

## EMERGING TRENDS OF IOT IN HEALTHCARE

### Abstract

The rise of the Internet of Things (IoT) has led to the development of a vast network of connected devices that can collect and store data without requiring human interaction. This technology can help improve the efficiency and effectiveness of healthcare by allowing providers to monitor and diagnose patients. Due to the emergence of the COVID-19 pandemic, many governments and decision-makers have started implementing policies that encourage the use of technology in the healthcare industry. This is why it is important that they understand how emerging and established IoT technologies can help improve the efficiency and effectiveness of their healthcare systems. This paper aims to provide an overview of the future trends of the IoT technology in health care, as well as how it can be used for improving the efficiency and effectiveness of the system. The paper states that the use of IoT can help improve the availability of preventive health services and the transition to a more coordinated system. The paper also explores the various barriers that prevent the adoption of IoT in the healthcare industry. These include the lack of confidence and security in the technology, privacy and security concerns, interoperability, and data storage and control.

**Keywords:** component; formatting; style; styling; insert (key words)

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## I. INTRODUCTION

The healthcare industry is expected to be one of the most prominent sectors that uses the Internet of Things (IoT) in the next few years. The COVID -19 pandemic highlighted the need for more effective and efficient IoT-based solutions. These include contact tracing and health monitoring. These solutions can help authorities control the spread of the disease. Internet of Things is a concept that refers to the connectivity of objects and devices to the internet. Unlike human interaction, IoT allows objects and smart devices to communicate with one another without requiring human interaction. This will allow patients to monitor their conditions and provide them with the necessary information to make informed decisions. According to a comprehensive research report published by Market Research Future(MRFR), the global Internet of Things in Healthcare market is expected to reach a value of over USD 320 billion by 2027. The report provides detailed information about the various components and applications of the market [1]. In addition to improving the efficiency and effectiveness of the healthcare industry, IoT can also help in the creation of more personalized and more cost-effective equipment. Patient-centered care will be provided through the use of IoT, which will reduce the number of visits to the hospital. The IoT has also allowed healthcare providers to improve the efficiency of their operations by allowing them to monitor the conditions of their patients and provide them with the necessary treatment. In-hospital hygiene tools can help prevent infections, while IoT devices can help in controlling the temperature of a refrigerator. Figure 1 shows the IOT in healthcare scenario.

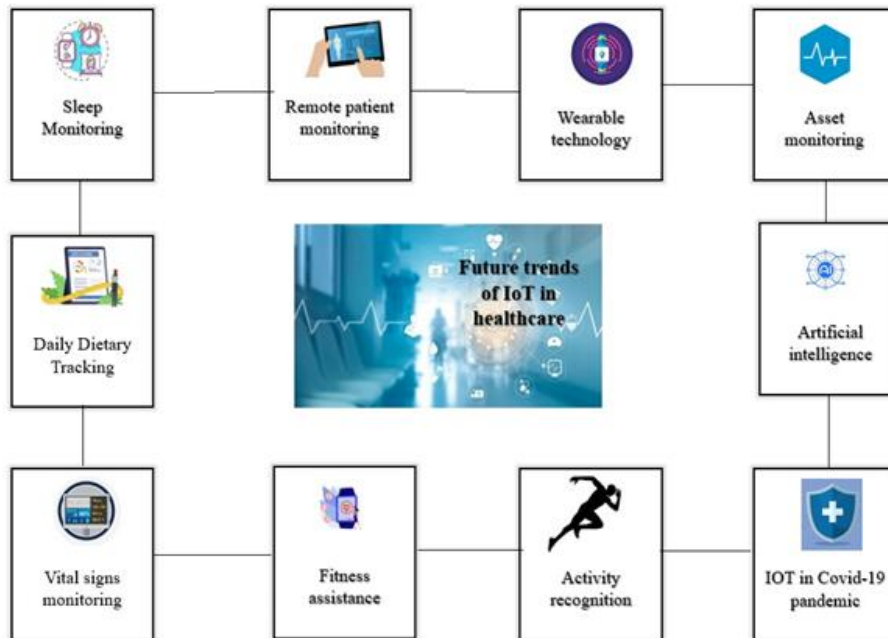


**Figure 1: IOT in Healthcare**

## II. FUTURE TRENDS OF IOT IN HEALTHCARE

- 1. Monitoring the health condition of patient remotely:** Through the use of IoT devices and software, doctors will be able to analyze the data collected from medical cards in real time. This will allow them to make better decisions regarding the treatment of their patients. The devices and software will be customized to allow them to analyze the data collected from the medical cards of patients. They will then be able to provide the necessary treatment recommendations. In addition to improving the quality of care, IoT can also help improve the experience of patients. Remote monitoring allows patients to receive regular updates about their health and can be used by healthcare providers to adjust their treatment plans. Another advantage of this technology is that it can help prevent patients from developing serious ailments before they reach the emergency room. The availability of the Internet of Things (IoT)[4] has allowed various technological advancements to be carried out in the field of remote patient monitoring. Although the current technology can be used to monitor a patient's condition, it's very challenging, to implement due to the lack of power and data capabilities. In a study conducted by researchers, One of the most important factors that researchers have considered when it

