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THE FIRST STEPS IN ARTIFICIAL INTELLIGENCE DEVELOPMENT IN MEDICINE IN UZBEKISTAN

PIERWSZE KROKI W ROZWOJU SZTUCZNEJ INTELIGENCJI W MEDYCYNIE W UZBEKISTANIE

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Authors' contribution
Wkład autorów:
A. Study design/planning
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B. Data collection/entry
zebranie danych
C. Data analysis/statistics
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D. Data interpretation
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F. Literature analysis/search
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Summary

Artificial intelligence (AI) as a field is based on such disciplines as computer science, biology, psychology, linguistics, mathematics, and mechanical engineering. AI uses algorithms, heuristics, pattern matching, rules, deep learning, and cognitive computing to approximate conclusions. With its ability to analyze complex medical data it can be used in the diagnosis, treatment, and predicting the outcome of many diseases. This paper presents the importance of AI in the healthcare system and by extension in our everyday lives. AI techniques have the potential to be applied in almost every field of medicine and every sphere of our life. AI has the possibility to help in areas with less hands-on healthcare. It is believed that geographically isolated areas can benefit from AIs which could replace physicians. Uzbekistan is one of the first countries in Central Asia which is enthusiastically moving towards digitalization. A group of scientists from Tashkent Pediatric Medical Institute (TPMI) created an AI system for diagnosing electrocardiogram (ECG) waveform outputted from the portable biometric sensor "Bitalino" in order to find out problems for introducing AI in the medical field in Uzbekistan. From this experience and the general literature, we conclude that the main barrier to mass use of AI in healthcare including in Uzbekistan may be two things: a huge amount of data for training, and personnel problem.

Keywords: artificial intelligence, medicine, Uzbekistan, healthcare, robotics

Streszczenie

Sztuczna inteligencja (ang. *Artificial Intelligence*, AI) jest działem nauki komputerowej i opiera się na takich dyscyplinach, jak: informatyka, biologia, psychologia, językoznawstwo, matematyka oraz budowa maszyn. Sztuczna inteligencja wykorzystuje algorytmy, heurystykę, dopasowanie do wzorca, reguły, głębokie uczenie i przetwarzanie kognitywne do szacowania wniosków. Dzięki zdolności analizowania złożonych danych medycznych sztuczna inteligencja może znaleźć zastosowanie w diagnostyce, a także leczeniu i przewidywaniu efektów wielu chorób. Niniejszy artykuł wskazuje, jak ważna jest sztuczna inteligencja w systemie ochrony zdrowia, a także w życiu codziennym. Techniki AI można zastosować w prawie każdej dziedzinie medycyny i każdej sferze życia. Sztuczna inteligencja może wspomóc te obszary, w których jest mniej specjalistów ochrony zdrowia. Uważa się, że w regionach odseparowanych geograficznie od reszty kraju AI mogłaby nawet zastąpić lekarzy. Uzbekistan jest jednym z pierwszych krajów Azji Środkowej, który wprowadza digitalizację z entuzjazmem. Zespół naukowców z Instytutu Medycyny Pediatrycznej w Taszkencie (TPMI) stworzył system sztucznej inteligencji do diagnozowania zapisu fal elektrokardiogramu (EKG) otrzymanego z przenośnego sensora biometrycznego „Bitalino", aby określić problemy, które mogą pojawić się podczas wprowadzania sztucznej inteligencji do medycyny w Uzbekistanie. Bazując na tym doświadczeniu oraz ogólnej literaturze, można stwierdzić, że głównym problemem hamującym wykorzystanie sztucznej inteligencji w uzbeckiej ochronie zdrowia na skalę masową mogą być dwie kwestie: ogromna ilość danych do przyswojenia oraz kłopoty z zasobami ludzkimi.

Słowa kluczowe: sztuczna inteligencja, medycyna, Uzbekistan, ochrona zdrowia, robotyka

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Introduction

Artificial intelligence (AI) is the ability of a digital computer or computer-controlled robot, or a program that can also think intelligently like a human, to perform tasks commonly associated with intelligent beings [1]. AI research has explored a variety of problems and approaches since its inception, but for the last 20 years or so has been focused on the problems surrounding the construction of intelligent agents-systems that perceive and act in some environment [2,3]. We are living in the age of intelligent machines. AI permeates our lives, performing tasks that, until quite recently, could only be performed by a human with specialized knowledge, expensive training, or a government-issued license [4]. Widespread use of AI is due to some major factors: it can automate even those processes that previously required human participation; it can quickly process and analyze truly gigantic amounts of information and calculate options using a variety of variables. And in this area, AI gives qualitatively better results compared to humans.

