

Combined Effects of IoTs and Medical Sensors for Effective Application of Smart HealthCare System

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Abstract

Smart healthcare is a health service **system** that uses technology such as wearable devices, IoT, and mobile internet to dynamically access information, connect people, materials and institutions related to **healthcare**, and then actively manages and responds to medical ecosystem needs in an intelligent manner[4].

The Internet-of-Things (IoT) has taken over the business spectrum and its applications vary widely from agriculture, and healthcare, to transportation etc. A hospital environment can be very stressful, especially for senior citizens and children. With the ever-increasing world population, the conventional patient-doctor appointment has lost its effectiveness. Hence smart healthcare becomes very important. Smart healthcare can be implemented at all levels, starting from temperature monitoring for babies to monitoring vital signs in the elderly. The complexity and cost of implementation varies based on the required precision of the individual devices, functionalities and sophistication of the application for which they are used. Smart healthcare also falls under vertical areas such as VLSI, embedded systems, big data, machine learning, cloud computing and Artificial Intelligence. This article discusses the importance, requirements and applications of smart healthcare along with the current industry trends and products. It gives a deeper insight about the different platforms across which more research can be pursued in this dynamic domain. [25]

Keywords: *IoT, Smart, Healthcare, Technology, Mobile Internet, Patient, Doctor, Hospital, Big Data, Sensors, Cloud Computing*

1. Introduction

Today's era is the one of informatization. With the advancement of technology and scientific theory, traditional medicine with biotechnology as its core, has gradually begun to digitize and to in format ionize. And smart healthcare incorporating a new generation of information technology has emerged. Smart healthcare is not just a simple technological advancement, but also an all-round, multi-level change. This change is embodied in the following: medical model changes (from disease-centered to patient-centered care), informatization construction changes (from clinical informatization to regional medical informatization), changes in medical management (from general management to personalized management), and changes in the concept of prevention and treatment (from focusing on disease treatment to focusing on preventive healthcare)[1]. These changes focus on meeting the individual needs of people while improving the efficiency of medical care, which greatly enhances the medical and health service experience, and represent the future development direction of modern medicine. This review will start from the concept of smart healthcare, then briefly introduce the key technologies supporting smart healthcare and explain the achievements and challenges of it by reviewing the application status of these technologies in important medical fields, before finally putting forward the future prospects of smart healthcare[20].

2. Concept

Smart healthcare was born out of the concept of “Smart Planet” proposed by IBM (USA) in 2009. Simply put, Smart Planet is an intelligent infrastructure that uses sensors to perceive information, transmits information through the internet of things (IoT), and processes the information using supercomputers and cloud computing[2]. It can coordinate social systems and integrate them to realize the dynamic and refined management of human society. Smart healthcare is a health service system that uses technology such as wearable devices, IoT, and mobile internet to dynamically access information, connect people, materials and institutions related to healthcare, and then actively manages and responds to medical ecosystem needs in an intelligent manner. Smart healthcare can promote interaction between all parties in the healthcare field, ensure that participants get the services they need, help the parties make informed decisions, and facilitate the rational allocation of resources. In short, smart healthcare is a higher stage of information construction in the medical field[3].

• **Components of Smart Healthcare Technologies [4]**

- Sensors that collect patient data
- Cloud computing to store, process and analyze the data
- Web and mobile applications for caregivers and patients
- Gateway to transmit the data

3. Key Technologies of Smart Healthcare

Information **technologies**, for example, IoT, mobile Internet, cloud computing, big data, 5G, microelectronics, and artificial intelligence, together with modern biotechnology constitute the cornerstone of **smart healthcare**. Smart Health Technologies are believed to cause drastic changes over a short period of time as well as provide an opportunity of incorporating both health data from private citizens through wearable technologies and smart health data from within the hospitals. This latter aspect will give rise to intelligent operations and maintenance. Hal Wolf argues that not only wearables, but also sensors and robotics will be available for remote monitoring by 2025.

According to [4], Smart Health Technologies cover a variety of solution types. In hospitals they can be e.g.:

- Sensors
- Medicine dispensation
- Smart pills
- Smart surgeries
- Holographic devices/simulation

4. Method

The term ‘Smart Health Technology’ combines the term ‘Smart Technology’ with health, i.e. smart technologies used for health purposes. Smart Health Technologies is capable of recording health information from increasingly advanced sensors, storing and computing this information automatically and deliver either personalized advice or automated actions from the collected data. As such, Smart Health Technologies are at least in part physical, and can include the means to interact and engage with data by way of e.g. Virtual or Augmented Reality as well as other forms of data representation.