comes to developing a block chain-based remote patient monitoring system is the availability of secure communication between the patient and the healthcare professionals. This proposed work would allow them to provide complete privacy to the data collected by the system. In addition to this, the researchers noted that the use of block chain would also reduce the computational efficiency of the system. The future trends of IOT in healthcare is shown in figure 2.



**Figure 2: Future Trends of IOT in healthcare**

2. **Wearable technology:** There are various gadgets that can monitor the daily activities of patients and store their data. These devices can also help prevent patients from experiencing an emergency. These gadgets can be used to monitor a patient's daily activities and provide them with the necessary information to make informed decisions. They can also prevent an emergency by sending the data to the doctor immediately. The increasing number of connected devices and the rise of wearable technology are expected to drive the growth of the global IoT in healthcare market. Wearables are expected to play a significant role in the development of the healthcare industry. Aside from improving the quality of care, the use of IoT can also help improve a patient's experience. In some cases, the implementation of wearable technology has led to shorter hospital stays and lower readmissions.

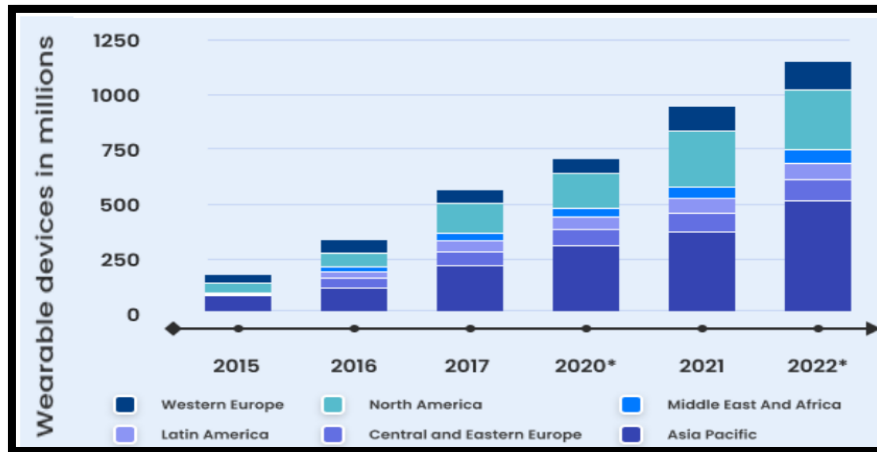
In addition to being used by adults, wearable technology has also been used by children to monitor their breathing patterns. This technology can be useful for parents as it allows them to make informed decisions regarding their kids' health. In [14] paper published by A. Dionisi and colleagues, they described an autonomous T-shirt that can be powered by a flexible solar panel. The T-shirt can be used to monitor various aspects of a person's health, such as their respiration rate and heart rate. It can be used in harsh environments due to its ability to operate in low light conditions. The Lifeshirt [15], uses a fabric known as Lycra to measure various aspects of a person's health. These include their temperature, respiration rate, and blood pressure [16].

