model involves dividing the project life cycle on subsequence iterations, each from which reminds

“mini-project”, including all phases of the life cycle as applied to the creation of smaller pieces of functionality compared to the project as a whole. The goal of each iteration is to obtain a working version of the software system, including functionality defined by the integrated content of all previous and current iterations. The result of the final iteration contains all the required functionality of the product. Thus, with the completion of each iteration, the product

develops incrementally.

The chances of successfully creating a complex system will be greatest if it is implemented in a series of small steps and if each step contains a clearly defined outcome, as well as the ability to return to the results of a previous successful iteration if it fails. Before putting into action all the resources intended for creating software, the developer has the opportunity to receive feedback from real world (customers, users) and correct possible errors in the project.

Incremental model

The idea behind the incremental model is that software system should develop by principle increments, so that the developer can use data obtained during the development of earlier versions of the software. New data is obtained both during software development and during its use, where possible. The key steps in this process are simply implementing a subset of the software requirements and refining the model over a series of successive releases until the software is fully implemented. During each iteration, the organization of the model changes and new functionality is added to it.

To organize incremental development, a characteristic time interval is usually selected, for example, a week. Then, during this interval, the project is updated: new documentation, both text and graphic, is added, the set of tests is expanded, are added new software codes and T. d. In theory Development steps can be carried out in parallel, but such a process is very difficult to coordinate. Incremental development works best if the next iteration begins after all artifacts V previous iterations finished, and significantly It's worse if the time required to update artifacts significantly exceeds the selected interval.

Conclusion

Selecting the appropriate model or methodology depends on various factors, including project size, complexity, team dynamics, and the nature of requirements. While traditional models like Waterfall and V-Model offer structured approaches for projects with stable requirements, Agile methodologies and DevOps provide the flexibility needed for modern, dynamic software development. The ongoing evolution of these methodologies reflects the continuous quest for more efficient, adaptive, and effective software development practices.

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QISHLOQ XO‘JALIGIDA RAQAM-LASHTIRISHNI RIVOJLANTIRISH-NING DASTLABKI SHARTLARI DIAGNOSTIKASI

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Annotasiya: Maqolada qishloq xo‘jaligi ishlab chiqarishi raqamlashtirishning muhim jihatlari tahlil qilingan. Qishloq xo‘jaligi ishlab chiqarishini axborotlashtirish tizimining rivojlanishining asosiy belgisi qishloq xo‘jaligi ishlab chiqaruvchilarining yangi texnologiyalarga bo‘lgan talabi ijtimoiy so`rov natijalarida bayon qilingan. Global rivojlanish indeksi ma’lumotlariga ko‘ra O‘zbekistonda raqamli iqtisodiyotga o‘tishda transformatsion o‘zgarishlarni natijalari tahlil qilingan. Sirdaryo viloyatida qishloq xo`jaligi korxonalarining innovatsion texnologiyalardan foydalanish va axborotlashtirish darajasi natijalari tahlili zamonaviy texnologiyalarga talabini o`rganish natijalaridan xulosalar chiqarilgan. Iqtisodiy rivojlangan jahon davlatlarining texnologik tuzilmalarining rivojlanish tendentsiyalariga mahalliy qishloq xo‘jaligi korxonalarini axborotlashtirishning rivojlantirishi yuzasidan xulosa va takliflar ishlab chiqilgan.

Kalit so‘zlar: Qishloq xo‘jaligi, raqamlashtirish, axborotlashtirish, avtomatlashtirish va kompyuterlashtirish, innovatsion texnologiyalar.

DIAGNOSTICS OF INITIAL CONDITIONS FOR THE DEVELOPMENT OF DIGITALIZATION IN AGRICULTURE

Abstract: The article analyzes the important aspects of digitalization of agricultural production. The main sign of the development of the information system of agricultural production is the demand of agricultural producers for new technologies, which is stated in the results of the social survey. According to the data of the global development index, the results of transformational changes in the transition to the digital economy in Uzbekistan were analyzed. Conclusions were drawn from the results of the analysis of the results of the use of innovative technologies and the level of informatization of agricultural enterprises in the Syrdarya region, and the study of the demand for modern technologies. Conclusions and proposals have been developed regarding the development of informatization of local agricultural enterprises to the development trends of the technological structures of the economically developed countries of the world.

Key words: Agriculture, digitization, informatization, automation and computerization, innovative technologies.

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Kirish

Qishloq xo‘jaligi ishlab chiqarishi raqamli o‘zgarishlargalarni o‘z boshidan kechirmoqda. Masalan, qishloq xo‘jaligi va oziq-ovqat sohalarida mobil texnologiyalarning tarqalishi, masofadan turib zondlash va ma’lumotlarga bo‘lgan ehtiyojlarni qoplaydi, bozorlarga kirishini yaxshilaydi, shu bilan ishlab chiqarish va unumdorlikni oshiradi, ta’minot zanjirini optimallashtiradi va tranzaksiya xarajatlarini kamaytiradi.

Shu bilan birga, qishloq xo‘jaligini raqamlashtirish va oziq-ovqat qiymatlari zanjiri ham engish kerak bo‘lgan muammolarni keltirib chiqaradi. Bu kiber makon va ma’lumotlarni muhofaza qilish, ishchi kuchini yangilash va qayta tayyorlash hamda yangi texnologiyalarni o‘zlashtirish uchun turli xil imkoniyatlarga ega mamlakatlar, sektorlar yoki fuqarolar o‘rtasida raqamli bo‘linish xavfini keltirib chiqaradi. Bularning barchasiga qaramay, qishloq xo‘jaligidagi raqamli transformatsiyalar muqarrar [1].

Asosiy qism

Raqamli iqtisodiyot – bu noldan boshlab yaratilishi lozim bo‘lgan qandaydir boshqacha iqtisodiyot emas. Bu yangi texnologiyalar, platformalar va biznes modellari yaratish va ularni kundalik hayotga joriy etish orqali mavjud isodiyotni yangicha tizimga ko‘chirish deganidir.

21-asrning birinchi o‘n yilligida faol bosqichga kirgan milliy va jahon iqtisodiyotining raqamli transformatsiyasi munosabatlarning yangi konfiguratsiyasining paydo bo‘lishi bilan birga iqtisodiyot, siyosat va jamiyatning barcha tarmoqlarida tizimli o‘zgarishlar bilan tavsiflanadi.

Dunyoning bir qator etakchi iqtisodiyotlarida axborot texnologiyalarining jadal joriy etilishi boshqaruv qarorlarini qabul qilishda foydalaniladigan ishlab chiqarishning asosiy omili sifatida axborotning ortib borayotgan rolini xolisona belgilaydi. Shu munosabat bilan agrar iqtisodiyotning raqobatbardoshligi ko‘p jihatdan uning axborotlashtirish darajasiga bog’liqdir.

Hozirgi vaqtda jahon va milliy iqtisodiyotga ta’sir etuvchi yana bir muhim omil raqamli texnologiyalarni rivojlantirishdir. Raqamli texnologiyalar zamonaviy jahon iqtisodiy makonini rivojlantirishning o‘zagiga aylanib, uning samaradorligi va raqobatbardoshligini oshirishga qaratilgan.

Agrar iqtisodiyotning axborot infratuzilmasi elementlarini shakllantirish sharoitida axborotlashtirish asosiy xom ashyo va oziq-ovqat mahsulotlarini arzon narxlarda ishlab chiqarishning asosiy omili bo‘lib, uning vektori ishlab chiqarishning barcha bosqichlarini avtomatlashtirish va kompyuterlashtirishga qaratilgan tsikl bo‘lib, resurslarni optimal boshqarish, atrof-muhitga texnologik yukni kamaytirish, ishlab chiqarish yo‘qotishlarini minimallashtirish, mehnat unumdorligini oshirish, faoliyatni tijoratlashtirish, integratsiyalashgan raqamli qishloq xo‘jaligi echimlarini joriy etgan va qo‘llagan “aqlli fermer xo‘jaliklari” sonning o‘sishi bilan kechadi.

Natijalar

Qishloq xo‘jaligi ishlab chiqarishini axborotlashtirish tizimining rivojlanishining asosiy belgisi qishloq xo‘jaligi ishlab chiqaruvchilarining yangi texnologiyalarga bo‘lgan talabidir (1-jadval).

1-jadval.

2023-yilda O'zbekistonda agrosanoat komleksining xo'jalik yurituvchi sub'ektlari tomonidan yangi texnologiyalarga bo'lgan talab

Texnologiyalar	Dehqon xo'jaligi (tomorqa er egalari)	Fermer xo'jaliklari (yarim tovar xo'jaliklari)	Qishloq xo'jaligi bilan shug'ullanadigan tashkilotlar (tovar xo'jaliklari)	Yirik agroxoldinglar (tovar va eksportga yo'naltirilgan xo'jaliklar)
"Organik" qishloq xo'jaligi	**++**	+	**+**	**+-**
Aqilli qishloq xo'jaligi	+-	+-	**+**	**++**
Yirik mashtabdagi chorvachilik kompleksi	+-	+-	**+-**	**++**
Tomchilatib sug'orish	+-	+	**+**	**++**
Ommaviy zararkunandalarga qarshi kurash	+	+	**++**	**++**
Avtomatlashtirish va kompyuterlashtirish	+-	+-	+	++
Chiqindisiz (ekologik toza) qishloq xo'jaligi	++	++	+	+
Bioyoyoqilg'i	+-	+-	+	+
Amalga oshirish salohiyati: ++- Yuqori			+- O'rtacha	+- - Past

Bizning tadqiqotlarimiz shuni ko'rsatdiki, qishloq xo'jaligi ishlab chiqarishini axborotlashtirish nafaqat ishlab chiqarishni kompyuterlashtirish va texnologik boshqaruv vazifalarini, asosan, ishlab chiqarish va texnologik jarayonlar sifatini oshirish maqsadida mikroprotsessor qurilmalarini mashinalar va uskunalarga "singdirish", shuningdek, axborot oqimlarining tezligi, ishonchliligi, aniqligini ta'minlaydigan zamonaviy telekommunikatsiya tarmoqlaridan foydalangan holda hujjat aylanishining elektron tizimiga o'tish va axborot almashish tizimini rivojlantirishdan iboratdir [2].

Muhokama

Qishloq xo'jaligida xo'jalik yurituvchi sub'ektlarning rentabellik darajasi, resurslar kontsentratsiyasi, ishlab chiqarish ko'lami va ixtisoslashuvi, boshqaruvning tashkiliy tuzilmasining tarqoq bo'linmalari bo'yicha tabaqalanishi tufayli o'ta notekis rivojlanishi axborotlashtirish tizimini rivojlantirishning turli modellaridan foydalanishdan dalolat beradi.

Shunday qilib, yirik qishloq xo'jaligi xo'jaliklari tuzilmalariga xos bo'lgan ishlab chiqarish jarayonlarini kompleks kompyuterlashtirish va mexanizatsiyalash tashkilotning ierarxik

tuzilishining turli darajalarida asosiy boshqaruv funktsiyalarini raqamlashtirishga asoslangan. Butun ishlab chiqarish tsiklining yaratilgan raqamli modeli texnologik zanjirning turli bo‘limlari ma’lumotlarini umumlashtirish, ularni yangi sifatdagi ma’lumotlarga aylantirish, qishloq xo‘jaligi jarayonlarining maksimal sonini avtomatlashtirishga qodir.

Global rivojlanish indeksi ma’lumotlariga ko‘ra O’zbekistonda raqamli iqtisodiyotga o‘tishda transformatsion o‘zgarishlarni amalga oshirayotgan, ushbu sohada jadal rivojlanish yo‘liga o‘tgan davlatlari biri sifatida e’tirof etilmoqda. Axborot texnologiyalari va kommunikatsiyalarini rivojlantirish vazirligi tizimidagi tegishli korxonalar tomonidan O’zbekiston Respublikasi Prezidentining 2020-yil 28-dekabrdagi PQ–4937-son qarori bilan tasdiqlangan 2021–2023 yillarga mo‘ljallangan Investitsiya dasturiga muvofiq soha bo‘yicha joriy yilning yanvar-sentyabr oylari davomida 8 ta investitsiya loyihalari doirasida jami 160 mln. dollarga yaqin investitsiya mablag’lari o‘zlashtirilgan, shundan, 80 mln. dollardan ortiq qismi to‘g’ridan-to‘g’ri xorijiy investitsiyalarni tashkil etadi [3].

Xususan, Iqtisodiy tadqiqotlar va islohotlar markazi ma’lumotlariga ko‘ra, O’zbekistonda IT-tarmog’iga kiritilgan investitsiyalar oxirgi 6 yilda 4 barobarga oshgan.

O’zbekistonda amalga oshirilayotgan raqamli iqtisodiyot inqilobi natijalarini 2020-yilda AKTni rivojlantirish xalqaro indeksi ma’lumotlarida ham ko‘rish mumkin. Xususan xalqaro elektron aloqalarning sakkiz ko‘rsatkichida AKTni rivojlanishini 2017-2019 yillar davri uchun 2020 yil avgust holatiga ko‘ra ma’lumotlar holatini dastlabki baholashga asoslangan.

Taklif etilayotgan ma’lumotlar 2020 yilda AKTni rivojlantirish indeksi to‘rt yoki undan ortiq ko‘rsatkichlar (ya’ni, 50% yoki undan ko‘p) bo‘yicha ma’lumotlar mavjud bo‘lgan iqtisodiy ko‘rsatkichlarni o‘z ichiga olgan (2-jadval).

2-jadval.

Markaziy Osiyo mamlakatlarida AKTni rivojlanish indeksi

	Ma’lumotlarni uzatishni etarli darajadaligi	1.1. Uy xo’jaliklarida kompyuter mavjudligi	1.2. Uy xo’jaliklarida intenetga ulanishi	1.3. Uzatish yo‘laklari	1.4. Tarmoq qamrovi	1.5. Tugallangan keng yo‘lakli tarmoqlar	2.1. Internetdan foydalanuvchilar	2.2. Keng yo‘lakli mobil aloqa	2.3. Trafik mobil internetga kirish
Qozog’iston	ha	ha	ha	ha	ha		ha	ha	ha
Qirg’iziston					ha			ha	ha
Tojikiston								ha	
Turkmaniston								ha	
O’zbekiston	ha	ha	ha	ha	ha	ha	ha	ha	ha

Manba: *Справочный документ Индекс развития ИКТ 2020 года: Предложение. https://www.itu.int/en/ITU- D/Statistics/ Documents /events/egti2020/I*

Jadval ma’lumotlaridan ko‘rinib turibdiki, markaziy Osiyo mamlakatlarida AKTni rivojlanish indekslari Tojikiston va Turkmanistonda jami 8 ta bandning 7 tasi, Qirg’isiztonda 6 ta, Qozog’istonda 1 ta qismi bajarilmayapti. Ushbu indekslar bo‘yicha O’zbekistonda barcha talablar ijrosi ta’minlanganligi e’tirof etilayapti.

Shuni ta’kidlash kerakki, kichik agrobiznes qishloq xo‘jaligi korxonalariga axborot xizmatlarini ko‘rsatadigan axborot-maslahat markazlari tizimini yaratishni nazarda tutuvchi modeldan foydalanishni afzal ko‘radi. Umuman olganda, qishloq xo‘jaligi ishlab chiqaruvchilarining katta qismi tomonidan axborot texnologiyalaridan past darajada foydalanish qishloq xo‘jaligining raqamli transformatsiyasiga jiddiy to‘siqdir.

Tadqiqot davomida o‘tkazilgan so‘rovga ko‘ra qishloqda axborot-kommunikatsiya infratuzilmasi rivojlanib borayotganini ko‘rsatmoqda, sifatli va yuqori tezlikda internetga ulanish imkoniyatlari yaratilgan. Qishloq aholisining ham ayniqsa yoshlarni “kompyuter savodxonligi” oshib borayotganini kuzatish mumkin. Biroq ananaviy iqtisodiy munosobatlarni ma’qul ko‘radigan, innovatsion texnologiyalardan foydalanish va axborotlashtirishning samaradorligini anglab etmaslik holatlari hamon kuzatilmoqda.

Biz Sirdaryo viloyati misolida global integratsiya sharoitida qishloq xo‘jaligining raqamli transformatsiyasini rivojlantirish bo‘yicha chuqurroq tadqiqotlar olib bordik.

2022-yilda viloyatda qishloq xo‘jaligi korxonalarining innovatsion texnologiyalardan foydalanish va axborotlashtirish darajasi natijalari tahlili zamonaviy texnologiyalarga talabning asossiz darajada pastligidan dalolat beradi (3-jadval).

3-jadval.

