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OVERVIEW OF CYBER-PHYSICAL TECHNOLOGIES AND THEIR PERSPECTIVES IN HEALTHCARE

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Abstract- This article discusses the concept of Cyber-Physical Technologies (Internet of Things, Big Data, and Cloud Computing), resulting from the integration of Cyber-Physical Technologies into the medical field. At the same time, there have been informed about the Internet of Things and its application fields. In addition to the Internet of Things, Big Data also plays a major role in medicine. Accordingly, this article examines the positive and negative impacts, as well as the prospects of big data in healthcare. In the context of the pandemic, special emphasis is placed on the introduction of cloud computing in health care. In this regard, this article discusses the main aspects and perspectives of cloud computing.

Keywords: IoT, Big Data, Cloud Computing, Medical-Objects Internet, IoMT, Technology, Information Technology.

1. INTRODUCTION

The implementation of Cyber-Physical Technologies began in all areas of activity on the eve of Industry 4.0. This leads to serious changes and the emergence of new directions in the economy and science. This article provides an overview of the impact of Cyber-Physical Technologies in medicine. Among them, special attention is paid to the Internet of Things, Big Data, and Cloud Computing.

1.1 Internet of Things

It is impossible to imagine today's world without the Internet. Through it, everything we want is one step away, in the language of technology, one click away.

Technology is evolving day by day and enters our lives with every minute of innovation. The concept of the Internet of Things, which is now widespread, was once one of the innovations that technology has introduced to us. There are very few people interested in technology and do not know about this concept. Therefore, let us simply mention a brief theoretical background on the concept of the IoT [1, 2].

The IoT (Internet of Things) is an environment where objects, each with a unique identifier, can send information over a network. There is no need for a human-to-human or human-computer relationship to exchange this information. The Internet of Things is created by combining wireless technologies, micro-electronic systems, and the Internet. Therefore, this concept can be called the IoT (Internet of Things)

Accessing things directly into computer systems leads to increased efficiency, new economic benefits, and savings in human labor. The Internet of Things includes access to the Internet from devices with standard Internet access, such as computers, laptops, smartphones, tablets, and other traditional "non-smart" items or everyday items. As a result of new technologies embedded in these items, they can now interact with each other over the Internet, as well as these items can be remotely controlled [3].

1.2 Big Data

The Internet of Things in medicine, like any other area, generates big data. The use and management of Big Data affect many areas of our society. Big Data applications show a level of adaptation to different requirements from different scientific fields and industry organizations. Problems that arise in very remote areas can sometimes be solved using same techniques and types of information.

The rapid growth of Big Data is a source of concern before the creation of comprehensive rules for the protection of private data. For example, it is necessary to prevent the identification of possible personal data through anonymous algorithms aimed at protecting privacy. In addition, access to information must be properly and impartially regulated to avoid competitive business practices that could strengthen market dominance. Creating a new digital divide between companies with different levels of access to information is a potential barrier to innovation.

Big Data has a profound effect on companies because they are forced to rethink their organizations and all business processes in the light of the availability of new data that could become a competitive advantage in a database-based market [4].

Big Data is spread almost everywhere. Big Data is an area that can be used in any area, given that large amounts of data can be used to its advantage. Areas of application of Big Data, in turn, are divided into two parts: (a) the application of Big Data in the fields of economics and economics, politics, industry, and (b) the application of Big Data in the fields of knowledge.

Examples of Big Data's main areas of application include [5]:
- Banking: Undoubtedly, one of the key terms that play a role in banking is information. Especially customer information. One of the most important issues is the storage, proper use, and, most importantly, security of this information. Many technologies are used in the banking sector for this purpose. One of them is Big Data. The use of customer information can also raise privacy issues. Big Data can even detect invisible connections between undiscovered data.
- Agriculture: A particular biotechnology firm uses sensor data to increase procurement efficiency. Big Data is constantly adapting to changes in the quality of different data it collects and the quality ranking of each plant based on temperature, water levels, soil composition, development, yield, and evidence.
- Security: Storing data in a unified, isolated system, etc. provides sufficient benefits and is both financially and environmentally sound.
- Smartphones: Smartphones are currently the closest technology to users. This is not only figurative but also real. Smartphones are just a step away from us. In this regard, the fact that this technology is closest to the users is due to smart technologies.

