Review Article

Artificial Intelligence Solutions for Health 4.0: Overcoming Challenges and Surveying Applications

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ARTICLE INFO

ABSTRACT

In recent years, the term Health 4.0 has appeared in health services and is related to the concept of Industry 4.0. The term Health 4.0 focuses on replacing traditional care in hospitals and medical clinics with home health services that are based on artificial intelligence techniques through the use of telemedicine applications that allow the monitoring of patients in a virtual environment. This term is utilized to represent digital change in the healthcare sector. Governments aim to develop the level of medical care in hospitals and clinics to ensure the provision of healthcare benefits at low costs and increase patient satisfaction. It has become vital for hospitals to grow their environment into digital environments in their services through the use of a set of computer programs based on artificial intelligence. Artificial intelligence techniques in Health 4.0 provide a set of procedures that benefit patients and healthcare workers, including early diagnosis, make inquiries into treatment, data analysis, reports on the patient's condition, and others. The primary purpose of this article is to determine the significance of Health 4.0 and AI techniques in healthcare by mentioning the most important benefits and weaknesses of using AI techniques in healthcare.

1. INTRODUCTION

Recent years have witnessed tremendous technological development and new inventions that contribute to the service of society, as it has entered many areas, including the healthcare area [1-3]. The conjunction between artificial intelligence and healthcare technologies has led to the entry of an advanced era of the Fourth Industrial Revolution, which contributes to the development of medical practices, making diagnoses, managing treatments, and patient care through a set of artificial intelligence techniques and applications [4][5]. State-of-the-art technology terms such as artificial intelligence, Internet of Things, 5G, cloud storage, Metaverse, Blockchain, and others have become a part of our lives. Hospitals and healthcare workers need to keep pace with digital transformation in order to maintain their reputation in healthcare and patient satisfaction with the services provided to them. Artificial Intelligence in Health 4.0 seeks to provide advanced techniques and applications for data analysis through machine learning to increase the capabilities of doctors, healthcare workers, and researchers to diagnose disease conditions, determine appropriate treatment, and monitor patients remotely [6-8]. In addition, AI techniques are distinguished by their ability to analyse huge medical data repositories, including X-ray images, MRI scans, and CT scans, to detect subtle patterns and abnormalities and determine the percentage of malignant diseases in the patient [9][10]. In cooperation with machine learning and artificial intelligence systems, healthcare workers and radiologists can detect early signs of diseases such as cancer and acute pneumonia, enabling early interventions to enhance the patient's condition.

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Industry 4.0 is a comprehensive concept of innovative automation systems and production technologies based on artificial intelligence applications. This concept utilizes the Internet of Things for computers, machines, and people in all areas [11][12]. Industry 4.0 has the capabilities of speed in completing tasks and the impact of the system in analysing data and contributing to decision-making. The fourth industry leads to the development of the healthcare environment by integrating computer applications with physicians and specialists in hospitals and clinics. Healthcare kept pace with development during the industrial revolution. Health 1.0 focused on clean drinking water and sanitation. Health 2.0 is concerned with the use of computers in the discovery of antibiotics and the pharmaceutical industry. Industry 3.0 is interested in applications that contribute to radiology and disease diagnosis. Health 4.0 seeks to integrate artificial intelligence methods, robotics and cloud computing in hospitals and clinics to help specialists make health decisions in diagnosing disease cases and monitoring the spread of epidemics and viruses—also, the use of cybersecurity systems to preserve patient data and records from any electronic attacks. Figure 1 illustrates the historical development of healthcare from the first industrial revolution to the stage of the fourth industrial revolution.
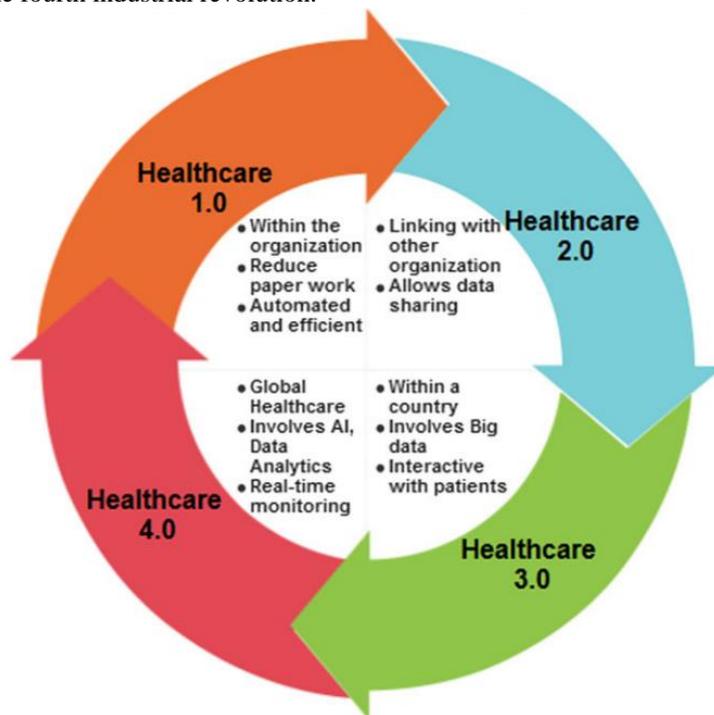