2021 yilda Sirdaryo viloyatida zamonaviy qishloq xo‘jaligi ishlab chiqarish texnologiyalariga talab darajasi

Texnologiyalar	Talab darajasi	Sabablari
Organik qishloq xo‘jaligi	qishloq xo‘jaligi yer maydonlarining 0,008 %i	Tizimga joriy etishga ilmiy asoslangan tavsiyalarning o‘rgatish va ishlab chiqaruvchilarda ko‘nikmalarning etishmasligi
Aqilli qishloq xo‘jaligi	10,0 % qishloq xo‘jaligi texnikalari navigatorlar (Jps) jihozlangan	
Tomchilatib sug’orish	5,0 % sug’oriladigan yerlarda yoki 1,4% haydaladigan yerlar	
Go‘ng aralashmalarini mustaqil tayyorlash	Talab darajasida emasligi	texnologik jarayon narxining oshishi
Zarakunandalarga qarshi kurashda ommaviy nazorat	Talab darajasida emasligi	Biotexnik labaratoriyalarni kamligi
Bioyoqilg’i	Talab darajasida emasligi	Infratuzilmaning etarli darajada rivojlanmaganligi
Avtomatlashtirish va kompyuterlashtirish	25 % 100 ga.dan 500 ga. gacha yer maydoni bo‘lgan xo‘jaliklar, 70,0 % 500 ga. dan 3000, ga. gacha yer maydoni bo‘lgan xo‘jaliklar 90,0% 3000 ga. dan yuqori yer maydoni bo‘lgan xo‘jaliklar	Dasturiy mahsulotlarni dasturiy mahsulotlarni unifikatsiya qilish zarur, AT sohasidagi ishchilarning malaka darajasi, tarmoqning raqamlashtirishning pastligi
Tadbiq etish imkoniyati:	O’rtacha	Past

Xususan, viloyatdagi qishloq xo‘jaligi yerlarining 0,5 foizdan kamrog’i “organik” qishloq xo‘jaligi texnologiyasidan foydalanadi. Qishloq xo‘jaligida o‘g’it aralashmalarini individual tayyorlash, zararkunandalarga qarshi kompleks kurash, bioyoqilg’idan foydalanish kabi zamonaviy texnologiyalar ishlab chiqarish va texnologik jarayon narxining oshishi, biotexnika laboratoriyalarining etishmasligi va tegishli infratuzilmaning rivojlanmaganligi sababli amalga oshirilmay qolib ketadi. Innovatsion texnologiyalarni qo‘llashda yana bir cheklovchi omil - aniq tabiiy va iqtisodiy sharoitlarda ularni amalga oshirish bo‘yicha mavjud ilmiy tavsiyalarni o‘zlashtirishga qiziqishning pastligida ko‘rish mumkin.

Bu holat mahalliy qishloq xo‘jaligi fanining ishlanmalarini joriy etishning past darajasi bilan izohlanadi, chunki mamlakatdagi bir qator ilmiy-tadqiqot institutlarining ishi ko‘pincha amaliy xususiyatga ega emas. Shu bilan birga, ilmiy-tadqiqot institutlari faoliyat ko‘rsatayotgan ilmiy yo‘nalishlar har doim ham hududiy qishloq xo‘jaligi ishlab chiqarishi ehtiyojlari bilan mos kelavermaydi, agrosanoat majmuasida iqtisodiy o‘sishni ta’minlaydigan ilmiy faoliyat va ishlab chiqarish o‘rtasida aniq belgilangan bog’liqlik mavjud emas.

Shuning bilan birga qishloq xo‘jaligi ishlab chiqarishining raqamli komponentini shakllantirishda inson kapitalining strategik roli yaqqol namoyon bo‘ladi. Raqamli texnologiyalar nafaqat agrosanoat majmuasini modernizatsiya va innovatsion rivojlantirish platformasi, balki zarur raqamli kompetensiyalarga ega bo‘lgan yoshlarni ushbu sohaga jalb qilish uchun asos bo‘lishi mumkin.

Zamonaviy davrda Sirdaryo viloyati qishloq xo‘jaligida avtomatlashtirish va kompyuterlashtirish asosan asosiy boshqaruv funktsiyalari va individual vazifalarni axborotlashtirishga qaratilgan. Shunday qilib, yirik va o‘rta qishloq xo‘jaligi korxonalarida ko‘p sonli me’yoriy hujjatlar talablarini, tarmoqning o‘ziga xos xususiyatlarini, ishlab chiqarish va iqtisodiy faoliyat uchun xavf va tahdidlarni hisobga olgan holda yuqori sifatli tahlil va rejalashtirishni yuqori texnologik axborot tizimlaridan foydalanmasdan amalga oshirish mumkin emas.

Xususan, boshqaruv funktsiyalarini avtomatlashtirish uchun viloyat xo‘jaliklarining ustun qismi 1C platformasida nafaqat buxgalteriya hisobini, balki statistik va boshqaruv hisobotlarini shakllantirishni ta’minlaydigan hamda resurslar ustidan har tomonlama nazoratni kafolatlaydigan maxsus dasturlardan foydalanadi. Xususan “1C: Buxgalteriya 8” dasturi yordamida hal qilingan vazifalarni quyidagicha shakllantirish mumkin: korxonaning iqtisodiy, tashkiliy va moliyaviy faoliyatini kompleks avtomatlashtirish; parallel buxgalteriya va soliq hisobi;. ishlab chiqarish

hisobi; asosiy vositalar va nomoddiy aktivlarni hisobga olish; ish haqi hisobi va kadrlar hisobini yuritish . Ko‘rinib turibdiki mazkur dastur orqali qishloq xo‘jaligini raqamlashtirish, aqilli qishloq xo‘jaligi dasturiga o‘tishning salkam 50 foiz ishini bajarishga erishish mumkin.

Qishloq xo‘jaligini kompyuterlashtirish darajasini oshirish, tarmoq xodimlarining “kompyuter savodxonligi”ning bilan bog’liq, deb hisoblaymiz. Global iqtisodiyot sharoitida aynan inson kapitali qishloq xo‘jaligining bilim talab qiladigan rivojlanishining hal qiluvchi omiliga aylanadi.

Qishloq xo‘jaligi ishlab chiqarishining turli tarmoqlariga IT-texnologiyalarni joriy etish, yuqori intellektga ega robototexnikadan foydalanish, yirik vertikal integratsiyalashgan agrosanoat tuzilmalarini rivojlantirish raqamli transformatsiya davrida qishloq xo‘jaligi yuqori kasbiy mahorat va ko‘nikmaga ega, tashqi va ichki muhit muammolariga bir zumda javob beradigan, aql-zakovatli moslashuvchan mutaxassislarga muhtojligidan dalolatdir.

Xulosa

Iqtisodiy rivojlangan jahon davlatlarining texnologik tuzilmalarining rivojlanish tendentsiyalariga mahalliy qishloq xo‘jaligi korxonalarini axborotlashtirishning rivojlantirishni quyidagilar bilan izohlash mumkin:

- O‘zbekistonning qishloq joylarida dehqon, fermer xo‘jaliklari va boshqa qishloq xo‘jaligi bilan shug’ullanuvchi korxonalarni axborot komunikatsiya infratutuzilmasi rivojlanishni qo`llab-quvvatlash tizimini joriy etish;

- hududiy davlat organlarining qishloq xo‘jaligi ishlab chiqarishini tizimli axborotlashtirish jarayonlariga va ularning agrosanoat majmuasining yagona axborot makoniga integratsiyalashuvida manfatdor ekanligini amalda ko‘rsatishi;

- qishloq xo‘jaligi korxonalarini axborotlashtirishning aniq strategiyasi va axborot bilan ta’minlashning rivojlangan infratuzilmasini rivojlantirishni moliyaviy qo‘llab-quvvatlash;

- rahbarlar va mutaxassislarni muntazam axborotlashtirish tizimlaridan foydalanish va rivojlantirishga oid bilimlarini oshirib boorish amaliyotini joriy etish;

- tarmoqning o‘ziga xos xususiyatlari va avtomatlashtirish, mexanizatsiyalash va axborot texnologiyalaridan foydalanish jarayonlari uchun cheklangan moliyaviy resurslar bilan bog’liq bo‘lgan qishloq xo‘jaligi ishlab chiqarishining o‘ziga xos xususiyatlari boshqaruvning asosiy funktsiyalarini kompleks axborotlashtirishdan foydalanish imkonini berishga erish choralarini ko`rish.

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RAQAMLI IQTISODIYOTNI RIVOJLANTIRISHDA KRIPTAVALYUTA BOZORINING O‘RNI

Annotatsiya: Ushbu maqolada asosan raqamli iqtisodiyotni yanada rivojlantirishda kriptovalyuta bozorining o‘rni hamda undagi kamchilik va muammolar va ularni bartaraf etish, raqamli iqtisodiyotning o‘sishi va rivojlanishi, insonlarning yashash tarzini sezilarli darajada yaxshilash qulayliklar yaratish kundalik paydo bo‘ladigan ehtiyojlarni elektron savdo orqali topishi yokida elektron tizim orqali savdo faoliyatini yuritishi, o‘z biznesiga ega bo‘lishi bu Insonlarning asosiy foydasi ekanligi yoritib berishga harakat qilingan, hamda raqamlashtirish iqtisodiyotining muhim ahamiyatlari va uning qo‘llanilish jarayonida olib kelingan qulayliklar yangiliklar insoniyatga yaratilayotgan imkoniyatlar haqida boradi.

Kalit so‘zlar: raqamli iqtisodiyot, kriptovalyuta bozori, internet iqtisodiyot, raqamlashtirish, elektron tijorat, aksiya, investorlar, fond bozori, qimmatli qog‘ozlar, kriptovalyuta sanoati.

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THE ROLE OF THE CRYPTOCURRENCY MARKET IN THE DEVELOPMENT OF THE DIGITAL ECONOMY

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Abstract: In this article, the role of the cryptocurrency market in the further development of the digital economy, its shortcomings and problems and their elimination, the growth and development of the digital economy, the significant improvement of people's lifestyles, the creation of conveniences, and the finding of everyday needs through e-commerce or electronic It has been tried to clarify that conducting trade activities through the system, owning one's own business is the main benefit of people, and the important importance of digitization economy and the conveniences brought in the process of its use, news is about the opportunities created for humanity.

Keywords: digital economy, cryptocurrency market, internet economy, digitization, e-commerce, share, investors, stock market, securities, cryptocurrency industry.

Kirish

Raqamli iqtisodiyotning yuksalishi va rivojlanishi 21-asrning o‘ziga xos xususiyatlaridan biridir, albatta bugungi kunni raqamli texnologiyalarsiz tasavvur qilish juda qiyin. Zamonaviy ilm-fanning cho‘qqisi yuqori texnologiyalarda, raqamli olamda ko‘zga tashlanadi. To‘rtinchi sanoat inqilobi taraqqiyotning yangi ko‘rinishi “raqamli iqtisodiyot” boshlanganini anglatadi. Raqamli va elektron texnologiyalarga asoslangan va elektron tijorat, bulutli texnologiyalar, raqamli texnologiyalar orqali bevosita amalga oshiriladigan odamlarning iqtisodiy faoliyatini tashkil etishdan iborat. Hozirgi vaqtga kelib, raqamli iqtisodiyot nazariyasi to‘laligicha hali shakllanmagan va ko‘pchilik iqtisodchilar tomonidan keng miqyosda o‘rganilmoqda. Ilmiy adabiyotlarda hozirgi zamon “Yangi raqamli iqtisodiyoti” turli xil atamalar bilan nomlanadi. Masalan, Raqamli iqtisodiyot tushunchasiga bir qator ta’riflar berilgan. Jumladan, iqtisodiyot fanlari doktori, Rossiya Fanlar akademiyasining muxbir a’zosi V.Ivanov “Raqamli iqtisod - haqiqatimizni to‘ldiradigan virtual muhit” - deb ta’rif bergan.

Tomsk davlat universitetining professori, R.Meshcheryakovning fikricha “Raqamli iqtisod” atamasiga ikkita yondashish mavjud deb hisoblaydi. Raqamli texnologiyalar asosida iqtisodiyotning va elektron tovar va xizmatlar eksklyuziv tavsiflovchi raqamli iqtisodiyot: birinchi yondashuv “klassik” deb nomlanib, klassik misollar - teletibbiyot, masofaviy ta’lim, dori-darmonlarni sotish (filmlar, televizorlar, kitoblar va boshqalar). Ikkinchi yondashuv: “raqamli iqtisod” ilg‘or raqamli texnologiyalardan foydalangan holda iqtisodiy ishlab chiqarishdir.

Ushbu ta’rif raqamli aloqa yoki tarmoq texnologiyalaridan foydalangan holda internetda amalga oshiriladigan barcha biznes, madaniy, iqtisodiy va ijtimoiy operatsiyalarni qamrab oladi. Ba’zilar raqamli iqtisodiyot nega kerak va nima beradi, deb o‘ylashi mumkin. Raqamli iqtisodiyot deganda, faqatgina blokcheyn texnologiyasini va ulardan xalqaro moliya bozorlarida foydalanish masalalarini yoki kriptovalyutalarni tushunish kerak emas. Albatta, blokcheyn texnologiyasi, kriptovalyutalar ham raqamli iqtisodiyotning bir bo‘lagi. Lekin raqamli iqtisodiyot deganda, raqamli kommunikatsiyalar, axborot texnologiyalari (IT) yordamida olib boriladigan iqtisodiyot tushuniladi. Bunda, yashirin iqtisodiyotga barham berish vositasi sifatida ham qarash mumkin. Chunki birinchidan, barcha operatsiyalar elektron ro‘yxatdan o‘tilishiga, ikkinchidan shaffof bo‘lishiga erishiladi. Qolaversa, ishlab chiqarishda yangi axborot texnologiyalari (IT) texnologiyalar qo‘llanilishi tufayli mahsulot va xizmatlarning tannarxi pasayadi. Jahon bankining xulosalari mamlakatlar iqtisodiyotini rivojlantirishda raqamli iqtisodiyotning naqadar dolzarb va muhim masala ekanligini ko‘rsatadi. Xususan, internet tezligining 10 foizga o‘sishi mamlakat YaIM o‘sishiga olib keladi. Rivojlangan davlatlarda bu ko‘rsatkich 1,21 foizni tashkil etsa, rivojlanayotgan mamlakatlarda 1,38 foizga teng. Demak, internet tezligi 2 barobar oshadigan bo‘lsa, YaIM hajmi 13-14 foiz ortishiga erishish mumkin [1].

Zamonaviy taraqqiyotning keyingi istiqbolida katta hajmli ma’lumotlar (Big Data) bilan ishlash texnologiyalari, sun’iy intellekt, nanotexnologiyalar, kvant texnologiyalari, buyumlar interneti, robototexnika va sensorlik, raqamli elektron platformalar, bulutli va mobil texnologiyalar, virtual va qo‘shimcha reallik texnologiyalari, blokcheyn texnologiyalari, kriptovalyutalar va 3D-texnologiyalari singari raqamli texnologiyalar hal qiluvchi ahamiyat kasb etmoqda. Raqamli iqtisodiyot hozirgi mavjud sohalarning yarmidan ko‘prog‘ida beqiyos o‘zgarishlar keltirib chiqarishi ta’kidlanmoqda.

Jumladan Jahon banki ekspertlari fikricha, tezkor internetdan foydalanuvchilar sonining 10 foizga ko‘payishi milliy iqtisodiyotlar yalpi hajmini har yili o‘rtacha 0,4-1,4 foizga oshirish imkonini beradi [2].

Raqamli texnologiyalar, global miqyosda ham, mahalliy darajada ham katta ta’sir ko‘rsatadi. Raqamli iqtisodiyot yangi ishlab chiqarishlarning kombinatsiyasi sifatida global iqtisodiyotning tez o‘sib borayotgan qismidir, misol tariqasida "Bitcoin" bu eng mashhur kriptovalyuta bozoridagi valyutadir.

Bitcoin 2009-yilda "Satoshi Nakamoto" nomi ostida anonim shaxsga xos ravishda ishlab chiqilgan, U bu paytdan boshlab xavfsiz, anonim xizmat ko‘rsatish, valyuta hisob-kitoblari va boshqa tashqi banklardan o‘zbek investitsiya qilishga imkon beruvchi bir necha kriptovalyutalardan biri bo‘lgan.

Kriptovalyuta sanoati dunyodagi eng tez rivojlanayotgan bozorlardan biri hisoblanadi. 2023-yil 21-yanvarda bitkoinning bozor kapitallashuvi 1072,21 milliard dollarga baholandi. Shu bilan birga, ko‘plab istiqbolli altkoinlar 2023-yilning birinchi yarmida bitcoindan ham tezroq o‘sdi. Blokcheyn texnologiyasining global bozori 2023-yilga kelib 23,3 milliard dollar qiymatiga yetishi taxmin qilinmoqda.

Bu raqamlar kriptovalyutalarning jadal rivojlanayotganidan dalolat beradi. Ushbu raqamli valyutalar nafaqat ajoyib investitsiya imkoniyatini taqdim etadi, balki ular onlayn operatsiyalarni amalga oshirish, pul yuborish va moliyaviy tizimlarda markaziy boshqaruvga bo‘lgan ehtiyojni yo‘q qilish uchun ham ishlatilishi mumkin [3].