1.3 Cloud Computing

Cloud computing is not a new term for the healthcare industry. Over the past few years, cloud adoption has grown rapidly. The pandemic COVID-19 only intensified this trend. While the consequences of the pandemic are still developing, it is already clear that not all industries will suffer equally, and some even show promising growth. The health and technology sectors seem to fall into this category, making the coming years very promising for the global cloud computing market in healthcare.

2. THE CONCEPT OF "INTERNET OF THINGS"

As we mentioned in the introductory chapter, the concept of the IoT (Internet of Things) is one of the new technology concepts entering our lives. It not only entered our lives but also began to play a special role in our life. Let's not go beyond the specific topic of the scientific work, let's note some information about "Internet of Things technology" and in the next chapter "Areas of application of Internet of Things technology".

The IoT (Internet of Things) is a manifestation of the penetration of digital technologies into our daily lives. This indicates that interconnected computers are also connected to objects [6].

According to researcher J. Pascual-Espada, "The essence and purpose of IoT are that any object or object used in an appropriate form can communicate with other objects used in a similar form through Internet structure." It also links activity of one or more items to another.

The IoT - is the next step on the Internet. Here, objects can define themselves, provide data about themselves, and access data about various objects. The İoT allows humans and things to communicate anytime, anywhere, anything, and with anyone by internet.

IoT is an application integrated with many technical fields, such as sensor technology, data transmission, automation, high computing, data processing, and security, using current information technologies. The IoT (Internet of Things) has grown tremendously over the last decade and is still an evolving field for both academia and industry researchers.

Bingmei Wu, deputy secretary-general of the China Communication Standards Association, says IoT could be a reformative force that has a positive influence on the lives of many people around the world [7].

According to the "IEEE Internet of Things", the IoT is a smart system network, where a large number of objects/things/sensors/devices are usually provided with rich data processing and value-added services through communication and information infrastructure and management for various applications. combined for. IoT is a computer concept that defines a future in which normal physical objects will connect to the Internet and introduce themselves to other devices.

IoT allows interaction between the real and digital (physical and virtual) worlds. Areas of application of the IoT concept are supply chain management, transport, aerospace, automotive, smart environments, energy, defense, and more.

3. AREAS OF APPLICATION OF IoT

As some devices in our lives become increasingly intelligent, the concept of the IoT continues to have a positive impact on human life.
As we have mentioned, the Internet of Things technology is used in many areas. For example, transport, economy, environment, health, etc. noted. Now let's take a look at these areas in detail.

3.1. Areas of Application

- Energy
- Environment
- Agriculture
- Daily use Health

3.2. IoT Capabilities

Depending on the increase in population and demand for the next 30 years, global energy consumption is projected to increase by 50%. There is no doubt that the IoT will be useful in this regard as well. IoT, in turn, is a global energy problem; will help to produce clean energy technologies and optimize efficiency of existing products.

The world of 7 billion people has a big problem, such as the management of natural resources. Due to population growth, environmental protection continues to become an increasingly complex issue. At this point, IoT; clean water, air pollution, solid waste landfill, deforestation, etc. offers unique opportunities to solve problems such as. For example, sensor-based devices can be installed outside the city's forest areas, lake and river beds, and so on. collects garbage and sewage data. Some environmental threats can be complex, but the IoT is here to help. Even in the worst case, it is possible to diagnose and measure the problem, at least thanks to the IoT [8].

IoT allows for the establishment of smart areas where every step can be observed to increase agricultural production. In addition, solutions based on information provided by the IoT in terms of food safety offer consumers to even track the food they eat.

Some products contribute to social development, while others are designed to improve quality of life. We can say that such products attract more attention of the user at this stage. However, it should be noted that the IoT will provide its benefits in almost every area.

IoT offers a variety of solutions at the stage of intervention, control, and diagnosis, depending on the state of health. Devices help individuals monitor health conditions such as weight, body weight, sleep patterns, and daily activity levels. In the next chapter, we will provide detailed information on the role of IoT technology in health. Before that, let's take a brief look at some of the health care devices on the Internet.

3.3. Example of Applied IoT Devices

We can show you devices that optimize energy consumption, such as thermostats, lighting systems, dry cleaning machines that you can use at home and in the office [9].

Air Quality Egg - With this device you can measure the quality of air in the office and living space. By using the same technology on a large scale, city dwellers can be taught how much they pollute the air, and it is possible to create an even wider global awareness.