Fig. 1. Historical Evolution of Healthcare1.0 to Healthcare 4.0 [13].

Artificial intelligence techniques assist physicians in making medical decisions appropriately with patients' genetic makeup (genotype), medical history, lifestyle, and preferences [14-16]. Machine learning approaches carry out the tasks of predicting the extent of exposure to disease through predictive analytics, allowing for preventive measures and customized treatment plans that increase therapeutic results, for instance, monitoring the spread of coronaviruses and the extent of their impact on other areas and how to prevent these viruses [17][18]. Moreover, machine learning approaches have the ability to study the behavior of drugs and vaccines and develop them with the support of experts in the pharmaceutical industry. Machine learning is characterized by analysing big data, which accelerates the identification of potential drug candidates that are appropriate for the patient's condition. These procedures provide treatments for patients more quickly, and remote artificial intelligence applications can offer a range of medical consultations and track patients through wearable devices. Health 4.0 aims to provide medical services to patients in real-time and gain their comfort and satisfaction, especially for people living in isolated areas or areas without modern physician's clinics [19-22]. AI for Health 4.0 represents a significant quantum leap in developing the hospital and clinic environment, accelerating diagnosis, personalizing treatments, and improving healthcare [23][24]. Therefore, the combination of artificial intelligence and human medicine leads to the creation of a safe environment for patients and monitoring their condition firsthand. The main contribution of this article is to highlight the importance of artificial intelligence technologies in healthcare and what are the challenges and applications that contribute to the development of the medical environment.

2. GROWTH IN HEALTHCARE

The significant development witnessed by the healthcare sector through an interest in the inclusion of technology in hospitals and clinics, as well as attention to other aspects such as demographics, economic factors, and the environment. Modern technology and innovations contribute to the development of the health industry, such as telemedicine innovations, wearable devices, and electronic health records (EHRs), in order to extend the average life of individuals, as these technologies improve patient care, diagnosis and simplify administrative processes. Population increase, limited resources, and the emergence of epidemics significantly affect many countries, especially countries with little economies. Therefore, it is preferable for all countries to strive to develop healthcare systems by including modern systems that rely on artificial intelligence, get rid of traditional methods and seek digital transformation to care for all patients. Personalized medicine is one of the most critical advances in genomics and molecular biology, as it seeks to increase the effectiveness of treatments and reduce adverse effects. In addition, digital platforms contribute to developing digital health solutions through various health applications, monitoring devices, and health-related wearable technologies that enable individuals to control their health and view reports about their health status. The growth of healthcare is considered one of the most critical factors contributing to protecting the environment and reducing chronic diseases through health education for citizens, vaccination campaigns and promoting health behaviors. Data collection and analysis have become one of the most significant things that must be taken care of, as it supports healthcare workers to determine trends, enhance operations, and customize treatments. World health organizations are making great efforts to reduce the spread of global diseases and epidemics, strengthen the healthcare sector, and use robots with healthcare workers to track the spread of epidemics. The healthcare sector witnessed a significant development in the pharmaceutical industry with the development of treatments for various diseases, including cancer. Caring for the elderly is one of the things that Health 4.0 cares about, as the demand for healthcare services for the elderly increases, reducing ageing and managing chronic diseases. Governments and health organizations should focus on and develop healthcare infrastructure, including hospitals, clinics, and medical facilities. Health care aims to provide the best services to all individuals with high quality. Health care aims to provide the best services to all individuals with high quality. Moreover, it focuses on healthcare regulations and policies as they considerably affect the development of the healthcare industry and also healthcare workers. Governments should pay attention to medical tourism through low-cost and high-quality medical procedures.