Raqamli iqtisodiyotning o‘sishi raqamli va mobil texnologiyalar bilan bevosita bog‘liq bo‘lib, texnologiyalar rivojlanishining hozirgi bosqichida va bozorlaring hozirgi holati sharoitida raqamli iqtisodiyotni maqsad sifatida emas, balki iqtisodiy faoliyat samaradorligini oshirish vositasi sifatida ko‘rib chiqish kerak, Zamonaviy raqamli iqtisodiyot yangi biznes modellarini taklif qiladi va boshqaruv mexanizmlarini o‘zgaruvchan voqelikni aks ettirish uchun o‘zgartirish zarurligini ta’kidlaydi.

Metodologiya

Biz kundalik faoliyatimizda juda ko‘p eshitamiz raqamli iqtisodiyot raqamli iqtisodiyot o‘zi nima? u iqtisodiy, ijtimoiy va madaniy aloqalarni raqamli texnologiyalarni qo‘llash asnosida amalga oshirishning yaxlit bir tizimi sifatida qaraladi. Bunda raqamli iqtisodiyot yangi texnologiyalar, platformalar va biznes modellari yaratish va ularni kundalik hayotga joriy etish orqali mavjud iqtisodiyotni yangicha tizimga ko‘chirish demakdir [4]. Raqamli iqtisodiyot, boshqa nomi bilan "raqamli ekonomika" yoki "sifatli iqtisod" deyiladi, buni yaratishning asosiy maqsadi, raqamli texnologiyalar va ma’lumotlar analitikasi asosida iqtisodiy faoliyatni yangilash va optimallashtirishdir.

Raqamli iqtisodiyot, axborot texnologiyalarining (IT) va ma’lumotlar analitikasi muhitidagi rivojlanishlar yordamida moliyaviy va boshqa sohalar uchun yangi imkoniyatlarni ochadi. Dunyoda raqamli iqtisodiyot o‘sishining sur’atlari yiliga deyarli 20 foizni tashkil etmoqda. Taraqqiy etgan davlatlarda raqamli iqtisodiyotning yalpi ichki mahsulotdagi ulushi 7 foizga yetgan. Ular hozirning o‘zida raqamli iqtisodiyotning joriy qilinishidan juda katta naf ko‘rishmoqda. Xususan, Amerika Qo‘shma Shtatlari yiliga 400 milliard AQSh dollaridan ko‘proq raqamli xizmatlarni eksport qilmoqda. Mazkur davlat yalpi ichki mahsulotining 5 foizidan ko‘prog‘i bevosita internet va axborot-telekommunikatsiya texnologiyalari bilan bog‘liq sohalarga to‘g‘ri keladi. 2025-yilgacha AQSh sanoatni raqamlashtirishdan qo‘shimcha 20 trln. dollar daromad olishi kutilmoqda. Bunday iqtisodiy samaradorlik, ayniqsa iste’mol tovarlari ishlab chiqarish (10,3 trln. dollar), avtomobil sanoati (3,8 trln. dollar) va logistikada (3,9 trln. dollar) yuqori bo‘lishi ta’kidlanmoqda. Turli tadqiqotlar natijalari bo‘yicha raqamli iqtisodiyotning dunyo iqtisodiyotidagi salmog‘i 4,5 foizdan 15,5 foizgachani tashkil etadi. Jahon

axborot-kommunikatsiya texnologiyalari sektorida yaratilayotgan qo‘shilgan qiymatning deyarli 40 foizi va blokcheyn texnologiyalari bilan bog‘liq patentlarning 75 foizi Amerika Qo‘shma Shtatlari va Xitoy Xalq Respublikasi hissasiga to‘g‘ri kelishini ko’rsatadi [5].

Tahlil va natijalar

Kriptovalyutalar, raqamli iqtisodiyotda rivojlantirish uchun muhim bir vosita sifatida o‘rtacha o‘n yillar davomida katta ro‘l o‘ynagan. Ularning o‘rnini ko‘rib chiqish uchun, ularning avvalgi va joriy muhitdagi o‘rnini tushunish lozim.

1. Qabul qilinish, Kriptovalyutalar, jahonshumul darajadagi muomalada o‘z o‘rnini olishganligi uchun raqamli iqtisodiyotda qabul qilinishining o‘ziga xos ro‘lga ega. Bir nechta kompaniyalar va tizimlar kriptovalyutalarni to‘lov usullariga qo‘llash orqali mijozlarga xizmat ko‘rsatishni boshladilar, masalan, bir nechta onlayn do‘konlar va xizmatlar Bitcoin, Ethereum va boshqa kriptovalyutalarni qabul qilishni boshladilar.

2. Moliyaviy operatsiyalar: Kriptovalyutalar moliyaviy operatsiyalarda (masalan, xorijiy valyutalarni almashish) o‘zgarishsizlik, tezlik va to‘lovlar uchun ko‘p marta ishlatilmoqda. Bu, xususan xorijiy savdo operatsiyalarida raqamli iqtisodiyotda katta o‘rin egallaydi.

3. Texnologiyalar innovatsiyasi: Kriptovalyutalar, blokchain va smart kontraktlar kabi yangi texnologiyalar orqali, raqamli iqtisodiyotning yuqori tezlikda rivojlantirilishiga yordam beradi. Blokchain, ma’lumotlar bazasining desentralizatsiyasini ta’minlash va axborot almashishning ommaviy himoyalashiga imkon beradi.

4. To‘lov tizimlarining integratsiyasi: Kriptovalyutalar, tranzaksiyalarni amalga oshirish vaqtini vaqt va moliyaviy resurslarni tejamkorlikda kamaytirish imkonini beradi. Bu esa korxonalar va mijozlar uchun yanada samarali va tezroq bo‘lgan, bu esa raqamli iqtisodiyotning rivojlanishiga yordam beradi.

5. Imkoniyatlari: Kriptovalyutalar, investorlar uchun yangi yorqin imkoniyatlari yaratish orqali raqamli iqtisodiyotni rivojlantirishda ham muhim rol o‘ynaydi. Katta miqdorda kapital kriptovalyutalarga o‘tkazilishi, ularning kapitalizatsiyasini oshirishga yordam beradi va kripto-aktivlar uchun yangi sohalar yaratadi.

6. Bank va xizmat ko‘rsatuvchilar tomonidan ishlatilish: Kriptovalyutalar, banklar va xizmat ko‘rsatuvchilar tomonidan asosiy ma’lumotlar almashish, identifikatsiya va to‘lovlar uchun qo‘llaniladi. Bu, moliyaviy tizimlarni raqamli va o‘zgaruvchan kriptovalyuta bozoriga integratsiyalashda muhim bir qadam hisoblanadi.

Bular kriptovalyutalar va ularning raqamli iqtisodiyotdagi o‘rnini ta’riflashda asosiy faktorlar hisoblanadi. Ular raqamli iqtisodiyotni rivojlantirishda, valyuta vaqt qiymatlari, moliyaviy operatsiyalar, texnologiyalar, va sarmoyalar kabi turli sohalarda katta ro‘l o‘ynaydi [6]. Yuqoridagilarning barchasidan kelib chiqqan holda, bu muammolarning barchasi hozirgi vaqtda xorijiy va mahalliy investorlar faolligini oshirishga, shu bilan birga, O‘zbekiston fond bozorining muvaffaqiyatli rivojlanishiga to‘siq bo‘lib xizmat qilmoqda. Qimmatli qog‘ozlar bozorining faol rivojlanishi uchun aholining ishonch darajasini oshirish zarur, chunki qimmatli qog‘ozlar bozorining barqarorligi bunga bog‘liq. O‘zbekistonlik investorlarning ko‘pchilikning fond bozori taqdim etayotgan imkoniyatlarini to‘liq tushunmasligi, shuningdek, investorlarning investitsiya madaniyati va moliyaviy savodxonligi pastligi ham fond bozorining rivojlanmasligining asosiy sabablaridandir.

Ko‘pgina muammolar bo‘lishiga qaramay, respublika fond bozori juda istiqbolli hisoblanadi. Qimmatli qog‘ozlar bozorining rivojlanishi faqat davlat va bozorning o‘zi

tomonidan kompleks yondashuvni qo‘llash bilan amalga oshirilishi mumkin. O‘zbekiston fond bozori rivojlanishidan davlat, tadbirkorlar va fuqarolar manfaatdor. Bugungi kunda qimmatli qog‘ozlar bozori ko‘p jihatdan jismoniy va yuridik shaxslar jamg‘armalarni, har qanday ko‘chmas mulkka, chet el valyutasiga va boshqalarga investitsiyalarga, shuningdek inflyatsiyaga uchrashiga qarshi yoki alternativ yechim hisoblanadi. 5 yil davomida (2015-2020-yillar) o‘tkazilgan tahlillar natijasida “Toshkent” fond birjasida savdo qiluvchilar soni ortgani ma’lum bo‘ldi. O‘zbekiston qimmatli qog‘ozlari bozoriga sarmoya kirituvchi O‘zbekiston fuqarolarining ulushi, shuningdek, vositachi kompaniyalar soni va fond bozorining o‘zi aylanmasi yil sayin ortib bormoqda. O‘tgan davr mobaynida, jismoniy shaxslar tomonidan tijorat banklari aksiyalariga (87,3%), qurilish materiallari tarmog‘iga mansub kompaniyalar aksiyalariga (5,7%) va sug‘urta kompaniyalarining (2,7%) aksiyalariga yuqori qiziqish bildirishgan.

Yuqoridagi matnda, O‘zbekiston fond bozorining rivojlanishiga doir muammolar va ularning xalqaro va mahalliy investorlar faolligini oshirish, shuningdek, fond bozorining muvaffaqiyatli rivojlanishiga ta’sir etish talablari bayon qilingan.

1. Investorlarning ishonch darajasini oshirish: Qimmatli qog‘ozlar bozorining barqarorligi va faol rivojlanishi uchun aholining ishonch darajasini oshirish zarurdir. Bu investorlarning O‘zbekiston fond bozoridagi investitsiya imkoniyatlarini to‘liq tushunishiga asoslanadi.

2. Investorlarning investitsiya madaniyati va moliyaviy savodxonligining oshirilishi O‘zbekistonlik investorlarning ko‘pchiligining fond bozori taqdim etayotgan imkoniyatlarini tushunishlarini ta’minlash zarur. Bu investorlar uchun moliyaviy savodxonlik va investitsiya madaniyati bilan bog‘liq qoidalarni tushunishlarini ta’minlashni o‘z ichiga oladi.

3. Fond bozorining kompleks yondashuvni qo‘llash, qimmatli qog‘ozlar bozorining rivojlanishi faqat davlat va bozorning o‘zi tomonidan kompleks yondashuvni qo‘llash bilan amalga oshirilishi mumkin. Bu davlatning va bozor tashkilotlarining birlashishi bilan amalga oshirilishi lozim bo‘lgan ommalarni o‘z ichiga oladi.

4. Investitsiyalarga qarshi yoki alternativ yechimlar. O‘zbekiston fond bozori, jismoniy va yuridik shaxslar uchun alternativ investitsiyalar kabi yechimlar ko‘rsatadi. Bu jamg‘armalarni, chet el valyutasiga investitsiyalarga qarshi yoki alternativ yechimlar sifatida o‘z ichiga oladi. Shu jumladan, O‘zbekiston fond bozorining rivojlanishiga doir muammolar, investorlarning ishonch darajasini oshirish, investitsiya madaniyati va moliyaviy savodxonligini oshirish, kompleks yondashuvni qo‘llash, va alternativ yechimlarni taqdim etish. Bu talablarning qabul qilinganligi va ularning amalga oshirilishi O‘zbekiston fond bozorining muvaffaqiyatli rivojlanishini ta’minlaydi.

Xulosa

Darhaqiqat, har qaysi sohaga qarasak raqamli texnologiya kirib borib insonlar mushkulini osonlashtirmoqda deyarli har kuni raqamli texnologiyaga murojaat qilamiz endi biz shu texnologiyadan unumli foydalanib to‘g‘ri joriy eta olsak maqsadga muvofiq bo‘lar edi. Kriptovalyutalar, raqamli iqtisodiyotda rivojlantirish uchun muhim endilikda siz bankga omonatga mablag’ qo’ymasdan o’z aksiyalaringiz orqali uyda o’tirgan holda daromad qilishingiz mumkin, AQSH yoki boshqa istagan davlatning yirik kampaniyalari aksiyalariga egalik qilishingiz sotish yoki sotib olishingiz mumkin. Raqamli texnologiyalar nafaqat mahsulot va xizmatlar sifatini oshiradi hamda iqtisodiyotning o‘sishida xizmat qiladi,bizga qimmatli bo‘lgan vaqtni tejaydi qisqa vaqt ichida ko‘plab ma’lumotlarni topishga shakllantirishga yordam beradi balki ortiqcha xarajatlarni kamaytiradi.

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DEVELOPING THE METHODOLOGY FOR FIXED ASSETS VALUATION IN THE CONTEXT OF A DIGITAL ECONOMY

Abstract: The valuation of fixed assets—tangible and intangible resources used in production and business operations—is critical for financial reporting, investment analysis, and strategic decision-making. In the evolving digital economy, traditional valuation methods often fall short of capturing the true value of assets, especially those enhanced by digital technologies. This abstract explores a methodology for valuing fixed assets within a digital economy, emphasizing the integration of digital transformation metrics, advanced data analytics, and real-time valuation techniques.

Keywords: Fixed Assets Valuation, Digital Economy, Digital Metrics, Real-Time Data Analytics, Hybrid Valuation Approach

Introduction

In the era of the digital economy, traditional methods for valuing fixed assets—such as land, buildings, machinery, and intellectual property—face challenges in accurately capturing their true economic value. These traditional methods often overlook the enhancements and efficiencies brought by digital technologies, data-driven decision-making, and real-time analytics. This paper proposes a comprehensive methodology to bridge this gap, integrating digital economy metrics with conventional valuation approaches to reflect the augmented value and performance of fixed assets. The digital economy, characterized by the pervasive use of digital technologies and the proliferation of data, necessitates a re-evaluation of how fixed assets are valued. Conventional approaches, such as cost and market-based methods, often fail to account for the dynamic value contributions of digital enhancements, including software, data analytics capabilities, and digital connectivity. This necessitates a methodology that incorporates both traditional valuation principles and the unique aspects of the digital economy.

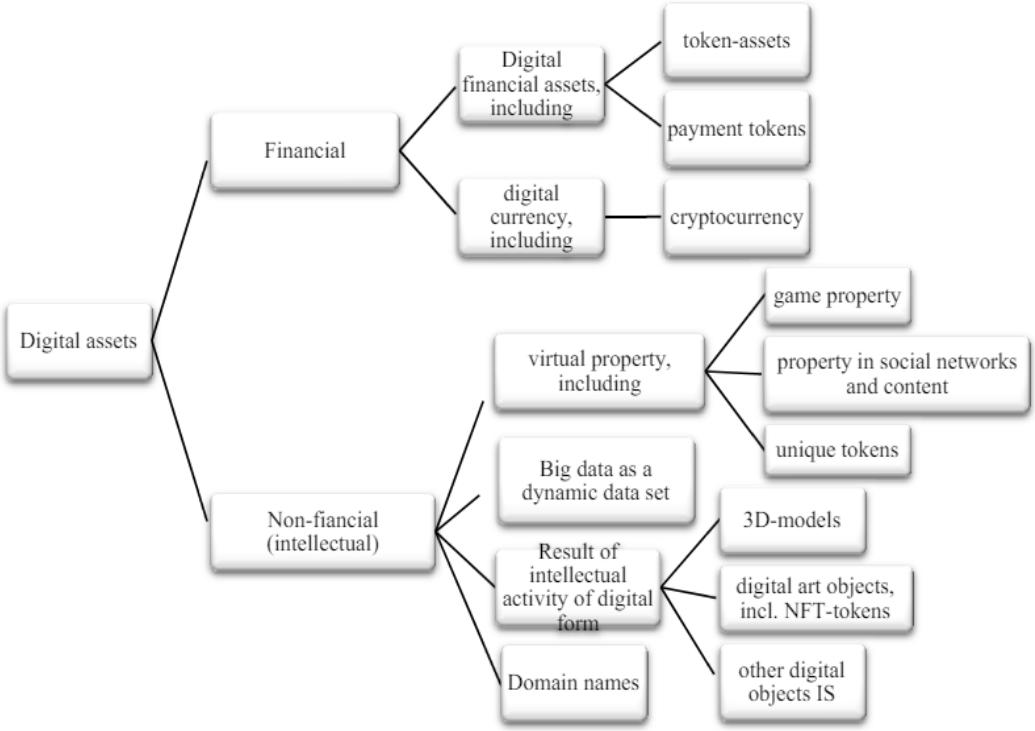

Figure 1. Classification of digital assets by form of functioning

Traditional Valuation Methods

Cost Approach: Valuing assets based on their acquisition cost minus depreciation. This approach calculates the value of an asset based on its original cost minus accumulated depreciation. While straightforward, it often fails to account for digital upgrades or enhancements that increase the asset's functionality and productivity.

Market Approach: Valuing assets based on comparable market transactions provides a snapshot of what similar assets are worth in the market. This method can be insufficient in a digital context where market comparable may not reflect the value added by digital features.