BigBelly - When a garbage can be called BigBelly, which works with solar panels, is full, sends a message to the cleaning staff. Operations such as changing the size/volume of the container are performed by controlling the level of movement of the bins.

Invisible Track - A small device called Invisible Track is placed on trees in protected forests and monitors illegal logging activities. Authorities can prevent these illegal activities, depending on the information on the device.

Waterbed - The intelligent irrigation system developed under this name ensures the reduction of water consumption and information about the condition of the soil with the help of sensors. The system analyzes the data collected and irrigates the area where the irrigation system is installed according to the needs of the soil.

Smart Bob - Calculates and measures grain and other foods in warehouses.

Z-Trap With this device, farmers can monitor the insect population in the region and protect their crops.

Bitponics - With a smart garden system called Bitponics, you can monitor the temperature of the water, air temperature, light, and humidity in your garden.

Edyn - Irrigation systems such as Edyn are also available. Belkin Echo Water If you are interested in water consumption in your home, you will be able to learn the consumption with the Belkin Echo Water module that you will place in the water pipe.

Lively - It is the product of the Internet of Things, which controls the daily activities of the older generation.

4. IoT IN THE HEALTHCARE

Advances in information, telecommunications, and network technologies play an important role in health and contribute to development of medical information systems.

With the integration of wireless technologies called the Internet of Things (IoT) and innovative systems that allow access to remote servers and the exchange of information over the Internet, revolutionary developments have begun in many sectors, especially in the health sector.

The integration of IoT technology into healthcare has given rise to a new concept. This concept is the concept of it. That is the Internet of Things. IoMT is an interconnected medical device, software, health systems, and services.

The IoMT has a special impact on the health sector. In other words, medical services and health services have the most attractive applications for the Internet of Things.

Modern healthcare is one of the most widespread areas of the Internet. According to analysts from IDC (International Data Corporation), the volume of wearable devices in 2021 alone will reach $ 222 million (in 2017, the market size was $ 113.2 million). The total number of medical devices in the world is expected to increase between 10 and 50 billion in the next 10 years.

IoT allows major applications such as the Internet, remote health monitoring, fitness programs, chronic diseases, and care for the elderly. Here different medical devices, sensors, and diagnostic and visual devices can be understood as an intelligent device or object that is the main part of it.

One of the biggest advantages of using IoT in healthcare is the availability of specialized solutions and a globally accessible and regular database for health. Successful and widespread adoption of IoT technology in the health sector will allow the industry to have better tracking, detection, communication, and monitoring capabilities. Information from various areas of health management and services, such as management, finance, logistics, diagnosis, rehabilitation, therapy, thinking, and day-to-day activities can be collected through IoT infrastructure.

The most important technological innovation introduced by IoMT technology to the health sector is the ability to place in the body, wirelessly connect and measure without long-term external interference, health, such as diabetes, cancer, cardiovascular disease, other chronic diseases, neurological seizures, orthopedic problems provides an easy and effective way to measure and maintain health records that can save the lives of patients with problems.

Helps to measure blood pressure, monitor blood sugar, keep records related to diabetes, supports calorie and diet control for obesity, constantly monitors dementia (Alzheimer's) patients via GPS, uses mobile phones with sensors for chronic diseases, detects respiratory infections IoT mobile applications have become popular today.

Safety and security play a key role in health parameters, and medical IoT affects both patients, treatment, equipment, and so on. can be improved by more accurate data transmission, as well as real-time data transmission and monitoring.

IoT; is an innovative technology that directly connects a range of sensors and devices (e.g., smartphones, smart glasses, smart socks, smart rings) to collect, store, transmit and share information for possible analysis. IoT has a broad spectrum of applications. One of the most innovative of these in the field of health, where patient health information is collected, analyzed, transmitted through a network, and distributed to health workers to evaluate patient care. Below are some internet applications in healthcare, internet applications for medical items.

AdhereTech: Medication boxes with the ability to connect to a wireless network send a message or warning to the patient when the patient forgets to take the medication.

Stanley Healthcare: To better understand the workflow processes in a hospital, it is to visualize the location and condition of all staff, equipment, and patients.

HealthPatch: A sensor used to monitor acute, chronic diseases, and sends changes in patients' biometric and vital signs to doctors via Bluetooth [10].