Another strength of AI in dealing with the consequences of natural disasters is how it increases our ability to predict and therefore plan events and circumstances. The potential of AI is not only to predict that a disaster will occur, but also to predict where it will strike the hardest, which defense systems may fail, and which communities are most at risk. This information can be used to improve decision-making about building permits and insurance.

Agriculture is also an important area of the economy where AI can be actively used. For this purpose, the world uses agricultural robots that cope with tasks such as harvesting, much more efficiently than humans; algorithms for monitoring the state of the soil and crop, which combines deep processing of data collected by drones and other sensors; forecasting algorithms that can predict the effect of various natural phenomena on the crop.

AI is actively used in the education system of developing countries, primarily in the form of some tools that help develop skills and testing systems. As educational solutions for AI continue to evolve, it is hoped that AI will help fill gaps in learning and teaching and allow schools and teachers to do more than ever before.

AI in medicine

AI in healthcare is the use of complex algorithms and software to emulate human cognition in the analysis of complicated medical data. Specifically, AI is the ability of computer algorithms to approximate conclusions without direct human input.

Alan Turing – the British mathematician was one of the founders of modern computer science and AI. In 1950s he defined intelligent behavior in a computer as the ability to achieve human-level performance in cognitive tasks, this later became popular as the 'Turing test' [5]. Researchers have explored the potential applications of intelligent techniques in every field of medicine and other spheres of our life [6,7]. The application of AI technology in the field of surgery was first successively investigated by Gunn in 1976, when he explored the possibility of diagnosing acute abdominal pain with computer analysis [8].

The last two decades have seen a surge in the interest in medical AI. Modern medicine is faced with the challenge of acquiring, analyzing, and applying the large amount of knowledge necessary to solve complex clinical problems. The development of medical AI has been related to the development of AI programs intended to help the clinician in the formulation of a diagnosis, the making of therapeutic decisions, and the prediction of outcome. They are designed to support healthcare workers in their everyday duties, assisting with tasks that rely on the manipulation of data and knowledge. Such systems include artificial neural networks (ANNs), fuzzy expert systems, evolutionary computation, and hybrid intelligent systems [9]. Most statistics show that AI, which is loaded with millions of medical documents and medical histories, often makes diagnoses more accurate than doctors and health professionals. IBM Watson, Google's DeepMind Health, and similar smart assistants not only give advice to doctors but also determine the predisposition to diseases or detect them at very early stage.

AI helps not only doctors but also patients. Telemedicine and related applications have been growing in popularity in recent years. They use a variety of algorithms: some collect data from wearable sensors like fitness bracelets; others are more like questionnaires designed to determine the exact symptoms and problems of patients [10]. Some experimental results show that the convolution neural network give very promising results. The latest medical research have demonstrated that human lymphocytes can be used as a biological dosimeter to relive the presence and the action of carcinogenic factors. The application of the neural network approaches for this important task of detection of micro nucleuses on human lymphocyte images, in particularly convolution neural network, allows improving the correctness of the final medical response [11,12].

Other research used ANNs to estimate the blood pressure (BP) from the PPG signal. Training data were extracted from the Multiparameter Intelligent Monitoring in Intensive Care waveform database for better representation of possible pulse and pressure variation. In total more than 15000 heartbeats were analyzed and 21 parameters were extracted from each of them that define the input vector for the ANN. The comparison between estimated and reference values shows better accuracy than the linear regression method and satisfy the American National Standards of the Association for the Advancement of Medical Instrumentation [13].

Other research using ANNs and smartphones has shown the ability to measure BP. In this research, smartphone cameras take pictures of the fingertip. These techniques use the photoplethysmogram (PPG) signal. This technique works by analyzing the volumetric blood variation in the fingertip as captured by images. BP is then estimated via trained ANNs.