Healthcare constantly grows through continuous support for scientific discoveries and technological integration into the work environment. In Health 0.1, attention was paid to drinking water since the eighteenth century witnessed many diseases caused by microbes through drinking water in homes. Health 1.0 concentrated on developing vaccines to treat these diseases and eliminate microbes. Health 2.0 paid increased attention to developing and manufacturing medicines as new antibiotics were produced, and health institutions increased. This led to the need for more physicians and specialists with a group of employees to work in hospitals. In Health 3.0, the advent of smaller and faster computers has contributed to the development of the healthcare industry. During this period, doctors were able to diagnose diseases early using images and determine the patient's needs. Health 4.0 contributes to providing healthcare services in real-time by providing a virtual environment that includes virtual people to assist patients in tracking their medical condition. Institutions and companies are developing effective Health 4.0 applications using cloud computing technologies, the Internet of Things and the fifth generation, especially artificial intelligence. The primary purpose of these applications is to transform into a digital environment, reduce costs, use resources efficiently, and maintain customer satisfaction by providing high-quality health services, all related to the development of technology and applications. Artificial intelligence techniques are vital in digital transformation as they offer promising future health solutions. These techniques have broad uses within the hospital and medical clinic environment. Also, these techniques analyse big data obtained from wearable devices and sensors, as this data contributes to developing applications based on artificial intelligence. Seeking to design advanced digital platforms that help healthcare professionals and workers monitor patients through early disease diagnosis, health promotion and rehabilitation processes—moreover, preventing diseases before they occur, diagnosing the disease before it develops, applying appropriate treatment, and getting rid of traditional methods and switching to electronic forms. Modern applications help older adults and people with disabilities to access health services faster, even if they are in remote geographical locations. Also, it reduces the workload of healthcare workers, supports doctors, makes appropriate clinical decisions, and provides early treatment for rapid diagnosis. In line with advances in imaging techniques, visualization of lesions that are difficult to see with the naked eye and detection of potentially overlooked images also give a positive direction for treatment. Therefore, it is necessary to use artificial intelligence applications to develop hospitals and medical clinics.

3. HEALTH 4.0 AND AI: THE SIGNIFICANCE

Artificial intelligence is the engineering of making smart machines and computer programs, as it can analyse, classify, and think. It is employed in many domains, including the military, education, energy, healthcare, etc. Health 4.0 is a concept that includes the integration of advanced artificial intelligence techniques in the healthcare industry as it emphasizes the

seamless convergence of digital technologies, artificial intelligence, data analytics and other methods that can be used in health institutions. Figure 2 illustrates the most critical technologies that can be used in developing health institutions and their services. The healthcare industry is a complicated system with many stakeholders within the healthcare organisation. Stakeholder roles in this system may change from time to time. An individual who has the ability to deal with AI techniques and disease trackers in a certain period of time can move to a patient and as a user of these techniques in a different period of time. Therefore, governments must cooperate with healthcare workers to develop the hospital environment, shift to a digital environment, and contribute to reducing potential risks, funding scientific research studies, and supporting researchers for the most effective use of health data. Health 4.0 supports health service technologies by efficiently using existing resources in health institutions. It contributes to personalized treatment and drug development by establishing a centralized patient management system. Moreover, it contributes to reducing medical errors by making the proper diagnosis by people expertly trained in these techniques. Health institutions should encourage the use of diagnostic procedures while supporting the process of reducing digital health costs.
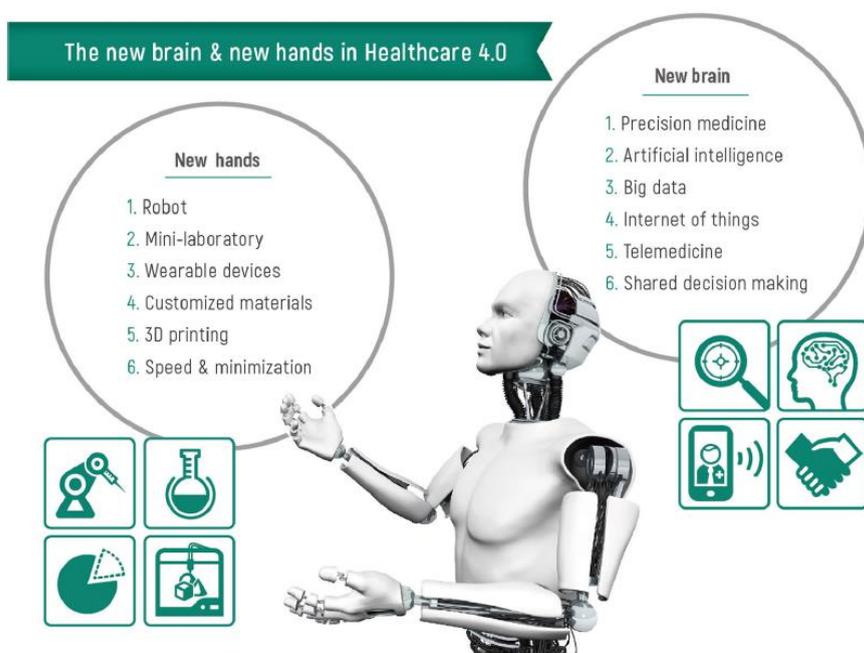