Sustainable Glucose Monitor (CGM): A device that helps patients with diabetes to manage their blood sugar levels regularly for several days by making periodic changes. The US Food and Drug Administration (FDA) allowed the first CGM system in 1999, and many smart CGMs have been released in the last years.

Proteus Digital Health: Pills that dissolve in the stomach and generate a small signal collected by a corresponding sensor that attaches to the body. After that, the data is transferred to an application on a smartphone and verified to see if the patient is using the medication according to the instructions.

Measuring depression with the Apple Watch monitor: Developed in 2017 to track and evaluate patients with major depressive problems.

Bluetooth coagulation system: This device is the first of its sort for anticoagulated patients and has been self-tested to help patients remain within the therapeutic range and lower the risk of infarction or bleeding.

- ADAMM: A device that monitors patients with asthma.
- Progress in healthcare through medical IoT has been visible.
- Benefits of the IoMT

Let's take a brief look at what is shown in the picture:

- Patients can afford better medical devices, medicines, etc. at an affordable price. years are provided. This reduces the overall cost for patients.
- Offers better treatment results.
- Provides more confidence in doctors. This is because IoMT technologies increase the capacity of doctors and researchers.
- Errors are greatly reduced.
- It is possible to monitor and control medication intake.
- It is easy to ensure the use of medical devices in such an
- IoMT network.
- Better control of diseases.
- Hospitals can monitor patients and treatments by obtaining information from their devices, for example, through applications installed on smartphones. glucose meter, heart rate monitor, etc.

5. PROBLEMS WITH INTERNET OF THINGS

IoMT has many benefits, some of which we mentioned above. But at the same time, there are certain problems in IoT, as in many technologies. Examples include security, connectivity, high cost, and so on. we can show.

Security - IoT generally involves processing a large amount of information transmitted through sensors. When it comes to IoT in medical devices, patients' condition and location, treatment information, and so on. Such information is often sensitive. The growth of connected medical devices poses additional risks to information security. Therefore, special attention is required to appropriate security measures and practices to eliminate existing cyber attacks.

Connection - A reliable device uninterrupted connection that needs to constantly manage data in real-time. Only in it, the cost of this shortcoming is high. Because of this, special attention should be paid to the hardware and software of medical devices and the connection problem should be solved.

High price - It should be noted that medical IoT is taken more slowly than other smart systems. This is normal for a conservative and highly regulated industry like healthcare. Another reason why it is not easy to implement is the high cost and integration into the existing health infrastructure. Therefore, in general, the Internet technology of medical devices is used more, especially in economically developed countries.

Regulatory change - managing the regulatory change that occurs is critical to the success of both evolving medical devices and IoMT.

6. THE DIFFERENCE BETWEEN IoT AND IoMT

The Internet of Medical Things is part of IoT as a general term for related technology and big data solutions.

Among the related technologies built for other industries, what makes it special is the set of features that are unique to eHealth and medical technology.

The following are examples of differences between IoT and IoMT.

Pay attention to safety - IoMT handles a wide range of sensitive information.

Advanced reliability (enhanced reliability) - Development of IoMT devices, the design of IoT medical devices focuses on reliability and robustness beyond the consumer's ability.

Slowly accepted - Compared to the application of other IoT systems, IoMT systems have a lower degree of integration. We hope to see progress soon.

7. BIG DATA IN THE HEALTHCARE FIELD

One of the fields for the Big Data application is healthcare.

Traditionally, the healthcare industry has lagged behind other areas in the use of Big Data. This is because part of the health problem stems from resistance to variables, and they are accustomed to making their own clinical decisions using their own clinical decisions, rather than relying on treatment decisions.

Recently, many health care providers have invested in information technology due to uncertain income.

Although older systems are operational, their ability to standardize and consolidate data is limited. The nature of the healthcare industry also poses challenges: while there are many participants, there is no easy way to share information between different providers or businesses, partly because of privacy issues. Even within a single hospital or pharmaceutical company, it is important to store data within a group or department because organizations do not have procedures for combining data and delivering findings.

Health stakeholders are already gaining access to promising new knowledge. This information is a form of Big Data, not only because of its large volume but also because of its complexity, diversity, and timing.

Pharmaceutical industry exporters and providers are starting to analyze Big Data to gain insights. While these efforts are still in their infancy, they can collectively help address the challenges associated with variability in health quality and increasing health care costs. Researchers are trying to determine which treatment is more effective for certain treatments, side effects of medications, and so on. can extract information to identify related patterns and obtain other important information that can help patients and reduce costs. Recent technological advances in the industry have improved the ability to work with such data, although files are huge and often have different database structures and specifications [5].