There is also an accurate evaluation of the BP by an ANN from the PPG signal. The PPG can be seen, without using a cuff or invasive tool by evaluating the BP for each heartbeat. For each heartbeat, a fixed number of features, which characterize the PPG pulse, are extracted and given as the input to the ANN. A systolic, diastolic and mean BP are obtained as the output. The improvement of the BP evaluation accuracy is obtained by removing artifacts from the references used to train the ANN [14-17].

Another research presents an innovative system for the simultaneous noninvasive monitoring and synchronized storage of PPG signals and BP values. Because it is noninvasive, the monitoring system permits to achieve signals from both healthy and un-healthy patients and then to create a wide and heterogeneous base of knowledge to properly train automatic classifiers, which helps to permit the reliable BP evaluation through the umpteen IoT devices able to acquire the PPG signal, nowadays available on the market. This allows the BP monitoring every time and everywhere and then the early diagnosis of several cardiovascular diseases [18].

The increasing pervasiveness of wearable sensors opens new scenarios in the continuous monitoring of health parameters. In particular, wearables are becoming the sensing part of the Internet of Medical Things (IoMT). Currently, several IoMT based devices capable of measuring BP are starting to be offered on the market, giving the possibility to monitor BP daily in all environments. An open issue is the lack of traceability and reliability of the BP measurements [19].

AI allows hospitals to have adequate supplies, thereby increasing patients' access to medicines and other services that can potentially save lives. Using AI chat, health care workers can be equipped with the necessary skills to help them provide the best possible medical care. With AI, healthcare workers can freely communicate and share vital information with their patients. Using chatbots that have AI embedded in them, doctors can use their mobile phones to inform patients when they receive their prescriptions, when the drug is almost finished, and also remind them of their next appointments.

AI enhancement is particularly useful in rural areas, where patients can get medical care without having to go to the hospital. It is noteworthy that most medical institutions in rural areas are understaffed and do not have sufficient resources, but if AI is available, assistance can be enhanced, since the AI can be trained to recognize and diagnose certain diseases when a doctor is unavailable.

AI in Uzbekistan

Uzbekistan is one of the first countries in Central Asia which is enthusiastically moving towards digitalization. Different ministries are promoting digitalization in the areas of telecommunication, information technology, government, and foreign investments. The government has approved the "smart city" concept: implementation of technology solutions in education, medicine, housing and communal services, and territorial management. This idea of the "smart city" that Uzbekistan has already introduced can be extended to "smart products" [20].

Development in AI is an area of intense international rivalry, large investments, higher and very complex mathematics, as well as high stakes. It is believed that AI can give a productivity increase of 40%, and the countries that will use it will be among the economic leaders in the world [21]. The government is already implementing digitalization in its operations, service delivery, to improve efficiency, save time and money, and deliver better quality public services. Every country is trying to improve its standing in global competition and to direct technological innovations and AI onto a path that benefits its economy and citizens. This paper argues that Uzbekistan needs to draft an AI Policy for making innovative economy sustainable [22].

In 2018, Uzbekistan adopted the strategy of innovative development for 2019-2021, where it is noted that an important condition for the dynamic development of the Republic is the accelerated introduction of modern innovative technologies in the economy, social and other spheres with a wide application of science and technology. Recent research shows that in the next few years, along with the development of blockchain and robotics, the widespread use of AI and machine learning will be the most promising technological trends.

The 21st century is becoming a digital and AI age. The Strategic Action Plan for the development of the Republic of Uzbekistan in five priority areas for 2017-2021 sets the task for the world market to dramatically change, to make our country more stable and dynamic, to accelerate its competitiveness in the conditions of increasing globalization, competitive environment. Successful implementation of this strategy depends, first of all, on the national human capital – the deep profound knowledge and high professionalism of all our citizens. Therefore, the acceleration of e-business in our country has become a strategic task [23].

The Uzbek approach to AI

In Uzbekistan, there are many areas where specialized intelligent systems can be used. This includes healthcare, fighting the consequences of natural disasters, agriculture, and education. It is essential that Uzbekistan has a valuable opportunity for broad cooperation with Russia, which is one of the world leaders in the development and use of AI. This is the best option, in which there are benefits of certain proximity of the mentality, and there are no problems associated with the language barrier. Russian as a common language makes it very easy to develop, introduce, and use intelligent systems [21].

In Uzbekistan domestic pharmaceuticals will be digitalized: medicines will be developed by special computer applications using AI. The use of AI in pharmaceuticals will be the first stage of general projects. It is possible that in the future, other public and private organizations will be involved in the work [24].

