An Analysis of Recent Developments in Healthcare Technology from the Standpoints of Artificial Intelligence, the Internet of Things, and Remote Health Monitoring

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Abstract. During the last ten years, the healthcare market has been propelled by technological advancements in disease diagnosis, prevention, and treatment. This would not have been possible without the rapid development of AI-driven technology and also the digitization of healthcare operations in response to worsening global conditions and the increasing demand for rapid and high-quality medical assistance. In this paper we researched the most crucial technologies that can revolutionize healthcare sector. We delved into the technological developments that are pushing the healthcare sector forward into digital transformation especially from the perspective of artificial intelligence, internet of things and remote patient monitoring.

Keywords: Healthcare Industry · Remote patient monitoring · Internet of things · Artificial Intelligence

1 Introduction

With 2021 well behind us, COVID-19's presence still continues to linger around the world. Of all the industries that have been forever changed by the impacts of the global pandemic, healthcare arguably has changed the most [1]. With significant advances in technology and methods necessary to support the high demand of access to healthcare and growing digitization of protected health information, the healthcare industry has evolved in novel ways to continue to deliver the same exceptional quality of service [2]. As we go forward into the future, it will be important to keep in mind the underlying trends in healthcare technology that will shape the industry this year. Remnant technology and infrastructure is essential for the smooth operation of contemporary healthcare facilities, but it is crucial to think about how it may be updated or even replaced by more current alternatives. Efficiency, effectiveness, profitability, and security should all be prioritized without compromising accessibility or dependability. In this study we

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have made attempts to explore the recent trends in technological innovations driving the healthcare industry towards digital transformation in coming years. Here we will take look at the most important technologies that have the potential to transform the healthcare industry.

2 Trend 1: Artificial Intelligence (AI) in Healthcare

Artificial intelligence (AI) has been gaining a lot of attention as a promising new technology with wide-ranging applications, but particularly in the medical field. Some of the most important areas where AI has shown its worth in recent years are listed below.

2.1 AI's Role Against COVID-19

The worldwide epidemic has had a significant effect on our culture, yet modern technology has allowed us to adapt and survive. Specifically, a firm based in Toronto, Canada accurately predicted the global spread of COVID-19. The BlueDot app may detect potentially harmful epidemics in near real time [3] by scanning over 65 languages and 100,000 news sources every day. The advancement of machine learning has contributed significantly to the success of vaccine development. With the use of machine learning to easily determine protein fragments [4], COVID-19 vaccines were created in record speed [5]. Crowd temperature data analysis is another area where AI has proven useful [6]. This strengthens the case for using thermal screening as a means of detecting those who may develop symptoms. Additionally, recent developments in AI-powered face detection [7] have made it feasible to identify people even if they are using a facial mask [8]. In regions where it is required, it may also determine if indeed the user is using a mask.

2.2 AI in Diagnosis and Drug Development

Beyond pandemic medicine and response, AI has many more potential uses. Artificial intelligence is tremendously useful for speeding up the time spent on processing data and making decisions. Machine learning has been very useful in the healthcare sector, enhancing research into new drugs and improving the speed with which diagnoses may be made [9]. For those being treated for the effects of COVID-19, AI is helping analyze CT scans to detect pneumonia [10]. Microsoft developed Project InnerEye, a radiotherapy AI tool [11]. This dramatically speeds up the process of 3D contouring of the patient, bringing time to completion down to minutes instead of hours. The project is open source on GitHub. Project Hanover is another Microsoft AI system meant to catalog biomedical research papers from PubMed [12]. This helps reduce time for cancer diagnosis and assists with deciding on which drugs should be used for each patient.

2.3 AI in Mental Health

The benefits of AI advancements extend beyond the realm of medicine. Researchers from MIT and Harvard have used machine learning to monitor mental health trends and the spread of the COVID-19 pandemic [13]. An artificial intelligence programme was used

to sift through hundreds of Reddit posts and discover an alarming uptick in discussions of depression, isolation, and suicide. Possible game-changer for our knowledge of the mental health of large sections of the population.

2.4 Chatbots

Telehealth might benefit from chatbots powered by Natural Language Processing. UCLA researchers developed a VIR (Virtual Interventional Radiologist) by integrating chatbot and AI systems [14]. This was created to aid in both patient self-diagnosis and medical professionals' ability to correctly identify a patient's condition. While NLP-powered chatbots aren't quite ready for primary care, they can be useful in supporting doctors. As an added bonus, they are prepared to help gather patient information that is necessary to provide effective care.

3 Trend 2: Telemedicine and the Evolution of Remote Care

From the time the epidemic started in 2020 until now, telehealth has advanced significantly. Treatment teams have regular online video conferences with patients to address issues and offer guidance. The underlying infrastructure is in much better shape to facilitate this. By 2026 [15], the global value of telehealth services is projected to reach $185.6 billion.