8. FUTURE PROSPECTS OF BIG DATA IN HEALTHCARE

The rating of health care's impact on the big data analytics market is quite high.

Studies show that more than 30% of all data stored on the planet are medical data [19]. In the future, this share is expected to increase rapidly due to the creation of new and digitization of already available information, and the volume of costs for Big Data in the field of medicine by 2022 will reach 34.27 billion dollars [20, 21]. Also important is the fact that all this information is no longer exclusively statistical, but an array of unstructured and heterogeneous data, which defines various tools and methods for their collection, storage, and analysis. Deloitte forecasts that spending in the global health market will reach $10.059 trillion by 2022 [22].

The United States is the world leader in the implementation and development of Big Data technologies in healthcare today. The main basis for their development is economic efficiency from their implementation. According to analysts McKinsey the Global Institute, using Big Data technologies in US healthcare will form a financial flow of $300 billion in value terms, of which two-thirds - due to the reduction of US healthcare costs.

It should be noted that today "Big Data" is not only information but also a tool that has unlimited opportunities and contributes to obtaining new solutions, the qualitative transformation of medical care processes, and progressive development of the health care system as a whole. Scientists are investigating the use of large amounts of data to improve evidence and clinical decision-making. Big Data in medicine and health allows a completely new approach to medical care both for one person and taking into account the state of affairs on the scale of the city or even the country. Currently, "Big Data" technologies are used to:

- Improve decision-making in clinical practice;
- Identifying at-risk patients with side reactions or drug inefficiency;
- Improving the quality of individual care for patients with a view to achieving better results;
- Improving the proven effectiveness of drugs, taking into account evidence from actual practice;
- Improving health resource planning.

The great potential of using Big Data technologies in medicine is related to the development of algorithms for recognition, further analysis, and interpretation of signals and images. Wearable signals with high volume and speed of arrival, especially in continuous real-time use, generated by a plurality of sensors connected to a patient, have great complexity for processing, storage, and analysis.

Nowadays, Big Data technologies are actively used in medicine and allow a completely new approach to the provision of medical care both for one person and taking into account the situation on the scale of the city or even the country. It is possible thanks to the achievements in the field of Big Data:

- To implement a fully personalized approach to the patient and his history of diseases;
- Predict disease development and treatment risks;
- Identify signs of disease, patterns of disease, and therapy;
- Monitor a patient's condition using various devices;
- Assess the effectiveness of treatment and the identification of links between the causes of the disease and its symptoms;
- to predict more precisely;
- Calculate the need for equipment and medicines;
- Manage patient flows and more, making the lives of both doctors and patients a lot easier and more fun.

Digitalization of medicine is a promising direction that not only unifies the work of clinics or laboratories but can also save human lives.

In 2016, the digital medicine market was valued at the US $179.6 billion, according to Transparency Market Research. According to the analytical agency, GARP in this segment will be 13.4%, up to 2025, when its volume will exceed 536 billion dollars.[24]

Big Data technologies in medicine are used within the following directions:

- Prediction of disease development;
- Identification of genetic markers in oncology;
- Prediction of infant health;
- Diagnoses using wearable devices.

Watson Health and QPID (Queriable Patient Interface Dossier) can be highlighted as Big Data support tools. For example, Watson Health is a service from IBM in the field of medical analytics based on Big Data technologies.

Watson Health allows you to make decisions that are based on a large number of medical unstructured data, including clinical, scientific, genetic, and personal data [12, 13]. This may be particularly necessary because of the widespread of GMOs, pesticides, chemicals, and allergens, which at the genetic level negatively affect the human body. Prediction of risk factors in surgery can be organized based on the QPID analytical system, which allows controlling important information about the patient during the course of treatment, to predict surgical risks by means of the use of information from electronic medical cards. The QPID system automatically searches for treatment protocols and then displays the results with the calculated red, yellow, or green risk indicator [14]. This technology allows finding an accurate and fast way to determine which patients are at high risk of developing sepsis, which is a critical task and to monitor side effects of various drugs and outbreaks of epidemics.