Fig. 2.   The new brain and new hands in Health 4.0 [25].

The main purpose of using artificial intelligence in healthcare is significant, as it is expected that serious technologies and methods will emerge in the future that contribute to the service of humanity. Therefore, healthcare workers must constantly develop by training in the latest technologies, keeping up with the latest studies, and involving them in hospitals and medical clinics. It is expected that new professions will emerge due to the growth and widespread use of artificial intelligence techniques in the future. Artificial intelligence techniques play an important role in the development of healthcare:

-   **Data analysis:** these techniques have an important role in analysing huge amounts of healthcare data and studying the behavior of this data. These techniques analyse patient records, medical imaging, genetic information, and data coming from wearable devices. These techniques provide a complete interpretation of the data while discovering patterns that help diagnose the disease.
-   **Clinical Decision Support**: AI techniques help clinicians and healthcare experts make the right decisions by providing evidence-based recommendations. These techniques can analyse the patient's medical history, current symptoms, and other relevant data, as this leads to reducing errors and enhancing the efficiency of medical decisions.
-   **Predictive Analytics**: artificial intelligence techniques can predict disease outbreaks, epidemics, and potential health risks in real-time, enabling healthcare workers to intervene early, reduce risks, and enhance preventive care.
-   **Medicines and vaccines**: artificial intelligence techniques contribute to developing medicines and vaccines and discovering serious medicines through analysing big data and studying the behaviors of partial information to determine the required medication, which leads to reducing time and costs.

- **Personalized medicine**: these techniques allow the development of personalized treatment plans based on an individual's genetic makeup, medical history, and other relevant factors. Through artificial intelligence, it is possible to identify each patient's requirements, increase the effectiveness of treatment, and reduce harmful effects.
- **Remote monitoring**: is a group of wearable devices and sensors that support the Internet of Things, which track the patient, collect data, and send it to doctors in real-time. These devices allow healthcare workers to intervene immediately and reach patients quickly.
- **Resource utilization**: these techniques contribute to improving operations within hospitals by scheduling employees, managing inventory, improving performance efficiency, and reducing costs.
- **Radiology and imaging**: these techniques can analyse medical images such as X-rays, MRI, and CT scans to detect malignant tumors or viruses. Through this procedure, radiologists can make faster and more proper diagnoses.

In general, artificial intelligence techniques can extract valuable information from medical records and clinical notes, as this helps doctors to study the patient's condition more accurately, diagnose cases, and reduce human errors. Consequently, health institutions should continuously train employees to employ artificial intelligence in their tasks and help patients to receive the appropriate treatment for them.

4. CONCLUSIONS

Artificial intelligence plays a vital role in enhancing health 4.0, as it has the ability to enhance patient care, improve diagnosis, and address all challenges that hinder the process of developing the environment of health institutions. Artificial intelligence techniques are significant in analysing health data and detecting and diagnosing new patterns. These techniques contribute to preserving health data from misuse and prevent unauthorised persons from manipulating or changing it. Healthcare workers must be trained to use these techniques and computer applications and solve all the problems they face. So, artificial intelligence is important in our lives and cannot be dispensed with, and it is in continuous development of its tools and applications. In the future, the practices of AI techniques in Healthcare 4.0 will be studied.

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