Income Approach: This method estimates an asset's value based on the income it is expected to generate. Traditional income projections may not fully account for revenue enhancements and cost savings derived from digital integration. Determining value based on the expected income the asset will generate. While these methods provide foundational insights, they lack the granularity to capture the value added by digital components and data-driven efficiencies.

Digital Economy Considerations: In the digital economy, fixed assets often have augmented value due to:

Digital Integration: Fixed assets integrated with digital technologies (e.g., IoT-enabled machinery, smart buildings) can perform more efficiently, provide real-time data for decision-making, and adapt to changes dynamically. Enhancement of physical assets with software, IoT, and connectivity.

Data Utilization: The use of data analytics and AI to optimize asset performance and predict future value. The value of data generated and leveraged by fixed assets for predictive maintenance, operational optimization, and strategic planning needs to be included in the valuation.

Network Effects: Assets in a digital ecosystem often gain additional value through interoperability and connectivity with other systems and assets, enhancing overall performance and productivity. Value derived from the connectivity and interoperability of assets within digital ecosystems.

Digital Maturity Assessment: Evaluating the extent to which assets are integrated with digital technologies. Data Value Assessment: Estimating the contribution of data generated and utilized by the asset.

Proposed Methodology

Evaluate the extent and impact of digital integration on the asset. Metrics include the level of automation, data analytics capabilities, and connectivity. Quantify the value added by data generated through asset usage. This involves assessing the utility and economic benefits derived from data analytics and insights. Adjust valuations for the rapid pace of technological change, considering the likelihood of digital components becoming outdated and the cost of future upgrades.

Real-Time Data Analytics

Utilize IoT sensor data to assess real-time asset performance, operational status, and maintenance needs. This real-time insight can enhance the accuracy of the asset's valuation by reflecting current condition and efficiency. Apply machine learning models to predict future asset performance, maintenance requirements, and potential failures, thereby providing a more dynamic view of the asset's value over time.

Hybrid Valuation Approach

Incorporate costs related to digital enhancements (e.g., software upgrades, IoT integration) into the cost approach, adjusting for the improved functionality and lifespan. Combine traditional market comparables with digital-specific transaction data and trends. This provides a more accurate reflection of what similar digitally enhanced assets are worth in the market. Integrate additional revenue streams and efficiencies from digital features into the income approach, projecting higher and more sustained income generation capabilities.

Stakeholder Input and Regulatory Compliance

Involve diverse stakeholders, including asset managers, IT professionals, and financial analysts, to validate assumptions and provide insights into digital enhancements and their impact on asset value.Ensure that the valuation methodology complies with accounting standards and regulations that are evolving to address digital and intangible assets. Standards like IFRS and GAAP are increasingly recognizing the importance of digital asset valuation.

Technology Obsolescence Factor: Accounting for the rapid obsolescence of digital technologies affecting asset value.

Implementation and Case Studies: The proposed methodology can be implemented using a modular framework that adapts to various industries and asset types. Case studies on industries such as manufacturing, logistics, and utilities demonstrate how digital integration can significantly alter asset valuation. For example, a manufacturing firm using IoT for predictive maintenance can increase asset lifespan and optimize operational efficiency, thus enhancing the asset's value.

Conclusion

Developing a comprehensive methodology for fixed asset valuation in a digital economy requires the integration of traditional valuation methods with advanced digital metrics and real-time data analytics. This approach not only captures the augmented value contributed by digital enhancements but also provides a more dynamic and accurate assessment of an asset's worth in the rapidly evolving digital landscape. Future research should focus on refining these models and exploring their applicability across different sectors and asset types. The proposed methodology offers a robust framework for valuing fixed assets in the digital economy, integrating traditional valuation techniques with contemporary digital metrics and real-time data analytics. By considering the unique contributions of digital enhancements, this approach provides a more accurate and dynamic assessment of asset value, aligning with the rapid technological advancements and data-driven efficiencies characterizing the digital economy. Future research should focus on refining this methodology and exploring its application across various sectors and asset types to ensure its broad applicability and effectiveness.

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ЗАВИСИМОТЬ ПОТЕРИ ВОДЫ ОТ ИЗМЕНЕНИЯ КОЭФФИЦИЕНТА ПРОНИЦАЕМОСТИ ДНА И БОКОВЫХ СТЕНОК КАНАЛОВ

Аннотация: Рассматривается диффузия соленной воды из коллекторного источника в движущуюся воды канала. Исследуется распределения загрязнения вод по длине канала и приводится аналитическая формула по определению длины пути полного смешения коллекторной воды с пресной водой. Построены решения задачи для однородного случая коэффициента проницаемости. В случае переменной концентрации, получаемой за счет изменения концентрации солей, получены нейтральные представления, которые позволяют определить основные гидродинамические параметры фильтрационного процесса.

Ключевые слова: концентрация, компонент, загрязнения вод, диффузия, длина смешивания, коллектор, источник, пути полного смешивания, инжектор, диффузия соленой воды, диффузия в жидкость, фильтрации жидкостей.

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DEPENDENCE OF WATER LOSS ON CHANGE IN PERMEABILITY COEFFICIENT OF BOTTOM AND SIDE WALLS OF CANALS

Abstract: Diffusion of salt water from a collector source into moving water of a channel is considered. Distribution of water pollution along the channel length is investigated and analytical formula for determining the length of the path of complete mixing of collector water with fresh water is given. Solutions of the problem for a homogeneous case of permeability coefficient are constructed. In the case of variable concentration obtained due to change in salt concentration, neutral representations are obtained, which allow determining the main hydrodynamic parameters of the filtration process.

Key words: concentration, component, water pollution, diffusion, mixing length, collector, source, complete mixing paths, injector, salt water diffusion, diffusion into liquid, liquid filtration.

Постановка вопроса

Фильтрации воды из оросителя бороздового типа ирригационной системы. Почвы грунта являются многофазной и многокомпонентной средой, и состоит из почвенного скелета, которого берем за твердой фазой. Почвенный скелет имеет сложную геометрию и обладает большой удельной поверхностью. Который имеет своего рода большой проницаемостью, т.е. фильтрации жидкостей, поэтому коэффициент фильтрация имеет определённое значение в зависимости от концентрации жидкости.

Рассмотрим задачу о фильтрации воды из оросителя бороздового типа ирригационной системы (рис.1.) , при этом учитывается капиллярность грунта. Для применения к решению задачи струйного метода Жуковского, оросителя заменим источником жидкости. В дальнейших предположениях, принимая одну из линий равных напоров за поперечные сечения русла оросителя, распространим полученные результаты на случай оросителя, ближнего к трапеции поперечного сечения.

Рассматривается задача о фильтрационном течении воды из канала в плоской постановке ([7],[8]). Предположим, что поток воды течет равномерно по каналу трапецеидального поперечного сечения BCDC'B' со средней скоростью V_T - с расходом:

$$Q = V_1[bH + (B-b)H + \beta\pi]$$

H-глубина потока в канале определяемой равенств и свободной поверхности канала, b,B- ширина дна канала.

Где

$$H = \frac{B-b}{2} tg\beta\pi$$

По смещенному периметру DCB, происходит протекания жидкости (воды) в почву равномерно, а форма поперечного сечения призматического русла состоит из равнобедренной трапеции, с углом наклона- $\beta\pi$. боковых сторон к горизонтальной плоскости. Тогда вертикальная линия -DE будет симметричной линией фильтрационного потока и совпадает с координатной линией oy.Вследствие подвижности потока по (руслам) каналу, жидкость, проникает в грунт под углом $\alpha\pi$ (в область G_z).

Для водоема, где жидкость (вода) находится в колебании равновесия, угол проникание будет равен $\alpha\pi = \frac{\pi}{2}$ (вертикально к стенкам корпуса). Вдали от источника (стенки и дно канала) кривая депрессии становится горизонтальным и это создаёт условию применение рассматриваемой задачи струйную модель И.Е. Жуковского (рис.1). При предположение кривой подпора $К_1К$ (рис1) непроницаемой и расположенной горизонтально.

Канал расположен на поверхности грунта, который имеет коэффициент проницаемости- k. Через смоченный периметр трапеции BCDC'B' происходит фильтрации воды, которая распространяется по грунту, а на глубине h_F имеется непроницаемый водоупор EA. Если коэффициент проницаемости- $k(x,y)$ симметричен относительно вертикальной оси ED(Oy), то за областью течения G_z (z=x+iy) примем

AEDCBF (где x>0),при этом образуется свободная поверхность AFB, где точка F-является точкой перегиба. При отсутствии точки перегиба точка F совпадает с точкой B.

Вдоль границы DE, в основном, происходит вертикальное течение из-за симметрии области течения G_z. В качестве закона фильтрациии принят закон Дарси [1]:

$$\vec{V} = -kgradh \tag{1}$$

Где $\vec{V}$ – фильтрационная скорость; h- напор.

Здесь:

$$h = \frac{p}{\rho g} + y,$$

Где h - пьезометрическая высота, p, ρ – давление и плотность частиц жидкости, y – ордината точки.

Предположим, что течение потенциальное, тогда можно ввести потенциал скорости $\varphi(x, y)$ в виде

$$\vec{V} = u\vec{i} + v\vec{j} = grad\varphi.$$

откуда $u = \frac{\partial\varphi}{\partial x}, v = \frac{\partial\varphi}{\partial y}$. (2)

Отсюда получим равенство

$$grad\varphi. = -kgradh$$

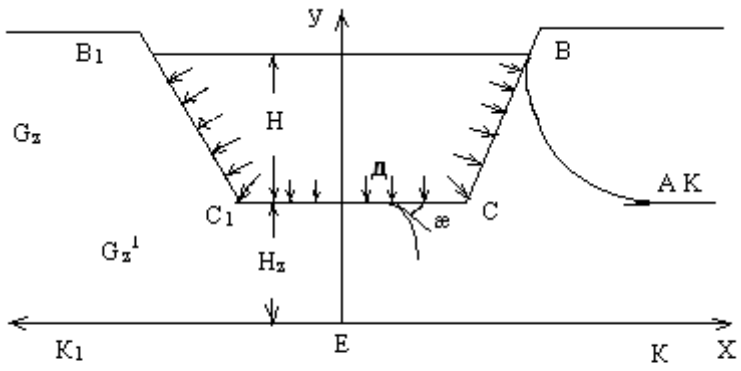

Рис.1.Зависимоть потери воды от изменений коэффициента проницаемости дна и стенок каналов

или

$$\frac{\partial\varphi}{\partial x} = -k\frac{\partial h}{\partial x}, \frac{\partial\varphi}{\partial y} = -\frac{\partial h}{\partial y}k. \tag{2}$$

При постоянстве коэффициента проницаемости k в области течения будем иметь

следующую функцию скорости потенциала:

$$\varphi = -kh + C \text{ или } \varphi + kh = C$$

Если жидкость несжимаема,то:

$$(\rho = const)$$

и поэтому уравнение неразрывности имеет следующий вид:

$$div\vec{V} = 0$$

Введем функцию тока, $\psi(x, y)$ удовлетворяющую уравнению неразрывности:

$$u = \frac{\partial \psi}{\partial y}, v = -\frac{\partial \psi}{\partial x}. \quad (3)$$

$$u = \frac{\partial \varphi}{\partial x} = \frac{\partial \psi}{\partial y} = -k\frac{\partial h}{\partial x}, \quad (4)$$
$$v = \frac{\partial \varphi}{\partial y} = -\frac{\partial \psi}{\partial x} = k\frac{\partial h}{\partial y}.$$

Учитывая равенства (2) и (3), получаем следующую зависимость между введенными нами к рассмотрению функциями $\varphi(x, y)$ и $\psi = (x, y)$:

$$\frac{\partial \psi}{\partial y} = -k\frac{\partial h}{\partial x}, \quad (5)$$
$$\frac{\partial \psi}{\partial x} = k\frac{\partial h}{\partial y}.$$

Если коэффициент проницаемости к постоянен, то функция $\varphi(x, y)$ $\psi = (x, y)$ и $h(x, y)$ будут гармоническими в области течения, а при переменном к(x,y) в силу равенства:

$$\vec{V}\psi = [gradk, gradh]$$

Получаем, что вдоль линии постоянного напора коэффициент проницаемости должен быть постоянным, т.е.

$$gradk = gradh,$$

отсюда получаем равенство

$$[gradk, gradh] = 0.$$

Решение задачи строим известным методом Жуковского [2]. Для этого введем в рассмотрение каноническую область G_0, (верхнюю полуплоскость, где $\varsigma = \xi + i\eta$ и $\eta = 0$), действительная ось которой совпадает с границей области течения Gz, где (z=x+iy), а также функцию Жуковского

$$\omega(\varsigma) = \ln\frac{V_0}{V} = \tau + i\theta(\xi, \eta),$$

Где V_0 – скорость фильтрации в некоторой точке свободной поверхности BFA; $\vec{V} = u - iv$ – сопряженная комплексная скорость, $\tau = \ln \frac{V_0}{|V|}, \theta(\xi,\eta)$ – угол наклона вектора скорости $\vec{V}$ к горизонту, т.е. к оси Ox.

Для введенной функции $\omega(\varsigma)$ будем иметь следующие граничные условия ([1],[2],[3]):

вдоль KA при $\eta = 0, \xi \in [-\infty,-a], lm\omega = 0,$

вдоль AFB при $\eta = 0, \xi \in [-a,0], \operatorname{Re}\omega = \tau_i(\xi),$

вдоль BC при $\eta = 0, \xi \in [0,c], lm\omega = \beta\pi - \alpha\pi,$

вдоль CD при $\eta = 0, \xi \in [c,1], lm\omega = -\alpha\pi,$

вдоль DE при $\eta = 0, \xi \in [1,e], \operatorname{Im}\omega = -\frac{\pi}{2},$

вдоль EK при $\eta = 0, \xi \in [e,\infty], lm\omega = 0.$

Введя функцию $\omega_1(\varsigma) = \frac{\omega(\varsigma)}{\sqrt{\varsigma}\sqrt{\varsigma + a}}$ и пользуясь интегральной формулой Шварца (4),

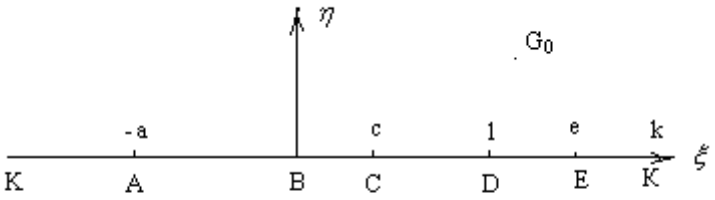

Рис.2. Каноническая область течения

получим аналитическое вкражение для функции Жуковского [5, 6]:

$$\omega(\varsigma) = \frac{\sqrt{\varsigma}\sqrt{\varsigma + a}}{\pi} \int_{-a}^{a} \frac{\tau_1(t)dt}{\sqrt{|t|}\sqrt{|t+a|}(t-\varsigma)} - (x-\alpha)I_2(\varsigma) - \alpha I_3(\varsigma) \qquad (6)$$

$$I_2(\varsigma) = \int_0^a \frac{dt}{\sqrt{t}\sqrt{a+t}(t-\varsigma)},$$

$$I_3(\varsigma) = \int_c^1 \frac{dt}{\sqrt{t}\sqrt{a+t}(t-\varsigma)},$$

$$I_1(\varsigma) = \int_{-a}^{a} \frac{\tau_1(t)dt}{\sqrt{|t|}\sqrt{|t+a|}(t-\varsigma)}$$

Для определения неизвестной функции $\tau_1(t)$, используя условие постоянства

давления вдоль свободной поверхности AFB, будем иметь равенство (при отсутствии инфильтрации и испарения) (1).

$$\tau_1 = \ln\left[\frac{k}{V_0}\sin\theta(\xi)\right] \tag{7}$$

Учитывая равенство (6) и (7), а также теорему Сохоцкого-Племеля (5), получим следующее сингулярное уравнение вдоль свободной поверхности AFB:

$$\theta(\xi) = \frac{\sqrt{|\xi|}\sqrt{|\xi+a|}}{\pi}\int_{-a}^{a}\frac{\ln\left[\frac{k}{V_0}\sin\theta(t)\right]dt}{\sqrt{|t|}\sqrt{|t+a|}(t-\xi)} + \theta_0(\xi) \tag{8}$$

Где

$$\theta_0(\xi) = lm\left[(\alpha - x)I_2(\varsigma) - \alpha I_3(\varsigma)\right]$$

Решение нелинейного сингулярного интегрального уравнения осуществляется методом последовательных приближений, где за нулевое приближение принимается случай отсутствия силы тяжести и сил поверхностного натяжения $\theta^{(0)} = \theta_0(\xi)$:

$$\theta^{(S)}(\xi) = \frac{\sqrt{|\xi|}\sqrt{|\xi+a|}}{\pi}\int_{-a}^{0}\frac{\ln\left[\frac{k}{V_0}\sin\theta^{(S-1)}(t)\right]dt}{\sqrt{|t|}\sqrt{|t+a|}(t-\xi)} + \theta_0(\xi) \tag{9}$$

Приведем решение задачи в линейной постановке, где предполагается, что модуль скорости фильтрации на отрезке [a,0] при $\eta = 0$ линейно зависит от ξ:

$$V = V_1(a+\xi) = V_0(1+\xi/a) \tag{10}$$

Тогда

$$\tau_1(\xi) = \ln(1+\frac{\xi}{a})$$

и для функции Жуковского в области G_0 имеет вид

$$\omega(\varsigma) = \ln[\varphi(\varsigma)] \tag{11}$$

Где

$$\varphi(\varsigma) = [F(-a,\varsigma)]^{-2}[F(c,\varsigma)]^{-2\beta}[F(1,\varsigma!]^{2a-1}[F(e,\varsigma)]^{-1}, \tag{12}$$

$$F(-a,\varsigma) = \frac{\sqrt{\varsigma+a}}{\sqrt{\varsigma}+\sqrt{\varsigma+a}},$$

$$F(1,\varsigma) = \frac{\sqrt{a}\sqrt{\varsigma-1}}{\sqrt{\varsigma}\sqrt{a+1}+\sqrt{\varsigma+a}},$$

$$F(c,\varsigma) = \frac{\sqrt{a}\sqrt{\varsigma-c}}{\sqrt{\varsigma}\sqrt{a+c}+\sqrt{c}\sqrt{\varsigma+a}},$$

$$F(e,\varsigma)=\frac{\sqrt{a}\sqrt{\varsigma-e}}{\sqrt{\varsigma}\sqrt{a+e}+\sqrt{e}\sqrt{\varsigma+a}},$$

Отсюда находим вкражение для сопряженной комплексной скорости в области G_0

$$\overline{V}=V_0[F(-a,\varsigma)]^{-2}[F(c,\varsigma)]^{-2\beta}[F(1,\varsigma)]^{1-2a}[F(e,\varsigma)]. \quad (13)$$

Теперь приступим кпостроению функции комплексного потенциала $w=\varphi+i\psi$ в области G_0 .