The rapid development of bioinformatics, as well as the possibility of analyzing Big Data tools, opens up fundamentally new methods of diagnostics and treatment, causes the need for further in-depth research. Application of Big Data in medicine will solve important problems from the field of bioinformatics, consisting of the creation and maintenance of databases and knowledge, such as specialized databases of protein structures, nucleotide sequences of genes, metabolic pathways, cell ensembles, and others [8, 15]. The number and volume of information of such databases are constantly increasing, working with such huge amounts of information requires fundamentally new approaches to data processing and corresponding software [16].

Big Data analytics in medicine combines analysis methods from a number of scientific fields (for ex., bioinformatics, medical informatics, medical imaging, sensory and, artificial intelligence and others [17]. Big Data technologies are aimed at analyzing increasingly complex sets of medical data, emerging from diverse in structure, format, reliability of information sources. Big Data includes both structured data and unstructured and semi-structured data (XML documents). About 80% of the data in medicine is unstructured and represents a set of files, tables, figures, graphs, and descriptions [18]. Today significant progress has been made in the use of instrumental technologies in data collection, storage, and cost analysis. The most pressing problem in Big Data operation was the development of algorithms for complex analysis and interpretation of data in real-time. The set of approaches and technologies for analyzing big data includes tools for massively parallel processing of undefined structured data, in particular NoSQL algorithms, MapReduce algorithms, and Hadoop design tools, als other solutions providing similar capabilities for processing ultra-large data arrays and some hardware.

Thus, Big Data in medicine is continuously and rapidly replenished electronic arrays, qualitatively different between medical and paramedical data of huge volume, which cannot be managed through traditional tools and methods of software and/or hardware. It is obvious that the introduction of Big Data technologies will allow not only to solve current problems in medicine but also to overcome unattainable horizons of medical data processing in the field of healthcare. At the same time, this study cannot be considered complete, it is necessary to continue work on Big Data technologies and algorithms of big data processing solutions. Research into the features and prospects of Big Data technologies in healthcare is a pressing scientific and practical task.

Companies that provide services for health analytics and clinical transformation contribute to a better and more effective outcome. These companies' common goals include reducing analytical funding, developing effective Clinical Decision Support (CDS) systems, providing platforms for better treatment strategies, and detecting and preventing Big Data-related fraud. However, almost all face challenges in federal matters such as how private data is processed, shared, and secured.

Researchers are using biomedical Big Data, despite infrastructure problems, with high hopes of gaining new and moving knowledge that will improve the current state of health care. Clinical trials, pharmacy, and insurance claims analysis, and the discovery of biomarkers are new and creative ways to analyze health data.

Big Data analytics takes advantage of gaps in structured and unstructured data sources.

Various trusted consulting firms and healthcare companies rightly predict that Big Data's healthcare market is ready to grow at an alarming rate.

The exponential growth of medical data from various fields has forced computing experts to develop innovative strategies to analyze and interpret such a large amount of data over a period. The integration of computing systems for signal processing from both research and practical medical professionals has seen growth. Thus, the development of a detailed model of the human body by combining physiological data and "-omics" methods can be the next big goal. This unique idea can increase our knowledge of the disease state and possibly contribute to the development of new diagnostic tools.

Big Data's greatest asset is its endless possibilities. Over the past few years, the creation and integration of Big Data have brought significant advances in the healthcare sector, from medical data management to drug discovery programs for complex human diseases, including human cancer and neurodegenerative disorders.

Big Data is believed to accelerate and accelerate advances in existing healthcare, rather than replacing a skilled workforce, knowledgeable professionals, and intellectuals. Collected together, Big Data will help present epidemic predictions (related to public health), provide early warning of disease conditions, and find new biomarkers and smart therapeutic intervention strategies for a new quality of life [10].

9. POSITIVE AND NEGATIVE EFFECTS OF BIG DATA ON HEALTHCARE

From the moment the technologies are applied in various fields, they have their positive and negative effects on those fields. However, it is normal for them to have both positive and negative effects. The negative effects

motivate developers to improve the technology. In this regard, when talking about and using any technology, innovation, it is necessary to note its disadvantages [11].
- Big Data technology also has positive and negative effects on applications.
- The positive effects of Big Data on healthcare
- High-quality care

Big Data is based on different sources such as previous meetings with doctors, social media, and external activities. As a result, it creates a structured image of the customer [8]. The abundance of information available today helps health care providers to analyze an individual more accurately and to provide accurate and quality care to the patient accordingly.