Tashkent Pediatric Medical Institute experience in AI research and project development

A group of scientists from Tashkent Pediatric Medical Institute (TPMI) created an AI system for diagnosing electrocardiogram (ECG) waveform outputted from the portable biometric sensor "Bitalino" to find out problems for introducing AI in the medical field in Uzbekistan. It is essential that ECG data that is the object of AI inference is digital and ECG was measured with "Bitalino", which is a general-purpose portable biometric sensor. The digital data of the ECG waveform output from Bitalino was input to the AI system [25]. We used a neural network called convolutional neural network (CNN) [26], which is one of the machine learning methods used for image recognition.

The study "AI and ECG" consists of the following stages. First of all, we had to select the algorithm of the AI model, which is the so-called brain of AI, depending on the nature of the problem to be applied in our case ECG process. Then we started to collect a large amount of ECG data diagnosed as healthy or arrhythmia (bradycardia or tachycardia). Then we converted the ECG data into a format that can be input to the AI model and randomly divided into training and testing data sets. The next step we started to teach AI model read and learn ECG training data with diagnosis result (normal or arrhythmia). After AI model given the ability to read ECG data for verification and infer the diagnosis result, then verify the correct answer ratio. At the penultimate stage, we repeated step 4 learning and step 5 verification processes until the correct answer ratio become satisfactory by review of the algorithm, accuracy of the training data, and so on. Finally, we have ensured that the AI model has obtained knowledge to diagnose new patient's ECG results.

From the very beginning of our research, we found that AI model learning process required a high-performance PC like a supercomputer in their work, so we built the AI model on Google Cloud, so the pre-processing step that processes ECG data from Bitalino for input to the AI model, and the post-processing step that displays the inference of AI as diagnosis result have been built on a local PC.

Processing is that the ECG data is processed appropriately as input data to the AI model in order to improve inference accuracy of the AI model. This process is done on our local PC. Once ECG data from Bitalino has a continuous waveform within the measurement period time, it is cut out as a waveform for 2 seconds centering on the peak of the waveform so that it includes two heartbeats. Then the waveform for these 2 seconds becomes one ECG data.

AI systems do not always give the correct answer. The correct answer ratio varies greatly depending on the quality of training data, the type of learning algorithm, and so on. If the AI model is trained with poor quality data, that is, misdiagnosis data, AI will also misdiagnose. AI systems can quickly and accurately carry out repetitive tasks, such as image diagnosis and medical examination, which are time-consuming for humans. The installation of AI systems reduces the burden on doctors, increase the amount of time to face-to-face examination for patients, and contribute to improving the quality of medical care.

Finally, it was understood how AI works by actually creating programs that input ECG waveform from the portable biometric sensor and output diagnostic result. They found some problems to put the automatic diagnosis program by AI into practical use, such as digitization of medical devices in Uzbekistan, collect large amounts of patient data for learning and validating AI model, lack of high-performance PC for AI model construction.

Conclusions

The areas of application of AI are very wide and are limited only by our imagination and the speed of implementation of technological innovations. The main difference between AI and conventional computer programs is that, unlike conventional computer programs, when creating an AI, a specialist does not need to know all the dependencies between input data and the result. In that case, if the specialist has already created a mathematical model – for example, for statistical processing of medical cards – the AI is not required. The AI's job is to train on an array of reliable data and search for those formulas and dependencies that are not defined by humans due to their volume.

AI techniques have the potential to be applied in almost every field of medicine and every sphere of our life. The practice and experience of an individual doctor may not be enough to correctly diagnose the disease. With access to scientific literature and millions of case histories, AI can quickly classify a case, correlate it with similar cases, and formulate suggestions for a treatment plan. AI has the possibility to help in areas with less hands-on healthcare. It is believed that geographically isolated areas can benefit from AIs which could replace physicians. AI programs in medicine are designed to support healthcare workers in their everyday duties, assisting with tasks that rely on the manipulation of data and knowledge.

The main barrier to the mass use of AI in healthcare, including in Uzbekistan, may be two things: 1. a huge amount of data for training and 2. personnel problem. So, without high-quality data, AI will not work with high accuracy, and without trained specialists, simply applying ready-made algorithms to prepared data will also not give the desired result for the health system.

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