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# Internet of Things for Smart Healthcare

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**Abstract:** ***The paper will focus on the Internet of Things (IoT) in healthcare, a rapidly evolving field. IoT is a network of physical devices embedded with electronics, software, sensors, and network connectivity. It gathers a vast amount of information that enables us to maintain a framework for storing and studying essential data. IoT has the potential to be used in the pharmaceutical industry for record-keeping, conducting studies and cost saving [1]. In this paper, authors are going to cover the general attributes of IoT, its benefits and applications in medical field, its limitation as a technology, successful stories in healthcare that harnessed IoT principle and lastly the future expectations about IoT technology.***

**Keywords:** IoT, AdOM, China, Covid-19, Capsule endoscopy

## 1. Introduction

The prevalence of technology in our lives has resulted in its integration across various sectors to streamline daily activities with minimal human intervention Metaphorically, if technology is a tree, Internet of things (IoT) is one branch that widely embraced in many applications, especially medical sector. IoT is an integration of physical objects and digital hubs, in which the objects are sensing the surrounding ambient then transmit a list of parameters to a common network, where complex computing processes are executed before the results are preserved. In the following lines, we are going to focus on IoT related to medical applications. The applications are not restricted to a wearable smart watch that measure user's heartbeat rate continuously and notifying him/her in case of abnormality, there are numerous sophisticated applications and aspects to be furnished.

## 2. Abbreviations

**IoT** : Internet of Things
**MIOT** : Medical Internet of Things

## 3. General Concept of IOT in Health Care

The proliferation of healthcare-specific IoT products heralds a new era of possibilities. The vast amount of data generated by these interconnected devices holds the potential to revolutionize healthcare. IoT's four-steps architecture , depicted in Figure 1), is a roadmap to this transformation. Each stage is intricately linked, with data captured or processed at one stage contributing value to the next. This Integrated approach not only provides insights but also opens dynamic business prospects.

**Step 1:** First step consists of deploying interconnected devices , including sensors, actuators, monitors, detectors, camera systems etc. These devices collect data.

**Step 2:** Data received from sensors and other devices are usually analog, which need to be aggregated and converted to the digital form for further data processing.

**Step 3:** Once the data is digitized and aggregated, it is preprocessed, standardized and moved to the data center or Cloud.

**Step 4:** Final data is managed and analyzed at the required level. Advanced Analytics, applied to this data, brings actionable business insights for effective decision-making.

IoT is revolutionizing healthcare offering the potential for better care, improved treatment outcomes and most importantly, reduced costs for patients. it is not just about data and processes, but about making healthcare more affordable. For healthcare providers, IoT offers the potential for better processes, improved workflows, and enhanced performance [2].


**Figure 1:** Four-steps architecture of IoT
***Reference:*** www.wipro.com

## 4. Applications and Benefits

### 4.1 IOT for Patients

There are many benefits of IoT in the healthcare sector, such as keeping track of patients by helping medical workers through wearables and home monitoring equipment to create records, alerts and medication schedules. Moreover, wearable smart devices like fitness bands, diabetic monitor devices and other wirelessly connected devices can check blood pressure and heart rate, glucometer, etc. IoT gives patients who suffer from critical illnesses access to personalized attention. It can be a reminder for calorie count, exercises are done, doctor's appointments, blood pressure variations and much more.

Also, it is a great tool to set it for senior patients who suffer from weak memory or Alzheimer's. According to alz.com, Alzheimer's is the most common form of dementia. Today, there are 5 million people living with Alzheimer's and this number is likely to rise to 16 million by 2050. With the help of IoT, healthcare workers and family members can keep track of patients with a wearable smart device by the patients and motion sensors that could alert caregivers if the patient

has left the facility and to prevent them from wandering off and causing more harm for themselves. In addition, IoT has a significant impact on people living alone and their families. For any disturbance or alterations in the patient's routine activities, an alert will send signals to family members and concerned health providers [3].