Big data: we can call it proper data management. In addition, proper data management leads to quality health care. This can be seen simply by comparing health services in the recent past with recent services.

Early intervention: The overall goal of Big Data in healthcare is to analyze, identify, and solve medical problems before they represent serious problems. Big Data makes the whole procedure efficient [9].

For example, a patient who consults a doctor about trying to lose weight may be prescribed medication to treat high cholesterol. If this patient reports on social media about stressful changes in his life, the Big Data algorithm can analyze this information and note that the patient is at risk of a heart attack. The doctor can then prescribe treatment to reduce the risk of heart attack, thus eliminating the problem without becoming life-threatening. Big Data can also be included in DNA records to see if there is a risk of an inherited disease from the patient's family [9].

Detection of fraud: Whether in the health sector, the banking sector, or the non-governmental sector, one of the main problems in any field is undoubtedly fraud and the fight against it.

The main problem in health and insurance fraud is to make false claims to patients in the hope of payment. Big Data is useful in combating this, as it can retrieve a large amount of information to find inconsistencies in the claims submitted, and can record potentially false claims for later review. Using advanced algorithms, Big Data can find errors faster than any group of people by reviewing thousands of reports. Medicare has saved more than $ 1 billion in the last two years by using Big Data to verify patient claims [8].

Make health services more accessible: Big Data also favors telemedicine, one of the key areas of health technology. The rapid growth of this sector, which is expected to reach $ 175 billion by 2026, is due to emerging technologies such as IoT, Machine Learning, and Artificial Intelligence, along with the widespread use of remote consulting.

For example, StethoMe - A wireless, electronic stethoscope equipped with an artificial intelligence-based system that detects lung and heart abnormalities in this way. Provides auscultation record along with 1,015,866 sound labels and 38,530 Artificial Intelligence analysis based on a detailed medical description [3].

- Adverse effects of Big Data on Health
- Privacy

One of the strongest disadvantages associated with Big Data is the lack of confidentiality, especially when it comes to confidential medical records. To be effective and provide a complete, comprehensive view of the patient, Big Data must have access to everything, including private notes and social media posts. According to many Big Data experts, the technology takes personal privacy for better profit. Although Big Data allows doctors to monitor a patient's health from anywhere, it does not give the patient freedom [9].

Replacement of doctors: While some people positively perceive the ability to predict future medical problems, Big Data also risks changing doctors. Big Data is not just at the point where it can be used on its own, and it is devoid of the individual touch of a human doctor. Some experts fear that the growth of Big Data could weaken doctors and make patients turn to technology for answers instead of using a licensed doctor. Big Data cannot be avoided in healthcare, especially as more companies and providers expand their investments in this area. However, as technology advances, shortcomings need to be addressed to create an effective and safe experience for patients and physicians [9].

10. MAIN ASPECTS OF CLOUD COMPUTING IN HEALTHCARE

Artificial intelligence and machine learning: With doctors' busy schedules - and now more than ever, as the world continues to grapple with the global pandemic - and with the complexity and growth of data, the power of artificial intelligence and machine learning could be a decisive factor for healthcare systems. As more and more cloud platforms integrate AI and machine learning into their services, cloud computing can support the transition of AI to mainstream healthcare operations and help users manage massive amounts of data. For the treatment to be correct and diagnosis accurate, it is necessary to study the patient's data: pictures, analyzes, examination protocols; anamnesis containing complete information [12].

Sometimes even experienced doctors are not able to see the full picture of the disease because the data in the card is not systematized, and the history is lost in the thickness of the sheets. According to Google, one in ten patients suffers because their illness has been misinterpreted. It is believed that AI can solve this problem. Google specialists are already working in some hospitals, where the Google Deep-mind Health program analyzes the available information about the patient's symptoms and gives a list of recommendations, and the doctor, using the tips of such an assistant, prescribes the course of treatment for the patient. The IBM Watson Health program also allows you to make diagnoses: recognize cardiomyopathy, thrombosis, heart attacks. AI also makes it possible to assess the effect of medications on the human body, helping doctors understand how the characteristics of the patient's genetic structure affect the course of the disease and what effect a new drug can have. Using the IBM Watson Health Cloud application, the doctor receives and

analyzes data about the patient's body from an electronic bracelet and, selects an effective course of treatment.