Вдоль BC, DC при

$$\eta=0,\xi\in[0,1],\ \mathrm{Im}\frac{dw}{d\varsigma}=\psi_\xi;$$

Вдоль KA, AB, DE, и EK при

$$\eta=0,\xi\in[0,1],\ \mathrm{Im}\frac{dw}{d\varsigma}=0.$$

Учитывая эти краевые условия и интегральную формулу Шварца, получим интегральную равенству:

$$\frac{dw(\varsigma)}{d\varsigma}=\frac{1}{\pi}\int_0^1\frac{\psi_1 dt}{t-\varsigma} \quad (14)$$

Отсюда при условии вдоль проницаемқх границ BC и CD ,$\eta=0,\xi\in[0,1]$ получим равенство:

$$\varphi(\xi,0)=\frac{1}{\pi}\int_0^1\frac{\psi_1 dt}{t-\varsigma} \quad (15)$$

Тогда для неизвестной функции ψ_ξ получим следующее сингулярное интегральное уравнение:

$$\psi_\xi=\frac{tg\alpha\pi}{\pi}\int_0^1\frac{\psi_1 dt}{t-\varsigma} \quad (16)$$

Решением уравнения (16) получим функцию

$$\psi_\xi=\frac{Q\sin\alpha\pi}{\pi\xi}\left(\frac{\xi}{1-\xi}\right)^a \quad (17)$$

Далее из равенств (15) и (16) определяем функции $w(\xi)$ и φ_ξ :

$$\varphi_\xi=\frac{Q\cos\beta\pi}{\pi\xi}\left(\frac{\xi}{1-\xi}\right)^a \quad (18)$$

Функция комплексного потенциала определится интегрированием из формулы (15):

$$w(\varsigma)=\frac{Q}{\pi}\left(\frac{t}{t-1}\right)^{a}\frac{dt}{t} \tag{19}$$

Используя выражения для комплексной скорости (13) и комплексного потенциала, получим выражение для функции, отображающей область течения $G_я$ на область G_0:

$$z(\varsigma)=\frac{Q}{\pi V}\int_0^c\frac{1}{\phi(t)}\left(\frac{t}{t-1}\right)^{a}\frac{dt}{t}+z_B \tag{20}$$

Где

$$z_B=b+\frac{B-b}{2}+i\frac{B-b}{2}tg\beta\pi$$

Таким образом, решение задачи определяется выражениями (13), (20), полученными в параметрической форме:

$$\begin{cases}\overline{V}=u-iv=\varphi(\varsigma)V_0\\ z(\varsigma)=\dfrac{Q}{\pi V_0}\displaystyle\int_0^{\zeta}\frac{1}{\varphi(t)}\left(\frac{t}{t-1}\right)^{\alpha}\frac{dt}{t}+z_H\end{cases} \tag{21}$$

$\overline{V}$ -скорость частиц жидкости, $z(\varsigma)$ - характерная функция движущейся жидкости.

Гидравлические параметры движущейся воды по борозде

С учетом граничных условий и условий для скорости фильтрации можно получить следующие аналитические выражения для определения неизвестных параметров отображения a,c,e и гидравлических параметров (параметр f определяется из условия на точке перегиба):

Длина наклонной части борозды:

$$l_{BC}=\frac{Q}{\pi V_0}\int_0^c\frac{1}{|\varphi(t)|}\left(\frac{t}{1-t}\right)^{\alpha}\frac{dt}{t}, \tag{22}$$

Глубина фильтруемой воды под борозды:

$$H_k=\frac{Q}{\pi V_0}\int_1^e\frac{1}{|\varphi(t)|}\left(\frac{t}{t-1}\right)^{\alpha}\frac{dt}{t},$$

Ширина дна борозды,

$$b=\frac{Q}{\pi V_0}\int_c^1\frac{1}{|\varphi(t)|}\left(\frac{t}{1-t}\right)^{\alpha}\frac{dt}{t}. \tag{23}$$

Глубина потока воды в борозде (рис.1.) определяется равенства выше приведенный формулы (21), т.е.

$$h = H = l_{BC} \sin \beta\pi$$

Расход воды в борозде определяется из условий:

$$Q = V \cdot S = V_0 \varphi(\varsigma) \cdot \frac{4b + 2l_{BC} \cos\pi\beta}{2} \cdot h$$

Изменение расхода воды в борозде определяется из условий

$$\frac{d}{dt} Q = \frac{d}{dt}(V \cdot S) = \frac{d}{dt}(V_0 \varphi(\varsigma) \cdot \frac{4b + 2l_{BC} \cos\pi\beta}{2} \cdot h)$$

Если точке перегиба линии депрессии находится в точке $\eta = 0, \xi = f$, то должно выполняться условие

$$x_\xi y_{\xi\xi\xi} - y'_\xi x_{\xi\xi\xi} = 0$$

$$\text{т.е } \frac{x_\xi}{y_\xi} = const$$

как известно отсюда можем написать условию

$$x_\xi = c y_\xi .$$

Расход воды в борозде, протекающие через проницаемые поверхности BC определяется формулой:

$$\frac{Q_1}{Q} = \frac{1}{\pi} \int_0^c \left(\frac{t}{1-t} \right)^\alpha \frac{dt}{t}, \qquad (24)$$

Расход воды в борозде через проницаемые поверхности CD, определяется формулой:

$$\frac{Q_2}{Q} = \frac{1}{\pi} \int_1^c \left(\frac{t}{1-t} \right)^\alpha \frac{dt}{t}.$$

Величина испарения с водной поверхности определяется из формулы:

$$E_i = Q - \frac{Q_1 + Q_2}{Q}$$

Таким образом, получим зависимость расходов Q_1 и Q_2 от параметров области течения $b, B, h_E, \alpha\pi$ и $\beta\pi$.

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YANGI INNOVATSION YONDOSHUVLAR ORQALI FIZIKA DARSLARINI SAMARALI TASHKIL ETISH

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Annotatsiya: Ushbu ishda axborot texnologiyalar sohasida kadrlar uchun fizika fanini o'qitishda muhum bo'lganzamanoviy dasturiy vositalar, xususan "FASTMEAN" dasturidan foydalanishning afzalliklari va yutuqlari haqida so'z yuritilgan. Ta'lim jarayonlarida zamonaviy axborot texnologiyalardan foydalangan holda darslarni tashkillashtirishdagi maxsus dasturiy vositalarni, fizik va matematik jarayonlarni kompyuterda modellashtirishni, real fizik jarayonning immitatsion kompyuter modelini yaratishnng asoslarini tushintirib berilgan. Modellashtirishning o'ziga xos muhim tomonlari, turli xil fizik qurilma va asboblar modellashtirish shartlari, hodisalarni jonli va tabiiy ko'rinishda tasvirlanishi, kuzatish qiyin bo'lgan jarayonlarni ham namoyish eta olish imkoniyatiga egaligidir.

Kalit so'zlar: Axborot - kommunikatsion texnologiyalarini, fastmean, ta'lim jarayoni, pedagogik dasturiy vosita, fizik jarayonlar, modellashtirish.

EFFECTIVE ORGANIZATION OF PHYSICS LESSONS USING NEW INNOVATIVE APPROACHES

Abstract: This paper discusses the advantages and achievements of using modern software, in particular the FASTMEAN program, which are important when teaching physics to personnel in the field of information technology. The educational process outlines special software for organizing classes using modern information technologies, computer modeling of physical and mathematical processes, and the basics of creating a simulation computer model of a real physical process. The unique and important aspects of simulation are various physical devices and tools for simulating conditions, vivid and natural depiction of events, and the ability to demonstrate processes that are difficult to observe.

Key words: Information and communication technologies, fastmean, educational process, pedagogical software, physical processes, modeling.

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Kirish

Axborot - kommunikatsion texnologiyalarini ta'lim jarayoniga qo'llash hozirgi vaqtdagi eng dolzarb muammolaridan biri bo'lib kelmoqda, sababi har bir sohada o'rganish, izlanish va tajriba orttirish uchun turli usullardan foydalanish kerak bo'ladi. Shuning uchun bog'chadan tortib to yuqori saviyadagi ishlarni o'rganishda hozir yangi axborot - kommunikatsion texnologiyalaridan foydalanish maqsadga muvofiqdir[1-2].

Ta'lim jarayonlarida zamonaviy axborot texnologiyalardan foydalangan holda darslarni tashkillashtirish uchun maxsus dasturiy ta'minotlar bo'lishi kerak. Bugungi kunda o'qitishning ananaviy ko'rinishidan farq qiladigan zamonaviy axborot texnologiyalarini qo'llash orqali o'qitishni tashkil etish yuqori samaradorlikka erishishga imkoniyat yaratadi. Fizika fanini o'qitish borasida o'quvchilar ongida nazariy modelning tasavvurlarini shakllantirish, hodisalar va jarayonlar bilan tanishtirishning samarali metodlarini ishlab chiqish muhimdir [3].

Pedagogik dasturiy vositalar talabalarga ko'pgina ko'z bilan ko'rib bo'lmaydigan fizik jarayonlarni sodda modellar orqali tasavvur qilishga, murakkab tushunchalarni tushunishda yordam beradi. Fizikada matematik modellash, simulyatsiya va vizualizatsiya muhim rol o'ynaydi, chunki bu usullar orqali talabalar abstrakt tushunchalarni aniqroq anglaydilar [4].

Asosiy qism

Pedagogik dasturiy vositalar quyidagi afzalliklarni mavjud:

Interaktivlik: Talabalar dars jarayonida faol ishtirok etib, o'rganilgan bilimlarni kompyuter modellar yordamida tezda sinab ko'ra oladi.

Simulyatsiya: Turli fizik hodisalarni vizual tarzda ko'rsatish orqali tushunishni osonlashtiradi.

Moslashuvchanlik: Professor-o'qituvchilar dars mavzularini turli darajalarda moslashtirib, talabalarning individual ehtiyojlariga moslab taqdim etishlari mumkin.

Fizik jarayonlarni modellashtirish imkoniyatini beradigan dasturlarga: Origin, MathCad, MatLab, Maple, Crocodile Physics, Electronics, Workbench, Interactive Physics va boshqa dastur paketlarini misol keltirish mumkin. Shu bilan birga tayyor ochiq kodli Phet pedagogik dasduriy ta'minoti "PhET Simulyatsiyalari", "GeoGebra" va Logger Pro ham mavjuddir [5].

PhET Simulyatsiyalari: Kolorado universiteti tomonidan ishlab chiqilgan interaktiv simulyatsiyalar fizik hodisalarni o'rganishda keng qo'llaniladi. PhET Simulyatsiyalari Interaktivlik, Vizualizatsiya, Keng qamrovli mavzular va foydalanishning osonligi kabi afzalliklaridan tashqari vazifalarni real tajribalarda emas modellashtirilgan kompyuter grafikasida bajarish, cheklangan imkoniyatli virtual laboratoriyalarni bajarish hamda internet va katta quvvatli kompyuterning mavjud bo'lishi.

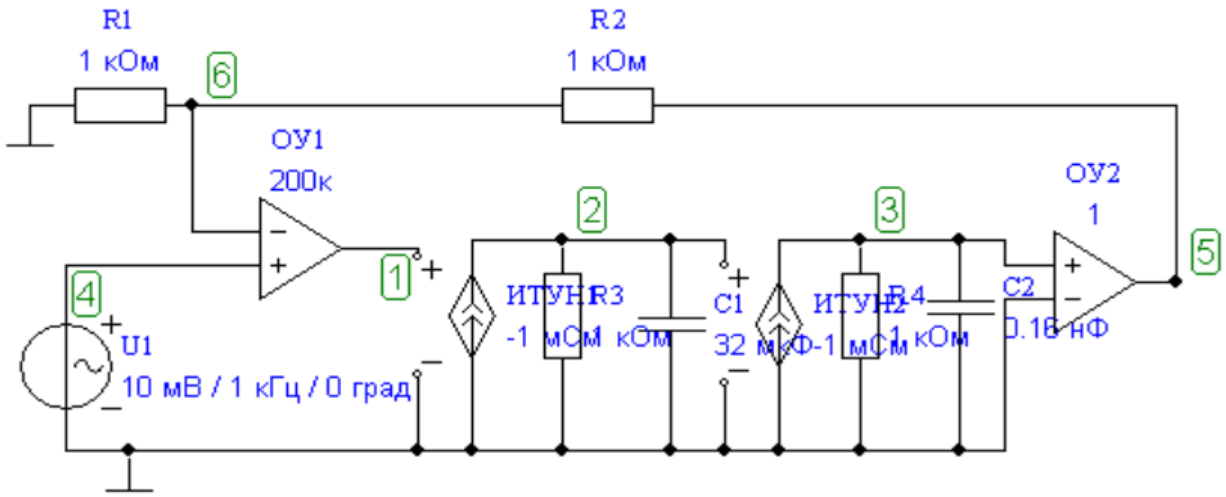
GeoGebra: Matematik va fizik tushunchalarni vizualizatsiya qilish uchun juda qulay bo'lgan dastur. GeoGebra orqali talabalar grafiklar chizish, modellashtirish va tahlil qilish kabi vazifalarni bajarishlari mumkin. GeoGebra - Matematik va fizik modellashtirish: Matematik va fizik modellarni yaratish va tahlil qiluvchi dasturiy vosita. U yordamida grafiklar va diagrammalarni dinamik tarzda ifodalash mumkin.

Logger Pro: Bu dastur laboratoriya ishlarini amalga oshirishda qo‘llaniladi. Sensorlar yordamida olingan ma’lumotlarni tahlil qilish va grafik ko‘rinishda taqdim etish imkonini beradi. Logger Pro - real vaqtda ma’lumot to‘playdi, tahlil qiladi hamda grafik va diagrammalarni yaratib beradi. Bu dastur yordamida fizika fanidan laboratoriya ishlarini samarali va interaktiv tarzda o‘tkazish imkoniyati mavjuddir.

Fizik va matematik jarayonlarni kompyuterda modellashtirish uchun informatsion texnologiyaga oid bilimlardan keng foydalaniladi [6]. Ta’lim tizimida multimediyali elektron o‘quv adabiyotlar, ma’ruzalar, virtual labaratoriya ishlari, har xil animasion dasturlar va yana boshqa ishlarni yaratishda kerak bo‘ladigan maxsus dasturlar mavjud. Fizik jarayonlarni modellashtirish imkoniyatini beradigan dasturlarga: Origin, MathCad, MatLab, Maple, Crocodile Physics, Electronics, Workbench, Interactive Physics va boshqa dastur paketlarini misol keltirish mumkin. Shu bilan birga tayyor ochiq kodli Phet pedagogik dasduriy ta’minoti ham mavjuddir. Phet pedagogik dasturiy paketini Kalorada universiteti olimlari tomonidan ishlab chiqilgan va keng ommoga ochiq kod bilan tarqatilgan [7].