5.1 Technologies for Healthcare [5]

1. Big Data in Healthcare

As smart connected devices gain popularity, Big Data has made inroads in the smart healthcare system. According to our analysts, there has been a steady rise in the demand for M2M and M2H communications so as to categorize the large volumes of medical data. Major healthcare technologies companies like Oracle, IBM, and SAP, have already increased their big data spending on healthcare to widen their reach in nascent markets in the APAC region[23].

2. IoT in Healthcare

IoT in healthcare technologies is also popularly known as IoMT (Internet of Medical Things) is one major technological innovation which has added the element of “smartness” in the healthcare industry. Along with identifying, monitoring, and informing caregivers about the patient’s vitals – it also provides the much-needed critical data to the health care providers so that issues can be identified at an early stage leading to better delivery of care services[7,8].

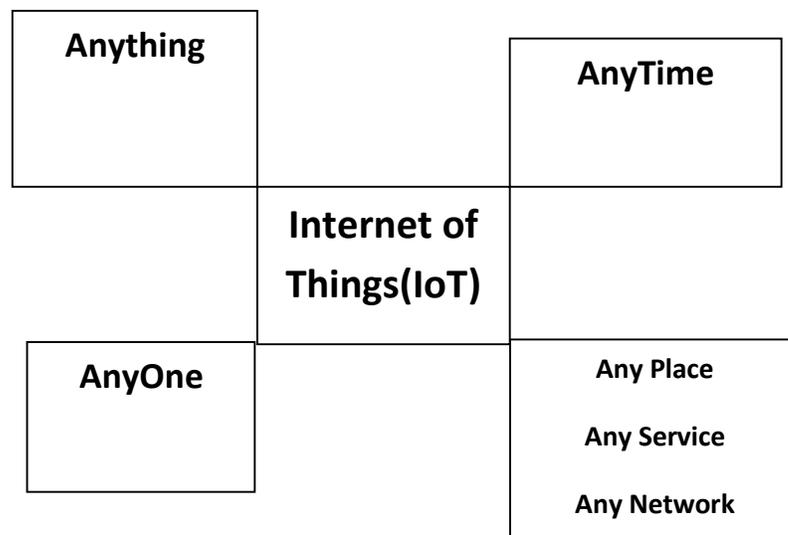


Fig.1: The IoT its Application for all connected Network

3. Machine Learning

With Google developing machine learning algorithm to identify cancerous tumors on mammograms, to the Stanford University using deep learning algorithm for diagnosing skin cancer – the application of machine learning in the healthcare systems has opened up new avenues in the smart healthcare market.

Personalized care has been the hallmark of smart healthcare solutions, which can be easily gained through machine learning. Especially in maintaining smart electronic health records, machine learning enables major stakeholders in the healthcare industry to gain advantage and speed up the care delivery curve.

4. Cloud Computing

After Big Data, if anything has made the healthcare technologies way smarter, then it is the cloud computing technology. As it is cloud computing encourages cost savings, scalability, and system flexibility; now with the increased use of cloud-assisted medical collaboration, the demand for cloud computed healthcare solutions has grown exponentially.

According to our newest market research report, major industry names like BioLert are employing edge computing to detect, monitor, and notify the occurrence of epilepsy episodes in a patient to its caregiver.

Smart Technology is an umbrella term covering all forms of technologies which have:

1. Physical sensors with which to register data from its surroundings
2. Computational capacity with which to store and analyse the data
3. The means to deliver either actionable advice tailored to the end-user or automated actions, based on the data input.

Smart Health Technology adheres to the above definition, with the clause that it is used with the purpose of, or within the domain of health.

How are Smart Health Technologies used

The use of sensors in self-monitoring has long been the cornerstone of the notion of Quantified Self. The combination of recording personal health and the possibilities within Data Analytics enable Smart Health Technologies to provide engaging and personalised output. Smart Health Technologies make both real time and historic health data available to the citizens and healthcare personnel. The reliability of the collected data, however, is often discussed. **Smart Health Technologies** are still in their infancy and the reliability of the data is still not high enough for healthcare providers or end-users to rely on the precision and accuracy of the data.

5. Key Challenges [4]

- Decreasing operational costs
- Eliminating system errors
- Disease management
- Enhancing patient experience
- Better management of drugs
- Improving treatment outcomes

On the one hand the challenges for Smart Health Technologies are related to the technical capabilities of the technologies, e.g. whether adequate precision and data security can be ensured. This will be necessary to ensure that Smart Health Technologies can be incorporated in healthcare. On the other hand incorporating Smart Health Technologies in healthcare will affect the healthcare personnel and the way that they work. A cultural change is in the cards.