3.1 WebRTC for Video Conferencing

A more specialized approach is often necessary to strictly comply with legal privacy standards. When developing a telemedicine app, one of the most crucial technologies is WebRTC, an open-source API-based technology that bridges the gap between web browsers and mobile apps to facilitate the transmission of voice, video, and data [16]. For teleconferencing functions, this is an absolute must-have.

3.2 Cloud Hosting and Data Storage

The majority of cloud storage providers are safe for storing data, however this does not mean they are compliant with regulatory requirements regarding PHI [17]. Video-conferencing and information hosting are two characteristics that may be valuable, but there are others as well. Security, location based services, appointment management, encrypted messaging, provider ratings, medical record keeping, wearable integration, and a comprehensive health record are just a few examples of additional features that might be useful. Data collected by consumer fitness trackers like Google Fit and Apple HealthKit may need to be stored in some apps [18]. Both the patient and the caregiver can benefit significantly from these connections being kept up in a safe and effective manner.

4 Trend 3: IoT and Wearables in Healthcare

Wearables and Internet of Things (IoT) technologies are growing in popularity [19], which means they have greater potential to improve healthcare. Many have begun to refer to this development in microprocessing, which has medical implications, as the Internet of Medical Things [20]. As of the beginning of 2021, there were already 11.3 billion IoT devices in use [21]. It is expected that the market for IoT medical devices would grow from $26.5 billion in 2021 to $94.2 billion in 2026 [22]. The healthcare sector is becoming increasingly interconnected with the help of these technologies, making it impossible to disregard IoT.

5 Wearables

The development of wearable technology is one of the most significant advancements in medical treatment. The capacity to keep tabs on one's own health or that of a loved one around the clock is a priceless asset. Deloitte discovered that 39% of respondents owned a smartwatch in their most recent study [23]. A growing number of people now have access to consumer smartwatches, and this has raised awareness of the devices' potential in the medical field. The ability to track heart rate is one of the most fundamental health metrics that may be provided by a wristwatch. The capabilities of a smartwatch extend much beyond this, though. Pedometers and oxygen saturation levels are only two examples of how these devices may be used to track physical health. Without the right equipment, hypoxemia saturation can be undetected for a long time [24]. Because this is potentially fatal, smartwatches equipped with this sensor can literally save people's lives. The capacity of smartwatches to monitor users' vital signs, such as heart rate, is also advancing. Variations in blood amount and composition can be measured using photoplethysmography (PPG), an optical technique [25]. With its miniaturization that can be used on smartwatches, it is now able to offer consumers with more information than ever before regarding their blood vital signs. This information may be used by medical professionals to better counsel patients and round out diagnosis.

Not only do smartwatches have promise for the medical field, but so do a variety of other wearable devices. The effects of bio patches and digital hearing aids are roughly the same [26]. If you don't want to wear a wristwatch but yet want to know how your body is doing, a bio patch may be the solution [27]. Hearing aids' ability to block out background noise can also be enhanced with the help of AI [28].

6 Smart Pills

The notion of a "smart pill" [29] is one of the most revolutionary uses of IoT technology in healthcare, since it effectively converts the Internet of Things into the Internet of Bodies. Smart pills are electronic medications that can also communicate with doctors and supply them with vital medical data. In 2017, [30] the first FDA-approved smart pill became available to consumers. One of the most profound applications for IoT technology in healthcare is the concept of a smart pill [29], which transforms The Internet of Things into The Internet of Bodies. Smart pills are edible electronics that not only

serve as pharmaceuticals, but can provide care providers with valuable information about patients. The first smart pill approved by the FDA was released in 2017 [30].

7 Wearables

Despite the growing popularity of integrating many microcontrollers in tandem, inter-computer communication remains a significant barrier to widespread adoption [31]. Another challenge is that practically every manufacturer utilises a different proprietary protocol for interoperability across their products [32]. Due of this, it may be challenging to integrate. Environmental considerations are just one source of connectivity problems. More reliable buffering mechanisms on nearby microcontrollers are required to address this. Concern about safety is also constantly present.

7.1 Conclusion

While in healthcare efficiency and quality are certainly important, privacy and security are also of paramount importance [33]. There was a data breach between the Kroger pharmacy database and Accellion's FTA secure file-transfer platform in February 2021 [34]. And they aren't alone. Over 40 million people were harmed by data breaches last year, affecting over 550 companies, according to HealthITSecurity.com [35]. Software like FaceTime as well as Skype, which are used by healthcare practitioners to interact with patients, may not adhere to all applicable regulatory requirements. There is currently no assurance that the external programme will adequately safeguard sensitive patient information. Additionally, it is challenging to ensure data security during telemedicine consultations.

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