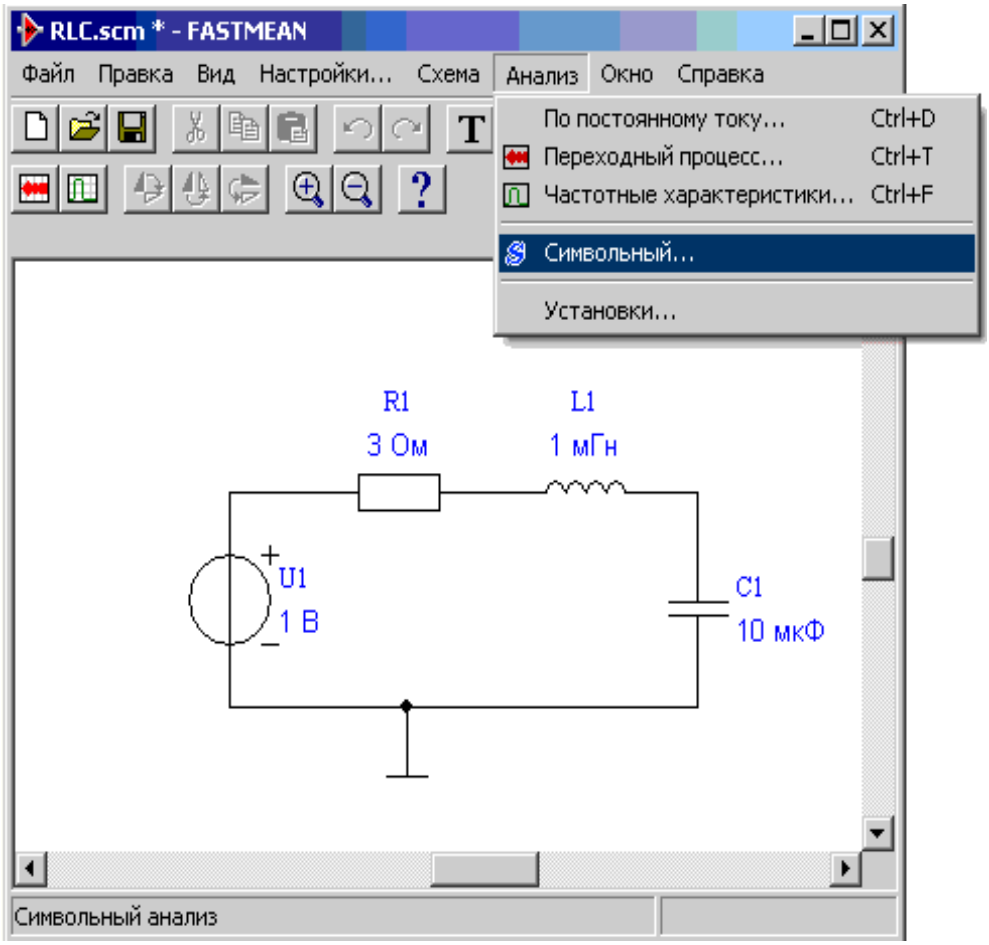
FASTMEAN - chiziqli va chiziqli bo‘lmagan elementlarni o‘z ichiga olgan sxemalar uchun o‘tish jarayonini, signal spektrlarini, chastota xarakteristikasini hisoblash imkonini beradigan elektr zanjirlarini modellashtiruvchi dasturi. Zamonaviy elektrotexnika va elektron qurilmalarni ishlab chiqish jarayonida nazariy va eksperimental tadqiqotlar bilan bir qatorda sxematik modellashtirish keng qo‘llaniladi [8-10]. Axborot texnologiyalari sohasida tahsil olayotgan talabalarga fizikani o‘qitishda sxematik modellashtirish o‘quv jarayonining muhim qismini tashkil qiladi. FASTMEAN dasturi elektr zanjirlar uchun tenglamalarni yechish uchun yangi algoritmlardan foydalanadi [11-12].

FASTMEANning ichki imkoniyatlaridan eng muhumi vaqt domenini tahlil qila olishidir. Chiziqli bo‘lmagan impuls tizimlarini tahlil qilganda, FASTMEANda hisoblash tezligi eng yaxshi ixtisoslashtirilgan dasturlarning tezligi marta yuqori. Shu bilan birga, aniqlik har doim yuqori bo‘ladi (1-rasm).



1-rasm. FASTMEAN dasturi yordamida sxema yaratish algaritmi

Barcha elementlar guruhlarga bo‘linadi. Har bir guruhda asboblar panelida tegishli tugma mavjud (2-rasm).



2-rasm. Asboblar paneli

Har qanday guruh elementlarini ko‘rsatish uchun tegishli tugmani bosing. Uning ostida elementlar bilan oyna paydo bo‘ladi. Sichqoncha ko‘rsatgichini elementni joylashtirmoqchi bo‘lgan diagramma ustiga olib boring va sichqonchaning chap tugmasi bilan bir marta bosing (2-rasm).

Xuddi shu elementni diagrammadagi boshqa joyga qo‘shish uchun sichqonchani o‘sha joyga olib boring va yana chap tugmasini bosing. Buni bir necha marta qilish mumkin. Elementni qo‘shishni tugatish uchun sichqonchaning o‘ng tugmachasini bosing.

Bu pedagogik daturiy vositalar yordamida o‘rganuvchi o‘quvchilar istalgan paytda fizik jarayonlarni to‘xtatib qo‘yishi, orqaga qaytarishi hamda dastlabki parametrlarni o‘zgartirib jarayonning ishtirokchisidek his qilishi mumkin. Fizik jarayonni o‘rganish albatta ma’lum bir model, ya’ni mazkur jarayonning mavhumlashtirilgan, soddalashtirilgan obrazi asosida olib boriladi. Real fizik jarayonning immitasion kompyuter modelini yaratishda ma’lum bir model asos qilib olinadi.

GeoGebra — bu matematik va fizik tushunchalarni vizualizatsiya qilish va modellashtirish uchun keng imkoniyatlar yaratadigan qulay dasturiy vositadir. U dars jarayonini interaktiv va qiziqarli qilishda yordam beradi. GeoGebra yordamida fizik hodisalarni grafik ko‘rinishda tasvirlash, modellashtirish va tahlil qilish mumkin.

Logger Pro — bu Vernier tomonidan ishlab chiqilgan, ilmiy ma'lumotlarni to'plash, tahlil qilish va vizualizatsiya qilish imkoniyatini beruvchi dasturiy vositadir. Fizika darslarida Logger Pro ni qo'llash talabalarga laboratoriya ishlarini samarali va interaktiv tarzda o'tkazish imkonini beradi

Shuningdek modellashtirishning o'ziga xos muhim tomonlari shundaki, turli xil fizik qurilma va asboblar tayyorlash shart emas, hodisalarni jonli va tabiiy ko'rinishda tasvirlanishi, tajribani oz fursat ichida istalgan marta takrorlash mumkinligi, kuzatish qiyin bo'lgan yoki umuman kuzatilishi mumkin bo'lmagan jarayonlarni ham namoyish eta olish imkoniyatiga egaligi. O'qituvchiga bu pedagogik dasturiy vositalar kompyuter monitorida shuningdek, multimedia proyektori yordamida ko'pgina fizik effektlarni namoyish etishning hamda yangi noan'anaviy o'qitish turini takomillashtirishning imkonini beradi. Bugungi kunga kelib informatsion texnologiyalardan foydalanish ko'zga ko'rinmas, tez yoki sekin o'tuvchi jarayonlarning, murakkab hodisalarning fizik mexanizmlarni animatsiya qilish imkonini yaratadi.

Xulosa

Shunday ekan ta'lim jarayoniga zamonoviy texnologiyalarni qo'llash orqali ta'limning sifat va samaradorligini oshirishimiz mumkin. Fundamental fizik nazariyalarga asosan fizika kursi materiallari to'g'ri va yagona sistemaga keltirilgan. Bu esa fan olamidagi barcha ilmiy yo'nalishlarning g'oyalari asosidagi ilmiy bilimlar o'quvchilarning ilmiy dunyoqarashini shakllantirish uchun asos bo'ladi, degan xulosaga olib keladi.

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APPLICATION OF GENERATING FUNCTIONS IN PROBABILITY AND COMBINATORICS

Abstract: In this paper, we introduce the importance of generating functions in probability and combinatorics. Generating functions and their properties were previously studied by many scientists and are considered to be one of the main tools of modern mathematics. These functions can solve a number of problems. We prove that problems Fibonacci number, problem with weight measurement, number division problem A and number division problem B can be solved using generating functions. During the study of the article, it can be seen that the method we propose is simple and easy to prove compared to the classical solution of the above problems.

Keywords: Generating functions; binomial coefficients; Fibonacci numbers; Bine formula; Euler's moment; number decomposition; Markov chains; stochastic branching processes; Q-processes.

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Introduction

The method of generating functions is considered one of the main parts of probability theory and mathematical statistics, in particular, the theory of stochastic branching processes and Markov chains. The method of generating functions is a very convenient and excellent mathematical method that allows solving the problems encountered in number theory, probability theory and combinatorics by bringing them to the problems of mathematical analysis. In many cases, the analytical expression of such problems created by the method of generating functions is quickly solved, and other methods do not give us anything; see [1-4]. At the same time, it is clear that the method of generating functions cannot be used in all cases. To see how the method of generating functions works, we solve several problems. Some of them are classical problems, the solution of which was found by L.Euler in the middle of the 18th century; see [5].

The purpose of this work is to show that generating functions play an important role in binomial series, Fibonacci numbers, weighting, and number decomposition problems. Theorems are proved by the method of generating functions. In combinatorics, the concept of series are used as a useful tool for working with sequences created by combinatorical objects. For example, if the question of division is being considered, the number of divisions $R(n)$ can be obtained as the sum of addends of $n-$natural number ($n \in \mathrm{N}$) as the elements of such a sequence of numbers. From the definition and properties of the generating function, it is clear that these functions can be used to study and solve various problems related to sequences.

Matherials and Methods

Generating functions are usually used in the theory of branching processes. For example, Galton-Watson branching processes. We introduce the population growth system called Q-processes. This is defined by the Galton-Watson Branching system conditioned on non-extinction of its trajectory in the remote future; see [6-9].

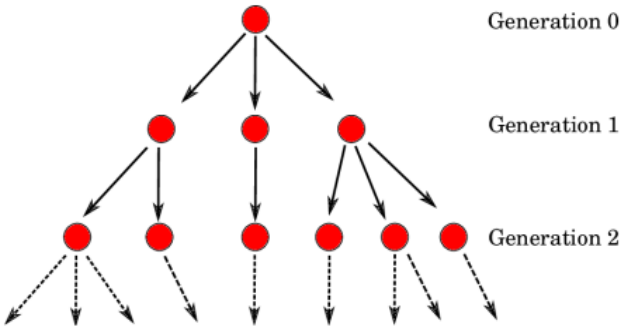

Figure 1. the number of generations produced by thr particle.

Let $Z(0)=1$. If we set $Z(n)$ as the number of particles in $n-$th generation, then we have

$$Z(n+1)=\begin{cases}\sum\limits_{i=1}^{Z(n)}\xi_{n+1}^{(i)}, & if \quad Z(n)>0,\\ 0, & if \quad Z(n)=0,\end{cases} \tag{1}$$

where $\xi_{n+1}^{(i)}$ is the number of generations produced by the $i-$th particle in the $n-$th generation. For example, in figure 1, we have

$$Z(1)=\xi_1^{(1)}=3 \text{ and } Z(2)=\xi_2^{(1)}+\xi_2^{(2)}+\xi_2^{(3)}=2+1+3=6.$$

Definition. (Generating functions) An important tool in the analysis of the process is the generating function

$$f(s):=\sum_{k=0}^{\infty}p_k s^k, \quad |s|\leq 1, \tag{2}$$

and its iterates

$$f_0(\mathrm{s})=\mathrm{s}, \quad f_1(\mathrm{s})=f(\mathrm{s}), \quad f_{n+1}(\mathrm{s})=f\left[f_n(\mathrm{s})\right], \tag{3}$$

where s is complex in general.

Generating functions of sequences related to combinatorial operations are of special interest. Generating functions can be used to prove many theorems or to re-prove existing theorems. We proved the following problems again by the method of generating functions:

1. Fibonacci number;

2. Problem with weight measurement;

3. Number division problem A;

4. Number division problem B.

Main Results

First, we will focus on the problem of finding the $n-$th term of the Fibonacci sequence, which is very popular. The original proof of this theorem can be found in [10].

Let the following sequence be given:

$$u_0=0, \ u_1=1, \ u_n=u_{n-2}+u_{n-1}, \quad n\geq 2. \tag{4}$$

This is called the generalized Fibonacci sequence.

Theorem 1. (Fibonacci number) Let u_n be the Fibonacci number. Then

$$u_n=\frac{1}{\sqrt{5}}\left[\left(\frac{1+\sqrt{5}}{2}\right)^n-\left(\frac{1-\sqrt{5}}{2}\right)^n\right]. \tag{5}$$

Theorem 2. (Problem with weight measurement) Let 1,2,4,8,... gram stones be given. In that case, a whole number of arbitrary loads can be measured by a single method.

Theorem 3. (Number division problem A) Let

$$x_1+x_2+\ldots+x_m=k, \ x_i\in \mathrm{N}_0, \ m\in \mathrm{N}, \ k\in \mathrm{N}_0, \tag{6}$$

where $\mathrm{N}_0:=\{0\}\cup \mathrm{N}$, $\mathrm{N}=1,2,3,\ldots$. Then, for fixed numbers m and k, the number of all solutions of the equation in non-negative integers is equal to

$$\bar{C}_m^k = C_{m+k-1}^k = \frac{(m+k-1)!}{k!(m-1)!}. \tag{7}$$

Theorem 4. (Number division problem B) Let

$$x_1 + x_2 + \ldots + x_m = k,\ \ x_i \in \mathrm{N},\ \ m \in \mathrm{N},\ \ k \in \mathrm{N}, \tag{8}$$

Then, for fixed natural numbers m and k, the number of all solutions of the equation in positive integers is equal to

$$C_{k-1}^{m-1} = \frac{(k-1)!}{(k-m)!(m-1)!}. \tag{9}$$

Proof of Theorems

Proof of Theorem 1. We use the method of unknown coefficients and, taking into account that the function

$$u(x) = \frac{x}{1-x-x^2}$$

is in the form of a fraction, we describe it as a sum of two fractions. To do this, we first find the roots of the quadratic equation $1-x-x^2=0$:

$$x_1 = \frac{-1-\sqrt{5}}{2} \quad \text{and} \quad x_1 = \frac{-1+\sqrt{5}}{2}.$$

If we set $-x_1 = \alpha$ and $-x_2 = \beta$, then $\alpha+\beta=1$ and $\alpha\cdot\beta=-1$. Now we divide the square trinomial $1-x-x^2$ into multipliers:

$$1-x-x^2 = -(x+\alpha)(x+\beta) = \alpha\beta(x+\alpha)(x+\beta) =$$
$$= (\beta x+\alpha\beta)\cdot(\alpha x+\alpha\beta) = (\beta x-1)(\alpha x-1) = (1-\alpha x)(1-\beta x).$$

And so,

$$u(x) = \frac{x}{(1-\alpha x)(1-\beta x)} = \frac{A}{1-\alpha x} + \frac{B}{1-\beta x},$$

$$\frac{x}{1-x-x^2} = \frac{A+B-(\mathrm{A}\beta+\mathrm{B}\alpha)x}{(1-\alpha x)(1-\beta x)},$$

$$x = A+B-(\mathrm{A}\beta+\mathrm{B}\alpha)x,$$

$$\begin{cases} A+B=0, \\ A\beta+B\alpha=-1. \end{cases}$$

Solving this system, we find that

$$A = \frac{1}{\alpha-\beta} = \frac{1}{\sqrt{5}} \quad \text{and} \quad B = \frac{1}{\beta-\alpha} = \frac{-1}{\sqrt{5}}.$$

According to the last expression and [11], we have the following relation:

$$u(x)=\frac{x}{1-x-x^2}=\frac{1/\sqrt{5}}{1-\alpha x}+\frac{-1/\sqrt{5}}{1-\beta x}=\frac{1}{\sqrt{5}}\left(\frac{1}{1-\alpha x}-\frac{1}{1-\beta x}\right)=$$

$$=\frac{1}{\sqrt{5}}\left(\sum_{n=0}^{\infty}(\alpha x)^n-\sum_{n=0}^{\infty}(\beta x)^n\right)=\frac{1}{\sqrt{5}}\sum_{n=0}^{\infty}(\alpha^n-\beta^n)x^n=$$

$$=\sum_{n=0}^{\infty}\frac{1}{\sqrt{5}}\left[\left(\frac{1+\sqrt{5}}{2}\right)^n-\left(\frac{1-\sqrt{5}}{2}\right)^n\right]x^n.$$

Since

$$u(x)=\sum_{n=0}^{\infty}u_n x^n,$$

the Bine formula (see [12]) is appropriate for the generalized Fibonacci numbers determined by the conditions $u_0=0$ and $u_1=1$. Theorem 1 is proved.