1. The introduction of **Smart Health Technologies** will no doubt foster a change in the healthcare system. Not only will the healthcare sector need to adopt a new way of managing citizens with illnesses and special needs, the healthcare personnel will also need to be more agile in relation to integrating and working with new technological devices. For example, the advances in especially Smart Health Technologies is expected to speed up the process of using telemedicine to monitor and treat patients remotely.
2. In general more healthcare will take place in the homes of the citizens or in their local environment. Telemedicine is often used to the benefit of chronically ill patients today, however in the future, treatment in the local environment of the citizens will expand to other patient types. This means that the healthcare personnel will be delivering healthcare in a different way.

6. Application of Smart Healthcare: Nano Smart As an Example Smart

SMART HEALTHCARE [25] Consumer electronics empowered with the latest wireless technologies and seamless architectures help in improving the quality of life through smart healthcare. One such example is the pill camera.

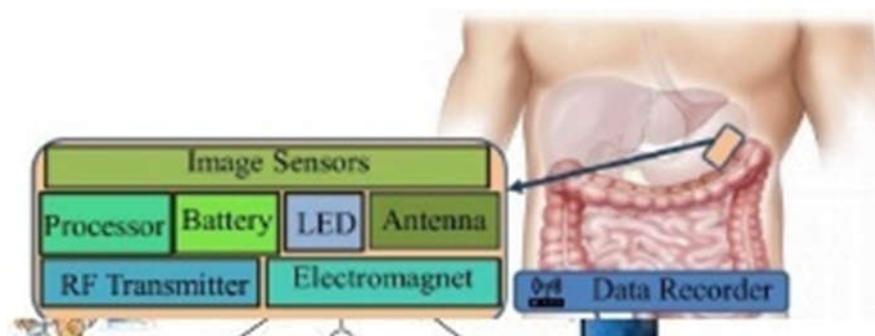


Fig.1: Pill Camera - As an Example for Nano Smart

Endoscopy or colonoscopy are procedures which are generally used by doctors for monitoring the internal organs for any gastrointestinal infections [25]. It is generally prescribed for patients with colon cancer, irritable bowel syndrome, stomach ulcers, tumors, piles and so on. These procedures are not just expensive; they also make the patient uncomfortable as a long tube is put inside a person. A pill camera makes the job easier for both the patient and the doctor. It is as

simple as swallowing a pill and getting high resolution pictures of the internal organs. Figure 12 shows the overall architecture of the pill camera. The pill camera is a light device with image sensors to capture the footage, and an RF transmitter and antenna to wirelessly transmit this acquired data in real time to the data recorder which is a waist belt or a shoulder strap. The magnetic strips help in activating the camera as and when required. The LEDs are timed in such a way that when the camera reaches the appropriate position, they are turned ON to monitor the exact location and obtain better images. This camera is either powered by a small battery or through induction charging with the help of the data recorder strap. As there is no on board memory in the pill camera, it makes it very light to navigate through the intestine. Though pill cameras have been around for almost a decade, the latest advancements can produce over 800,000 images in 8 hours, with the camera turning at around 60 degrees every 12 seconds.

7. Barriers for smart Health Technologies? [4,5]

There are some barriers like

1. The healthcare sector's readiness to adopt Smart Health Technologies and integrate them into their daily operations
2. The healthcare personnel's existing competencies for using Smart Health technologies
3. The readiness of the infrastructure to integrate Smart Health Technologies and data

8. Conclusion

This paper provides an extensive survey on the current research trends along with the challenges and opportunities available in smart healthcare. Needle-less and cost-effective healthcare solutions have always been on great demand. With enormous funding and increasing attention towards the smart healthcare domain, there are numerous products and applications available for users. As smart healthcare has multi-dimensional applications, it offers a lot of scope for researchers to constantly innovate new products and improve the already existing architectures. The transition towards smart healthcare services, is a slow and steady process. This is mainly because healthcare professionals need to be constantly educated and convinced to adapt to the digital era. By bridging the gap between researchers and healthcare professionals, more research problems and diseases can be addressed and smarter lifestyles can be adapted. Though the smart healthcare solutions backed by the IoT can improve revenue, and increase quality of life, the benefits can be easily overshadowed, if security is compromised. Additional measures need to be taken to handle threats and securing the potential information at both the customer and developer ends. Thus, the vision and long-term success of this dynamically growing industry lays in the synergy of researchers, healthcare professionals and the public.

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