- 3. Asset Monitoring in hospitals:** In addition to monitoring a patient's daily activities, IoT can also help prevent patients from experiencing an emergency. By connecting these devices to the hospital's central hub, staff members will be able to monitor their working properly. Defects in these equipment can be identified and fixed in real time, which can reduce the chances of improper treatment [2].
- 4. Artificial intelligence:** Through the use of embedded and wearable sensors, data collected by the IoT can also be analyzed and used to improve the efficiency of the system. This can be done through the use of machine learning and artificial intelligence (AI). One of the main advantages of using a traditional cloud-based architecture is its ability to provide high performance and reliability when dealing with non-safety critical applications [5][6][7]. However, when it comes to addressing time-sensitive and critical applications, a higher level of reliability and robustness is required. This is because the connectivity of the end user's device could be affected by various factors such as the availability of bandwidth and the disconnection of the core network. Since data collected by the IoT is heavily influenced by machine learning, it is very beneficial to use it in the development of AI programs [8]. According to a report by Research and Markets, the value of the global AI market will reach \$14,799 million by 2026. One of the most important factors that machine learning techniques need to consider when it comes to developing applications is the availability of high-quality data. For instance, analyzing the data collected by the IoT can help them determine when it's necessary to perform maintenance on their factory equipment.
- 5. IOT in COVID -19 pandemic era:** The pandemic led to an increase in the demand for remote treatment and monitoring solutions. This has allowed the healthcare industry to capitalize on the technological advancements that have been made in this field. Through the use of IoT-based remote monitoring solutions, medical professionals can now treat their patients remotely. They can then send the data collected by the system to healthcare providers in various regions. In addition to this, individuals can also benefit from the availability of wearable devices that monitor their vital signs. Due to the emergence of the Covid-19 pandemic, the need for effective and efficient health monitoring has become more critical. In order to develop a model that can monitor the health conditions of individuals, the researchers have used the IoT to develop a remote patient monitoring system [3].

The proposed model uses a combination of sensors and software to monitor a patient's vital signs, such as their temperature, blood pressure, and oxygen level. It then sends this data to the professionals for treatment and analysis. This model can be useful for rural areas as it allows healthcare providers to keep track of their patients' conditions. The researchers have identified Covid-19 as the main factor that they're working on, and they're currently testing the system's performance with high-speed internet connections.

- 6. Activity recognition:** The availability of technology can improve our lives in various ways. One example is the Human Activity Recognition (HAR), which is a type of research that's focused on the use of sensors to recognize and monitor the activities of individuals. This technology can potentially have a positive impact by removing the barrier of healthcare[a].

- 7. Fitness assistance:** The rise of the Internet of Things (IoT) has allowed various industries to capitalize on the technological advancements that have been made in this field. One of the most common examples of this is the fitness industry, which has started incorporating the IoT into its operations. Many clubs and gyms have started using wearable devices and software to monitor their members' activities. Number of connected wearable devices worldwide is shown in figure 3.



**Figure 3: Number of Connected Wearable Devices (<https://ideausher.com/blog>)**

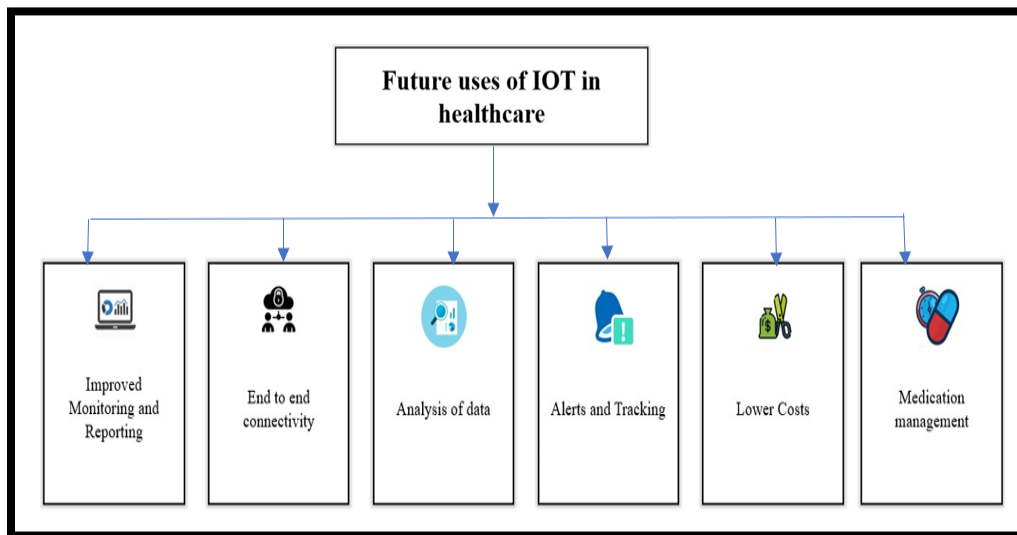
The global market for the fitness industry is expected to reach around 30 billion dollars by 2025, growing from 6 billion dollars in 2016. Due to the increasing number of gyms and the technological advancements that have been made in this sector, the market for IoT in the industry is expected to grow significantly. One of the main factors that's driving the growth of this industry is the increasing number of smart equipment and the ability to monitor the activities of its members. In addition to being used by individuals, various types of footwear and apparel have also started incorporating the IoT into their operations. For instance, smart apparel can monitor a person's overall health condition and provide helpful details such as their heart rate and breath. In addition, smart shoes can help guide users in choosing the proper running styles [9].