Proof of Theorem 2. How much time Euler spent on solving this problem and how he came to the solution is unclear to us, but his thinking, which has reached us, is very surprising for its extraordinariness. We consider the following

$$A(z)=\prod_{n=0}^{\infty}(1+z^{2n})=(1+z)(1+z^2)(1+z^4)\ldots$$

multiplication and, after opening the brackets and simplifying, express it in the form of the following infinite multiplication of z:

$$A(z)=1+a_1z+a_2z^2+a_3z^3+\ldots. \tag{10}$$

A natural question arises: what are the numbers $a_i,\ i\in\mathrm{N}$ equal to? Each a_n is the coefficient in front of z^n, which is the number of expressions in the form of the product of some z^{2^m} monomials, at most one from each parenthesis. In other words, a_n consists of the number of measurements of a load weighing n grams using the considered stones. So, to solve this problem, it is necessary to calculate a_n. Here Euler makes one most extraordinary case.

We multiply the following

$$(1-z)(1+z)=1-z^2,$$

$$(1-z^2)(1+z^2)=1-z^4.$$

$$(1-z^4)(1+z^4)=1-z^8$$

equations and reduce their common multipliers to form

$$(1-z)(1+z)(1+z^2)(1+z^4)(1+z^8)\ldots=1$$

or $(1-z)\mathrm{A}(z)=1$ equations. In this case, according to the formula of the sum of the infinitely decreasing geometric progression, we have:

$$A(z)=\frac{1}{1-z}=1+z+z^2+z^3+\ldots. \tag{11}$$

Comparing the following equations (10) and (11), it follows that $a_n \equiv 1$ for all n, that is, an arbitrary load of whole number of grams can be measured using $1,2,2^2,\ldots,2^n,\ldots$ gram stones in a single way. Theorem 2 is proved.

Proof of Theorem 3. Consider the following equation:

$$\mathrm{B}(z)=(1+z+z^2+z^3+\ldots)^m. \tag{12}$$

If we simplify the resulting expression by opening the parentheses, we get the following expression:

$$\mathrm{B}(z)=1+b_1z+b_2z^2+b_3z^3+\ldots,$$

where $b_i,\ i\in\mathrm{N}$ is the coefficient in front of z^n, which is the number of ways to choose one integer from each parentheses in the (12) expression. On the other hand, b_k is equal to the number of non-negative integer solutions of the equation (6).

So, the solution of the problem was brought to the calculation of b_k. For this, we will create the following

$$\mathrm{B}(z)=(1-z)^{-m}=1+b_1z+b_2z^2+b_3z^3+\ldots \tag{13}$$

equality, remembering the sum formula in geometric progression.

By differentiating this equation and taking $z=0$ in the resulting equation, we make sure that $b_1=m$. Continuing this, i.e. taking the k-order derivative from both sides of the equation (13) and taking $z=0$ in the resulting equation, we obtain the following equation

$$b_k=\frac{m(m+1)(m+2)\cdot\ldots\cdot(m+k-1)}{k!}.$$

Theorem 3 is proved.

Proof of Theorem 4. This theorem is proved in a similar way to the proof of Theorem 3.

Conclusion

In conclusion, the above theorems can be reproved using generating functions. It can be seen in the re-proof that our proposed method is simpler, faster, and more convenient than the classical proof (Euler's method). Using this method, you can try to prove other theorems.

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PROSPECTS FOR USING PEROVSKITE TANDEM SOLAR CELLS

Abstract: Perovskite solar cells represent the fastest growing solar cell technology in terms of improving energy conversion efficiency over the past decade. This has emerged as a promising technology for low-cost, high-efficiency next-generation photovoltaic systems, including multi-junction tandem cell concepts. Double junction tandem cells have a much higher efficiency of 45%, which exceeds the Shockley–Queisser limits of single junction solar cells.

Keywords: perovskite, solar cells, efficiency, tandem, multijunction tandem cells.

ПЕРСПЕКТИВЫ ИСПОЛЬЗОВАНИЯ ПЕРОВСКИТНЫХ ТАНДЕМНЫХ СОЛНЕЧНЫХ ЭЛЕМЕНТОВ

Аннотация: Перовскитные солнечные элементы представляют собой самую быстроразвивающуюся технологию солнечных элементов с точки зрения повышения эффективности преобразования энергии за последнее десятилетие. Это стало многообещающей технологией для создания недорогих и высокоэффективных фотоэлектрических систем нового поколения, включая концепции многопереходных тандемных элементов. Тандемные элементы с двойным переходом имеют гораздо более высокий КПД - 45%, что превышает пределы Шокли–Квиссера для солнечных элементов с одним переходом.

Ключевые слова: перовскит, солнечные элементы, КПД, тандем, многопереходных тандемных элементов.

Mualliflar

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Основная часть

Технология солнечных элементов на основе кристаллического кремния в настоящее время доминирует на коммерческом рынке фотоэлектрической техники благодаря своей надежности с точки зрения технологии производства, надежности продукции и низким производственным затратам, которые значительно снизились за последнее десятилетие, что привело к экспоненциальному росту числа установок по всему миру. Однако существующая технология основана на однокристальном кремниевом солнечном элементе, который по своей сути ограничен с точки зрения эффективности преобразования энергии (PCE). Максимальный практически достижимый предел составляет 29,4% с учетом оже-рекомбинации в кремниевом материале. В случае, когда ширина запрещенной зоны одиночного перехода не ограничена и отсутствуют неидеальные потери, теоретический предел при стандартном освещении AM1.5G составляет 33,8%, что далеко от 100%. Основными факторами, влияющими на это различие, являются подзонный зазор и потери на термализацию. Первое происходит от фотонов с энергией, меньшей, чем ширина запрещенной зоны полупроводника в однопереходном солнечном элементе, которые не могут быть поглощены путем создания электронно-дырочных пар, а второе - от фотонов с энергией, превышающей ширину запрещенной зоны, которые поглощаются, но их избыточная энергия рассеивается в виде тепла.

Многопереходные тандемные солнечные элементы представляют собой совокупность солнечных элементов с различной шириной запрещенной зоны (наибольшей на стороне, обращенной к солнцу), что позволяет каждому элементу более эффективно поглощать различные части солнечного спектра, сводя к минимуму подзонную ширину и потери на термализацию. На рисунках 1(a) и 1(b) показаны две конфигурации тандемных ячеек с двумя переходами. На рисунке 1(c) показано уменьшение подзоны и потерь на термализацию по мере увеличения числа переходов в тандемной батарее. Предел теоретической эффективности многопереходных устройств также увеличивается с увеличением количества переходов с 45% для двойных переходов до 51% для тройных переходов и до 55% для тандемов с четырьмя переходами, как показано на рис. 1(d). За последние несколько десятилетий для солнечных элементов III-V типа были внедрены концепции с несколькими переходами, особенно для космических применений, где эффективность преобразования энергии имеет первостепенное значение, перевешивая затраты.Тандем с двумя переходами является простейшей реализацией многопереходного подхода. Они могут быть реализованы путем механического наложения элемента с высокой пропускной способностью поверх элемента с низкой пропускной способностью, при этом элементы работают независимо друг от друга электрически. Общая мощность - это сумма мощностей, генерируемых каждым элементом. Такой подход требует наименьших усилий по интеграции, позволяя изготавливать и оптимизировать элементы независимо друг от друга за счет дополнительной проводки и изолирующего слоя между элементами, что влечет за собой дополнительные затраты. Изолирующий слой необходимо выбирать таким образом, чтобы уменьшить несоответствие показателя преломления при взаимодействии с ячейками, чтобы свести к минимуму оптические потери из-за френелевского отражения. Прозрачные электроды также должны обладать достаточной боковой проводимостью для автономной работы ячейки, но неизбежно приведут к некоторому уровню потерь оптической передачи.

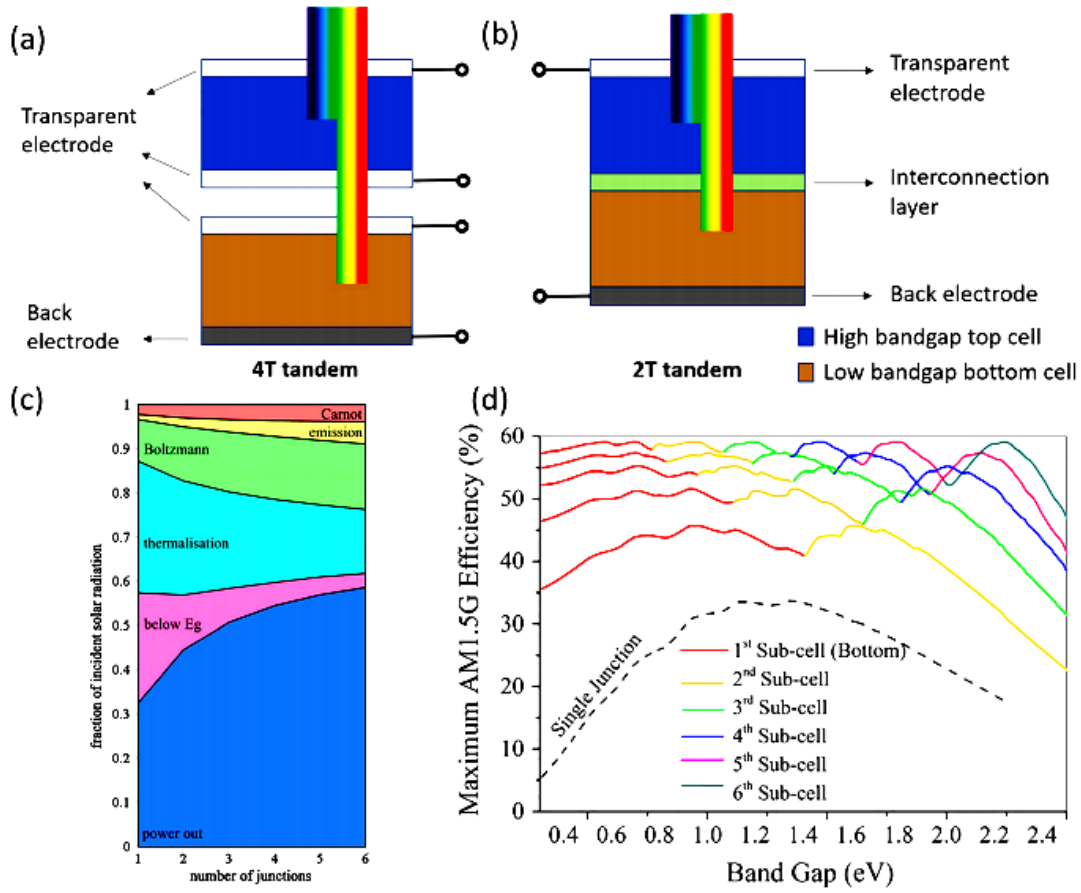

Рисунок 1. Схемы двух типов тандемных конфигураций с двумя переходами: (a) тандем с механическим соединением четырех выводов (4T) и (b) тандем с монолитной интеграцией двух выводов (2T).

Монолитно интегрированный тандем представляет собой более элегантный тандемный подход, обычно включающий изготовление ячейки с высокой пропускной способностью непосредственно на ячейке с низкой пропускной способностью. Это означает, что технологии изготовления верхней ячейки должны быть “совместимы с нижней ячейкой”, чтобы не привести к каким-либо повреждениям во время обработки ячейки. Также требуется изготовление соединительного слоя (слоев), но он может быть выполнен сверхтонким, поскольку слой или стопка отвечают только за вертикальную (а не боковую) транспортировку носителя. Это может быть сделано с помощью туннельных или рекомбинационных слоев в виде селективных слоев-носителей, прозрачного проводящего оксида (TCO), такого как оксид индия-олова (ITO), или ультратонкого металла. Поскольку ячейки электрически соединены последовательно, выходное напряжение тандема будет равно сумме напряжений отдельных ячеек. Однако ток будет ограничен ячейкой с наименьшей выходной мощностью. Это подчеркивает важность эффективности отдельных ячеек для тандемов. Нет смысла размещать низкоэффективную ячейку с высокой пропускной способностью поверх высокоэффективной ячейки, “отбирая” у нее ценный солнечный свет. Поэтому технологии, выбранные для тандемных ячеек, должны быть сопоставимыми и обеспечивать одинаковую эффективность.

Технология гибридных металлогалогенных солнечных элементов на основе перовскита (кристаллическая структура перовскита показана на рис. 2(a)) недавно стала перспективным кандидатом для использования в тандемах с несколькими переходами благодаря быстрому повышению эффективности преобразования энергии (КПЭ) с 3,8% в 2009 году до недавно сертифицированных 25,5% в 2020 году. Высокая производительность обусловлена высокой эффективностью внешнего излучения (ARE), сравнимой с эффективностью солнечных элементов из кремния и селенида индия-галлия (CIGS). Перовскиты обладают сильным оптическим поглощением, что означает, что ячейки могут быть изготовлены в виде тонких пленок и их можно легко изготовить с помощью обработки в растворе. Ширина запрещенной зоны также может быть изменена (например, с 1,20 до 2,3 эВ) с помощью разработки состава. Все эти свойства делают металлогалогенидные перовскиты весьма желательными для применения в тандемных элементах. Совсем недавно появились сообщения о тандемах перовскит–Si, перовскит–CIGS, перовскит–перовскит и перовскит–органическая фотоэлектрика (OPV), которые продемонстрировали многообещающую эффективность преобразования энергии.

На рисунке 2(b) показаны потенциалы эффективности тандемных солнечных элементов на основе перовскита с двойным переходом, основанные на расчетах предела Шокли-Квиссера с учетом ширины запрещенной зоны, указанной в таблице на рисунке. По 2 для каждого подэлемента. Значения запрещенной зоны для нижних ячеек Si, CIGS, перовскита и OPV основаны на том, что было продемонстрировано или осуществимо, особенно для перовскита и OPV. Верхние полосы пропускания ячеек основаны на наилучших значениях, которые обеспечивают наивысшую производительность тандемных ячеек при условии 100%-ного поглощения и отсутствия неидеальной рекомбинации несущих в любой из подсистем, что позволяет достичь эффективности преобразования энергии выше 40%. Это свидетельствует о большом потенциале этих технологий, позволяющем преодолеть пределы эффективности однопереходных ячеек.

Выводы и перспективы

Хотя некоторые проблемы уникальны для каждой технологии, общие задачи включают разработку высокопроизводительного и стабильного перовскита с широкой запрещенной зоной, что наиболее важно для полной реализации потенциала элементов с несколькими переходами на основе перовскита. Считается, что благодаря постоянным исследованиям и разработкам в области перовскитной фотоэлектрики будет достигнут дальнейший прогресс, и о прорывах в тандемах с тройным переходом будет сообщено в самом ближайшем будущем.

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SOME NON-GENERIC VOLTERRA-TYPE STOCHASTIC OPERATORS OF ORDER 4 ON S^2 SIMPLEX

Abstract. In the 70s of the last century, quadratic stochastic operators and their application in modeling genetics began to be studied. The study of cubic stochastic operators and their applications began in 2000. Currently, there is a lot of information about them. But it was not possible to fully study cubic operators in two-dimensional simplex. Due to the large number of parameters, no internal fixed point overview was found. It is not even possible to fully study the volterra type. Therefore, an attempt is being made to isolate and study a larger family.

Key words: Simplex, stochastic operators, volterra-type operators, two-dimensional, V quadratic evolutionary operator, ergodic, fixed point.

S^2 SIMPLEKSDA VOLTERRA TIPIDAGI, UMUMIY HOLATDA BO‘LMAGAN BA’ZI 4-DARAJALI STOXASTIK OPERATORLAR

Annotatsiya. O‘tgan asrning 70-yillarida kvadratik stoxastik operatorlar va ularning genetika masalalarini modellashtirishdagi tadbiqlari o‘rganila boshlandi. Kubik stoxastik operatorlar, ularning tadbiqlarini o‘rganish 2000 yillarda boshlangan. Hozirgi kunda ular haqida olingan ma’lumotlar anchagina ko‘p. Lekin ikki o‘lchamli simpleksdagi kubik operatorlarni to‘liq o‘rganish imkoni bo‘lmagan. Parametrlar ko‘pligi bois, ichki qo‘zg‘almas nuqta umumiy ko‘rinishi topilmagan. Xatto, volterra tipidagilarni to‘liq o‘rganish mumkin bo‘lmayapti. Shuning uchun biror kattaroq oilani ajratib olib o‘rganishga xarakat qilinmoqda.

Kalit so‘zlar: Simpleks, stoxastik operatorlar, volterra tipidagi operatorlar, ikki o‘lchamli, V kvadratik evolyutsion operator, ergodik, qozg‘almas nuqta.

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Kirish

Populyatsiya genetikasi masalalarida kvadratik stoxastik operatorlar tabiiy tarzda paydo bo‘lib, cheklangan o‘lchovli simpleksda ishlaydi. Bunday holda, biologik tizimning evolyutsiyasi kvadratik stoxastik operator tomonidan yaratilgan diskret dinamik tizim bilan tavsiflanadi.