Data storage: Healthcare providers have to deal with electronic patient records, mobile apps, and analysis. This is a large amount of data that needs to be processed and analyzed, and not all internal equipment can store it. Cloud computing allows healthcare providers to store all of this data, avoiding the additional overhead of maintaining physical servers. For example, America uses the Electronic Health Record (EHR) system. It keeps all records of the patient's condition, in all areas of medicine, throughout the patient's life. Almost 94% of clinics are connected to it. This has helped improve cardiovascular health outcomes and generated about $ 1 billion in savings by reducing doctor visits and lab tests, according to McKinsey.

Adaptation: Unlike traditional self-hosted models, cloud computing gives healthcare providers the ability to grow or shrink storage based on patient flow. This way, healthcare providers can adapt their technology for peak seasons, such as the flu season, when the number of patients increases, without wasting time and money on recent hardware purchases or software updates.

Safety: One of the most common cloud-related issues is how secure is it to store all your apps and patient data on a third-party server? In the event of a hardware failure, healthcare facilities can lose all of their data and applications. Naturally, they cannot take such risks. But when done right, cloud servers help improve the security of healthcare providers. Cloud computing not only allows users to remotely access information, as it includes automated backup and disaster recovery options, but in the event of a breach, healthcare providers do not lose any data and can minimize the downtime of their staff. Most providers of cloud service now offer security, risk management, and monitoring services to protect their users from unauthorized access and hacking.

11. PROSPECTS OF CLOUD COMPUTING IN HEALTHCARE

In recent years, based on leading research centers in medicine, the Amalga cloud computing system has been evaluated as a tool for increasing the efficiency and effectiveness of translational research. They allow you to more quickly obtain analytical information about clinical situations and provide options for using the knowledge accumulated in the basic sciences for their application in clinical medicine [13].

Using the Amalga system, researchers were able to develop more than a dozen projects to improve patient safety and quality of care through rapid monitoring of clinical data. Many reports were presented on the reduction of morbidity and mortality, on the optimization of care for patients with diabetes mellitus, as well as on the successful prevention and treatment of many obstetric complications, such as placental insufficiency, fetal growth retardation [14].

Cloud technologies were applied using virtual analysis of data clusters in proteomics. Modern mass spectrometers are capable of generating data many times faster than a personal computer can analyze it. To overcome this problem, the power of a cloud consisting of a large number of processors was used to analyze the clusters of information. The use of these types of computing resources did not require significant investments in equipment, and the cost of software licensing fees, additional space for hosting the cluster, and trained personnel for its administration [15].

Researchers from the Department of Bioengineering and Therapeutic Sciences, University of California, analyzed the mechanistic hypothesis of hepatic distribution of xenobiotics and variations in liver function. To implement these studies, it was required to process large data clusters with subsequent analysis of the results, which was successfully performed using the Amazon EC2 cloud platform. To date, the scientific benefits of experimenting with multiscale biomedical models have been limited to the small number of researchers with access to the computing cluster. Cloud technologies have lowered the barrier and greatly facilitated experimental models, providing a simple tool for large-scale modeling that can be done without costly hardware investments. The flexibility and extensibility of dynamic cloud infrastructure are essential for a variety of research options and mechanisms [16].

Cloud computing provides the ability to manage information across multiple platforms, systems, and applications. Formed mobile systems that allow storage, updating, and search of electronic data in the healthcare system using Cloud Computing [17, 18].

12. CONCLUSION

Cyber-physical technologies (Internet of Things, Big Data, and Cloud Computing) have improved people's living conditions since their inception. These technologies have been applied in many areas. Undoubtedly, the most important of these areas is healthcare.

Because of the integration of the Internet of Things, Big Data, and Cloud Computing into healthcare, the work of both doctors and patients has become a little easier. Because of these technologies, it has become possible to obtain more accurate and rapid information about patients' diseases.

Internet of Things, Big Data, and Cloud Computing are expected to provide better healthcare at a lower cost, reduce inefficiency, reduce direct interaction with patient health care providers, provide effective treatment of chronic diseases, improve quality of life, etc.

In health care, the Internet of Things, Big Data, and Cloud Computing are currently used in the United States, China, Japan, and other countries. They are used more often in economically developed countries, for example, compliance and security, as well as the high cost of technology, are the main obstacles to the development of such systems in economically underdeveloped countries.

They are also considered the features and prospects of cyber-physical technologies in medicine, where privacy takes a special place.

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