- 8. Vital signs monitoring:** According to the researchers, the use of wearable technology connected to hospital systems has been shown to reduce the number of unplanned admissions and emergency calls [17].
- 9. Daily dietary tracking:** A proposed system [19] that would allow food manufacturers to monitor and analyze the nutritional content of their products has been shown to be powered by Wi-Fi and an app. The device, which would be equipped with a weighing sensor, would be able to analyze the data collected by the app and send it to the cloud. The proposed system [19], which is powered by Wi-Fi and an app, would allow food manufacturers to monitor and analyze the nutritional content of their products. It would be able to do so by calculating the weight of their products and sending the data to the cloud.

**10. Sleep monitoring ;** In a study conducted by Kshipra Rajguru et al. [20] they developed a low-cost system that can be used to monitor a patient's sleep quality and temperature. The system, which is equipped with a gyroscope and a heart rate sensor, can be used to analyze the data and provide a personalized response to the patient.

In a study conducted by Diana C. Yacchirema et al. [21], they developed a system that can be used to monitor the activities and sleep status of elderly people. The system can also collect data from various factors such as the sleep environment and physical activities.

### III. FUTURE USES OF IOT IN HEALTHCARE



**Figure 4: Future Uses of IOT in Healthcare**

- 1. Improved monitoring and reporting:** In certain medical emergencies, such as heart failure or asthma attacks, remote supervision using IoT devices can help save lives. Through the data collected by these devices, the doctor can immediately provide the necessary treatment. A study conducted by the Centre for Connected Health revealed that remote supervision reduced the re-admission rate of patients [22]. Figure 4 shows the future uses of IOT in healthcare.
- 2. End to end connectivity:** The use of IoT can help improve the efficiency and effectiveness of the healthcare delivery system by allowing patients to receive the best possible care. Through the various connectivity protocols that are available in the devices, hospital personnel can also spot early signs of illness. Through the use of connected devices, doctors can now make informed decisions regarding the treatment of patients. This can help reduce the amount of time that patients spend in hospitals and doctor's offices [23].

- 3. Analysis of data:** The ability of IoT devices to collect and analyze vast amounts of data in a short time has allowed healthcare providers to focus on the treatment of their patients. This will allow them to make better decisions and improve the efficiency of their operations. Due to the increasing amount of data being collected, the need for fast and accurate analysis is also increasing. This will result in the need for more effective tools that can help organizations make informed decisions. One of the most common factors that will affect the growth of the global IoT in healthcare market is the increasing number of machine learning algorithms [24].
- 4. Alerts and tracking:** One of the most critical factors that a healthcare provider needs to consider when it comes to developing effective and efficient strategies is the availability of timely warnings. With the help of IoT devices, they can collect and analyze data in real time, which can then be sent to a doctor for evaluation.
- 5. Lower costs:** Through the use of wearable and connected devices, patients can connect with their doctor from their homes. This will allow them to avoid going to the doctor for routine tests and procedures. One of the most important advantages of IoT is its ability to help prevent patients from developing a serious illness. Through the use of this technology, healthcare providers can identify those who are at risk for certain ailments and provide them with the necessary treatment. Another advantage of this technology allows doctors to monitor their patients 24/7, which can help improve the efficiency of their operations.
- 6. Medication management:** The use of smart wireless pill bottles can also help people keep track of their medication schedule. This will allow them to take their medicine on time. The ability to monitor and analyze data in real time will allow doctors to provide better care [2].

#### IV. FUTURE CHALLENGES OF IOT IN HEALTHCARE

Due to the increasing number of connected devices and the data collected by them, the security issues related to the use of IoT will also rise. This will allow unauthorized individuals to access the data and cause harm to the users. In order to prevent unauthorized access, it is important that the users have proper authorization and authentication. The availability of the Internet of Things (IoT) can pose a threat to the privacy and security of users. It can allow unauthorized access to a person's private information, and it can potentially cause health conditions to worsen. Medical devices, which are connected to the Internet, are prone to being vulnerable to various attacks such as tag cloning and RF jamming [12]. One of the most common attacks that can be used against the IoT is a man-in-the-middle attack, which involves sending commands to a device through a direct connection. This type of attack can be carried out through a service discovery protocol, which can be used to locate and target the IoT devices. Despite the increasing number of connected devices, the applications that are related to the use of IoT are still in their early stages of development. The rapid emergence and evolution of the Internet of Things will greatly affect the healthcare industry.

## V. CONCLUSION

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