### 4.2 IOT for Physicians

embedded equipment with IoT has supported physicians to keep track of patients' adherence effectively to treatment plans or any need for immediate medical attention. IoT enables healthcare professionals to be more watchful and make better diagnoses based on collected data and reach the expected outcomes.

Moreover, IoT creates safer hospital facilities for the staff and patients through many security solutions. For example, improving the hospital's physical and digital design will result in more straightforward monitoring that can help ensure an efficient flow of patients, which could minimize the need for waiting rooms and reduce crowding in treatment spaces. According to the Occupational Safety and Health Administration (OSHA) , overcrowded waiting areas and long waiting for patients are two main factors in violence against healthcare workers. Moreover, with the help of IoT, it created a safer place for both parties [4].

### 4.3 IOT for Hospitals

Apart from monitoring patients' health and assisting physicians, there are many other areas where IoT devices are handy in hospitals. For instance, medical equipment's tagged with sensors are used for tracking real time location of the equipment like wheelchairs, defibrillators, nebulizers, oxygen pumps and others. Additionally, deployment of medical staff at different locations can also be analyzed in real time.

The spread of infections is a primary concern in hospitals. IoT enabled hygiene monitoring devices help in preventing patients and hospital staff from getting infected. IoT sensors can also help in environmental monitoring by checking refrigerator temperature, humidity and temperature control of laboratories, kitchens, blood banks and the storing conditions of medications. Furthermore, IoT can warn of potential harmful leaks and other hazards for more secure and safe facilities. Likewise, IoT is an excellent addition to the pharmaceutical industry for archiving records, controlling medication dispensing and cost savings [5].

### 4.4 IOT for Health Insurance Companies

IoT is a powerful tool that empowers health insurance companies, enabling them to successfully achieve cost savings. With the capability to monitor data generated from healthcare facilities for their financing and claims. The claims management process that is led by IoT will allow them to detect fraud claims and identify prospects for underwriting. Also, it can lead to

transparency between insurers and customers in the activities, pricing, claims handling and every decision made and their outcomes. Insurers now may offer tools for their customers to keep track of their routine activities, validate claims through data, adherence to treatment plans and protective health measures [2].

## 5. Risk and Limitations

Despite the many benefits of IoT in healthcare, it is also vulnerable to network attacks such as data theft and phishing attacks. These can lead to cyber security threats and serious data breaches that can result in companies' loss of money and effort [6]. Furthermore, there are other challenges faced during the implementation of IoT.

### 5.1 Privacy of Data

Privacy is the biggest challenge with IoT, as all connected devices transfer data in real-time. If this end-to-end connection is not secure, personal data can be hacked, and criminals can use this personal data of others for their own benefits.

### 5.2 Accuracy

Accuracy issues may arise due to the handling of such massive amounts of data in real-time.

### 5.3 Cost

IoT may reduce the cost of diagnosis and treatment for patients, but installing all the devices and their maintenance is relatively high

### 5.4 Risk of Failure

Failure or bugs in the hardware or even power failure can impact the performance of sensors and connected equipment, placing healthcare operations at risk. In addition, skipping a scheduled software update may be even more hazardous than skipping a doctor's checkup.

### 5.5 Integration

The absence of a unified approach to IoT protocols and standards is a significant challenge, this means that devices produced from different manufacturers may not be fully compatible. The lack of uniformity prevents full-scale integration of It therefore limiting its potential effectiveness.

## 6. Case Study

In the recent digitalization era, substantial competition is being observed and experienced in the medical industry. Hats off to all innovators who could strive and come up with new healthcare solutions during the pandemic crisis, Covid-19. UAE has utilized IoT successfully during the spread of Covid-19. It has implemented a smart application "Al-Hosn" that helped control and monitor the pandemic closely by employing cameras in every private and government entity that can identify infected persons with the virus. The cameras scan the individuals' faces and detect a threat. As a result, The US-based Global Excellence Award (GEA) has awarded

"Al Hosn" app. the "App of The Year 2021" in the Covid-19 Response category. The achievement reflects the advanced level of the UAE's health system in the digital transformation, and the efficiency of the relentless efforts made to curb the spread of the pandemic..