Genetik tizimlarning dastlabki eng oddiy modellari V.Volterra , S.N.Bernshteyn [10], Yu.I.Lyubich va boshqa mualliflarning ishlarida o‘rganilgan. Biologik tizimni o‘rganishda analitik va ehtimollik usullarini qo‘llash T.A. Sarimsoqovning [15] asarlarida taklif qilingan va ishlab chiqilgan. Uning taklifi bilan Volterra tipidagi kvadratik stoxastik operatorlar atroflicha o‘rganildi. R.N.G‘anixo‘jaev [16] Volterra tipidagi kvadratik stoxastik operatorlarni grafik nazariyasi va differensial tenglamalar nazariyasidan foydalangan holda o‘rgangan. Bu nazariyaning asosiy vazifasi kvadratik stoxastik operatorlar traektoriyasining cheklovchi xatti-harakatlarini o‘rganishdir. E'tibor bering, hatto ikki o‘lchovli simpleksda ham muammo to‘liq hal qilinmagan.

Populyatsiya genetikasi muammolari so‘nggi ikki asr davomida ko‘plab matematiklar tomonidan o‘rganildi. Chekli o‘lchovli simpleksda harakat qiluvchi kvadratik stoxastik operatorlar populyatsiya genetikasi muammolarida tabiiy ravishda paydo bo‘ladi. Bunday holda, biologik tizimning evolyutsiyasi diskret dinamik tizim bilan tavsiflanadi. Birinchi marta genetik tizimlarning eng oddiy modellari G.X.Xardi, Yu.I.Lyubich, G.Kesten, V.Volterra, S.N.Bernshteynlar asarlarida o‘rganilgan. Dinamik tizimlarni o‘rganishning ehtimollik usullari birinchi bo‘lib T.A.Sarymsokov tomonidan qo‘llanilgan. Uning taklifi bilan diskret dinamik tizimlar batafsil o‘rganila boshlandi. R.N.G‘anixo‘jaev ishlarida Volterra tipidagi kvadratik stoxastik operatorlar grafiklar nazariyasi va differensial tenglamalarning sifat nazariyasidan foydalangan holda o‘rganilgan. Ushbu nazariyaning asosiy vazifasi Volterra xaritalash traektoriyasining cheklovchi xatti-harakatlarini o‘rganishdir.

Matematik- biologiya masalalarida tabiiy ravishda dinamik sistemalar paydo bo‘ladi, (m-1) o‘lchovli

$$S^{m-1} = \{x = (x_1, x_2, \dots, x_m) : x_i \geq 0, \sum_{i=1}^{m} x_i = 1\}$$

simpleksda

$$V:\ x_k' = \sum_{ij=1}^{m} p_{ij,k}\, x_i x_j \qquad (1)$$

ko‘rinishidagi kvadratik akslantirish aniqlangan, bu yerda

$$P_{ij,k} \geq 0,\ \sum_{ij=1}^{m} P_{ij,k} = 1,\quad P_{ij,k} = P_{ji,k} \qquad (2)$$

Ushbu shartlar simpleksning saqlanishini ta’minlaydi.

Biologiyada V populyatsiyaning evolutsion operatori deyiladi. Populyatsiya organizmlar ko‘payishining birlashmasiga nisbatan yopiq aniqlanadi. Populyatsiyaning turli ketma-ket avlodlari ustma-ust tushmaydi, turli avlod vakillari o‘rtasida chatishish bo‘lmaydi deb faraz qilamiz.

Faraz qilamiz, populyatsiyadagi 1,2,...,m har bir individ m turning ba’zi (yagona) qismiga tegishli bo‘ladi. Tur (belgi) shkalasi shunday bo‘lishi kerakki, i,j ota-ona turi k turning nasl uchun ehtimolligini aniqlaydi. Bu ehtimollikni (nasl koeffisienti) $P_{ij,k}$ orqali belgilaymiz. Agar turlar jinsga bog‘liq bo‘lmasa, jumladan, $P_{ij,k} = P_{ji,k}$ bo‘lsa, u holda (2) shartlar bajariladi.

Faraz qilaylik, populyatsiya cheksiz (haqiqatda shunchalik kattaki, chastota tebranishini

e'tiborsiz qoldirish mumkin). U holda uning holatini $x = (x_1, x_2, \dots, x_m)$ turlarning ehtimolligi to'plami bilan tasvirlash mumkin. Panmiksiya yoki tasodifiy chatishtirishda ota-ona juftligi $x_i x_j$ ehtimollik bilan x holatda hosil bo'ladi.

Ya'ni,

$$x'_k = \sum_{ij=1}^{m} p_{ij,k}\, x_i x_j \tag{3}$$

bo'ladi.

Agar biror avlodda populyatsiya x holatda bo'lsa, u holda bu tur keyingi avlodda $x' = Vx$ holatda bo'ladi. Asosiy vazifalardan biri $x^0, Vx^0, V^2x^0, \dots$

trayektoriyalarning cheklangan harakatlarini, ya'ni V akslantirish iteratsiyasini o'rganishdan iborat ekanligi aniq.

Agar trayektoriya yaqinlashsa, u holda qo'zg'almas nuqta $x = Vx$ uning chegarasi bo'ladi, ya'ni muvozanat holati. Hech bo'lmaganda bitta qo'zg'almas nuqta mavjudligi Brauzr teoremasini qanoatlantiradi.

Umumiy olganda trayektoriya holati $\overline{x_1}, \overline{x_2}, \dots, \overline{x_p}$ chekli limit nuqtalar to'plamiga ega, ya'ni mos ravishda $\overline{x_1}, \overline{x_2}, \dots, \overline{x_p}$ ga yaqinlashadi. Bu holda (3) V akslantirishga nisbatan p tartibli sikl bo'lishi kerak, ya'ni (raqamlashgacha):

$$V\overline{x_s} = \overline{x_{s+1}} \qquad (s = \overline{1,p}, \qquad \overline{x_{p+1}} = \overline{x_1})$$

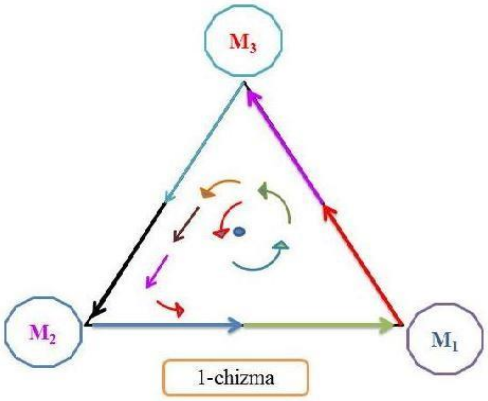
Ammo, bundan tashqari, limit nuqtalar to'plami cheksiz bo'lishi mumkinligini ko'ramiz. 1959-yilda Menstel, Smit va Ulam Los-Alamoss electron moshinasida ikki o'lchovli simpleksning 97 turdagi kvadratik akslantirish uchun trayektoriyalarning raqamli tahlilini o'tkazdi. Ular turli xil holatlarda topilgan [7]. Xususan, ular

$$V_0 := \begin{cases} x_1' = x_1^2 + 2x_1x_2 \\ x_2' = x_2^2 + 2x_2x_3 \\ x_3' = x_3^2 + 2x_1x_3 \end{cases} \tag{4}$$

misolni ko'rib chiqishdi va trayektoriya holati spiral shaklda ekanligini qayd etishdi. Kesten bu misolniV_ε $(0 < \varepsilon \leq 1)$ oilada ko'rdi:

$$\begin{cases} x_1' = x_1^2 + (1+\varepsilon)x_1x_2 + (1-\varepsilon)x_1x_3 \\ x_2' = x_2^2 + (1+\varepsilon)x_2x_3 + (1-\varepsilon)x_1x_2 \\ x_3' = x_3^2 + (1+\varepsilon)x_1x_3 + (1-\varepsilon)x_2x_3 \end{cases} \tag{5}$$

va matematik izlanishlar olib bordi [4]. Vallender 97 turdan 59 turini tekshirgan holda to'la natijalarga erishdi. Ko'rish osonki, V_ε akslantirish 4 ta qo'zg'almas nuqtaga ega: $C\left(\frac{1}{3},\frac{1}{3},\frac{1}{3}\right), M_1(1,0,0), M_2(0,1,0), M_3(0,0,1)$, ya'ni simpleks markazi va uchlari. Oddiy hisob-kitoblar shuni ko'rsatdiki, C itaruvchi fokus, $M_i(i = \overline{1,3})$ esa egar nuqta deyiladi. Simpleksning qirrasi invariantligi aniq. Vektor maydoni 1-rasmdagi ko'rinishga ega bo'ladi.



1 – rasm. Vektor maydoni.

Vallander simpleksning ichida yotgan C qo‘zg‘almas nuqtadan farqli bo‘lgan boshlang‘ich nuqtada trayektoriya chegaralar to‘plami simpleks chegarasida yotishini va cheksiz bo‘lishini isbotladi (Kesten bu tasdiqni boshlang‘ich nuqtasi C ga yaqin bo‘lmasligi sharti bilan isbotladi).

Vallandernng maqolasida ko‘rsatilgan, bu chegara simpleksning butun chegarasiga to‘g‘ri kelish yoki kelmasligi noma’lum, ammo barcha holatda uchlar to‘plamining ixtiyoriy atrofi uchun C.Ulam quydagi farazni ilgari surgan [13]:

Ergodik gipoteza. Simpleksning hamma joyida ixtiyoriy V kvadratik evolyutsion operator uchun $\frac{1}{n}(V + V^2 + \cdots + V^n)$ o‘rta arifmetik qiymat mavjud.

1978-yilda M.I.Zaxarevich (4) operatorga nisbatan quydagi tasdiqni isbotladi [7]. Ixtiyoriy $x^{(0)} \in intS^2, x^{(0)} \neq C$ uchun

$$\frac{1}{n}\sum_{k}^{n-1} V^k(x^{(0)})$$

ketma-ketlik mavjud bo‘lmaydi.

1982-yilda A.T.Sarimsaqov va R.N.G‘anixodjayev [15],[16],[17],[18],[19] ishlarida S^2va S^3 simpleksda

$$x_k' = x_k\left(1 + \sum_{i=1}^{m} a_{ki}x_i\right)$$

ko‘rinishdagi volterra tipidagi kvadratik stoxastik operatorlar (v.t.k.s.o.) o‘rganildi, bu yerda $a_{ki} = -a_{ik},\ |a_{ki}| \leq 1$. Ta’kidlab o‘tamiz $a_{ki} = \pm 1,\ x \in S^2$

da (4) k.s.o. ni olamiz.

Ushbu ishlarda har qaysi v.t.k.s.o. bilan yonma-yon turnir va S^2 va S^3 simpleksda trayektoriya xarakteri o‘rganilgan. Ergodik xossalar o‘rganilmagan.

Asosiy qism

Ikki o‘lchamli $S^2 = \{(x, y, z): x \geq 0, y \geq 0, z \geq 0\ \ x + y + z = 1\}$ simpleksda Volterra tipidagi to‘rtinchi darajali operator quyidagi ko‘rinishda bo‘ladi:

$$V_{42}\begin{cases} x' = x\{x^3 + 4[ax^2y + (1-b)y^3 + dx^2z + (1-c)z^3] + \\ +6[kxy^2 + (1-l)xz^2] + 12[h_1xyz + s_1y^2z + g_1yz^2]\} \\ y' = y\{y^3 + 4[bxy^2 + (1-a)x^3 + ey^2z + (1-f)z^3] + \\ +6[(1-k)x^2y + myz^2] + 12[s_1xyz + h_2x^2z + g_2xz^2]\} \\ z' = z\{z^3 + 4[cz^2x + (1-d)x^3 + fyz^2 + (1-l)y^3] + \\ +6[lzx^2 + (1-m)zy^2] + 12[g_3xyz + h_3x^2y + s_3y^2x]\} \end{cases}$$

Bu operatorni umumiy holatda o‘rganish anchayin qiyin, chunki operatorning parametrlari soni 15 ta bo‘lib, bunday operator dinamikasini o‘rganish murakkab. Shuning uchun parametrlar sonini kamaytirishga harakat qilamiz. Ikki o‘lchamli simpleksning uchchala qirrasi nuqtalari qo‘zg‘almas bo‘lsin. M_1M_2 da z = 0

$$x' = x\{x^3 + 4ax^2y + 4(1-b)y^3 + 6kxy^2\}$$
$$y' = y\{y^3 + 4bxy^2 + 4(1-a)x^3 + +6(1-k)x^2y\}$$
$$x' = x[x+y]^3 = x$$
$$y' = y[y+x]^3 = y$$

Bundan; 4a = 3 , 4(1-b) = 1 , 6k = 3 , 4b = 3 , 4(1-a) = 1 , 6(1-k) = 3 kelib chiqadi. U holda $= a = \frac{3}{4}, k = \frac{1}{2}$ bo‘ladi.

M_1M_3 da y = 0 bo‘lganda;

$$x' = x\{x^3 + 4dx^2z + 6(1-l)xz^2 + 4(1-c)z^3\}$$
$$z' = z\{z^3 + 4cz^2x + 6lzx^2 + 4(1-d)x^3\}$$
$$x' = x[x+z]^3 = x$$
$$z' = z[z+x]^3 = z$$

Bundan; 4d=3 , 6(1-l) = 3 , 4(1-c) = 1 ekanligi kelib chiqadi. U holda $d = c = \frac{3}{4}, l = \frac{1}{2}$ bo‘ladi.

M_2M_3 da x = 0 bo‘lganda;

$$y' = y\{y^3 + 4ey^2z + 6myz^2 + 4(1-f)z^3\}$$
$$z' = z\{z^3 + 4fyz^2 + 6(1-m)zy^2 + 4(1-l)y^3\}$$
$$y' = y[y+z]^3 = y$$
$$z' = z[z+y]^3 = z$$

Bundan ; 4e = 3 , 6m = 3 , 4(1-f) = 1 ekanligi kelib chiqadi. U holda $e = f = \frac{3}{4}, m = \frac{1}{2}$ bo‘ladi.

Dastlab, simpleksning barcha qirralari nuqtalari qo‘zg‘almas deb olsak, 9 ta parametr yo‘qoladi va operator ancha soddalashadi.

Demak, $a = b = c = d = e = f = \frac{3}{4}$, $k = l = m = \frac{1}{2}$ bo‘lganda operator quyidagi ko‘rinishga keladi :

$$V:\begin{cases} x' = x\{1+yz[(12h_1-6)x+(12s_2-3)y+(12g_3-3)z]\} \\ y' = y\{1+xz[(12s_1-6)y+(12h_2-3)x+(12g_2-3)z]\} \\ z' = z\{1+xy[(12g_1-6)z+(12h_3-3)x+(12s_3-3)y]\} \end{cases} \quad (6)$$

I. (6) operator 6 ta parametrga bog‘liq. Dastlab, ikkita parametrga bog‘liq operatorni qaraymiz. Agar $s_2 = s_3 = \frac{1}{4}$ $s_1 = \frac{1}{2}$, $g_2 = g_3 = \frac{1}{4}$ $g_1 = \frac{1}{2}$ desak, ikkita parametrga bog‘liq quyidagi operatorga ega bo‘lamiz:

$$V_h:\begin{cases} x' = x\{1+(12h_1-6)xyz\} \\ y' = y\{1+(12h_2-3)x^2z\} \\ z' = z\{1+[9-12(h_1+h_2)]x^2y\} \end{cases} \quad (7)$$

Ushbu operator uchun quyidagi teorema o‘rinli:

7- teorema: Agar boshlang‘ich nuqta $\overline{M_1M_2}$, $\overline{M_1M_3}$, $\overline{M_2M_3}$ qirralaridan birida yotsa , u holda bu nuqta qo‘zg‘almas nuqtadir, ya`ni qirradagi har bir nuqta qo‘zg‘almas bo‘ladi.

1) Agar $(h_1, h_2) \in \left[0, \frac{1}{2}\right) \times \left[0, \frac{1}{4}\right)$ u holda traektoriyasi $M_3(0;0;1)$ ga yaqinlashadi.

2) Agar $(h_1, h_2) \in \left[0, \frac{1}{2}\right) \times \left[\frac{1}{4}, 1\right)$, u holda traektoriyasi $M_1(1;0;0)$ ga yaqinlashadi.

3) Agar $(h_1, h_2) \in \left[\frac{1}{2}; 1\right] \times [0,1]$, u holda traektoriyasi $M_2(0;1;0)$ ga yaqinlashadi.

Isboti

1) $(h_1, h_2) \in \left[0, \frac{1}{2}\right) \times \left[0, \frac{1}{4}\right)$ bo‘sa , birinchi va ikkinchi koordinatalari kamayuvchi bo‘lib qoladi, uchinchi koordinata o‘suvchi va birga intiladi, ya’ni traektoriya $M_3(0;0;1)$ ga yaqinlashadi.

2) Agar $(h_1, h_2) \in \left[0, \frac{1}{2}\right) \times \left[\frac{1}{4}, 1\right)$ bo‘lsa, faqat birinchi koordinata o‘sadi, qolganlari kamayadi, traektoriya $M_1(1;0;0)$ ga yaqinlashadi.

3) Agar $(h_1, h_2) \in \left[\frac{1}{2}; 1\right] \times [0,1]$ bo‘lsa, faqat ikkinchi koordinata o‘suvchi bo‘ladi, traektoriya $M_2(0;1;0)$ nuqtaga yaqinlashadi.

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