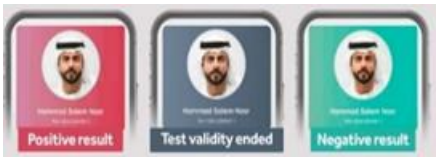


**Figure 2:** Al Hosn Application
***Reference***: https://mohap.gov.ae/en/media-center/news/1/2/2022/al-hosn-app-awarded-global-excellence-award-in-covid-19-response-category

China acted as a great fighter against Covid-19 by utilizing new technology as a weapon. Drones are an example of IoT-based applications used during the pandemic in China. It was used to remotely collect and transfer patients' test samples to avoid direct contact with them and expedite the procedures. In addition, Drones were a channel to capture and verify citizens adherence to the restrictions during lockdown and send the captured Data to the concerned authority. Moreover, Drones were a perfect solution to spray disinfectants in different locations where the virus is abundantly spread, as well as initiating warning sounds, asking people to be confined securely in their homes [7].

**Figure 3:** Drones used in China during Covid-19
***Reference:*** www.geospatialworld.net

## 7. Widly in the Martket

According to the Authors' expectations, in a few years, IoT is going to replace many physical devices used to take patients' measurements as well as save doctors' assistants' time. One of the existing examples is capsule endoscopy, which is a medical procedure to diagnose the entire gastrointestinal of any patient. It is a small-size swallowable capsule consisting of a tinny battery, LED light, camera and transmitter. The procedure takes a few hours, during which a number of adhesive sensors are placed on the patient's abdomen. Apart from this, a recorder fixed on a belt around the waist receives thousands of pictures from the transmitter inside the swallowable capsule [8].

**Figure 4:** Capsule endoscopy Technology
***Reference:*** www.ypo.education

The same concept with added features might soon be available in the medical market. Whenever a body vitamins check-up is needed, a patient may swallow a capsule at night before proceeding to bed. The capsule chemical parts shall be dissolved and transmit signals carry information to the user's smart appliances (i.e., smart mirror etc..). Visualizing the next day in the morning, a pop-up message appears in the smart mirror placed in the washroom, providing a concise report on the user's health. Subsequently, the patient will be advised to visit the nearest medical center in case needed.

Another example is implanting sensors inside a patient's body. These sensors can sense body temperature, blood glucose level, cholesterol level, minerals level and give feedback about the amount of nutrients to be taken as food intake to maintain a healthy life.

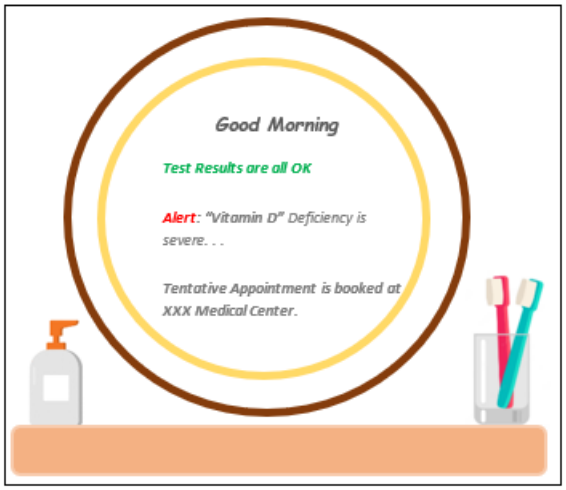


**Figure 5:** Example of MIOT in the future

## 8. Conclusion

IoT in healthcare improves convenience, higher engagement, and fewer in-person medical visits, which will benefit patients, doctors, hospital Management, Pharmacies and insurance companies. As stated by Dr. Brendan O'Brien, an American voice actor, stated "*If you think that the internet has changed your life, think again. The internet of Things is about to change it all over again*."

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