

International Journal of Advance Research in Computer Science and Management Studies

Research Article / Survey Paper / Case Study

Available online at: www.ijarcsms.com

Internet of Medical Things [IoMT]

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Abstract: *The Internet of Things (IoT) is the system of physical gadgets joined with hardware, programming, sensors, and system network that empowers these objects to collect and exchange data. The IoT has a variety of application domains, including health care. The IoT insurgency is redesigning current health care with promising technological, economic, and social prospects. This paper surveys advances in IoT-based health care technologies and reviews the state-of-the-art network architectures/platforms, applications, and industrial trends in IoT-based health care solutions. In addition, this paper analyses distinct IoT security and privacy issues.*

Keywords: *IoMT, IoT platform, healthcare, medical sensor device.*

I. INTRODUCTION

IoT is next big thing in Information Technology and its increasing rapidly. IOT has already integrated in many of the areas for example Smart cities, Smart homes, Smart securities etc. But there is still vast scope for integration. IoT (Internet of Things) is a currently advanced concept of ICT (information communication technology), in which all gadgets and administrations are teaming up while diminishing human mediation for better human life. The Gartner which is one of market research firms expected that IoT has been ranked in the top future promising technology. Also, healthcare service is making the application and advancement of the right now most dynamic IoT innovations. Mobile healthcare service is currently more popular since healthcare service with computer was started using ubiquitous computing, but now, it will be paid consideration to the next healthcare with wearable computer.

One of the major concepts of IoT is Internet of Medical Things (IoMT). From the very beginning of the civilization people realized that good health of people is important aspect of stable society, and for that human always managed to find new and efficient technologies in medical field. Internet of Medical Thing basically includes collection of medical devices and applications that connect to healthcare IT systems through online computer networks. Accordingly I propose the requirements for the design of the healthcare model to be offered on the open IoT platform as the healthcare service are given to users or patients. Chronic diseases - hypertension, diabetes, obesity, and so forth - are important to viably oversee by using healthcare service application wearable computer. Let's see the implementation of IoMT and issues of IoMT.

II. SCOPE OF IOMT

As mentioned earlier Scope of IoMT is so vast and there are numerous ways to implement. Scientist and technologists are already working on its integration. This paper proposes the IoT concepts for healthcare as a suitable self-management model. Some of the concepts are discussed below.

A. Patient Monitoring

IoMT can be used to monitor patients remotely. Doctors and caretakers can track the patient's medication order and location of hospital. Hospital beds connected with analytical dashboards can send vital signs of patient. IoMT device's to remotely monitor patients in their homes is also known as telemedicine. This kind of treatment spares patients from traveling to a hospital or physician's office whenever they have a medical question or change in their condition.

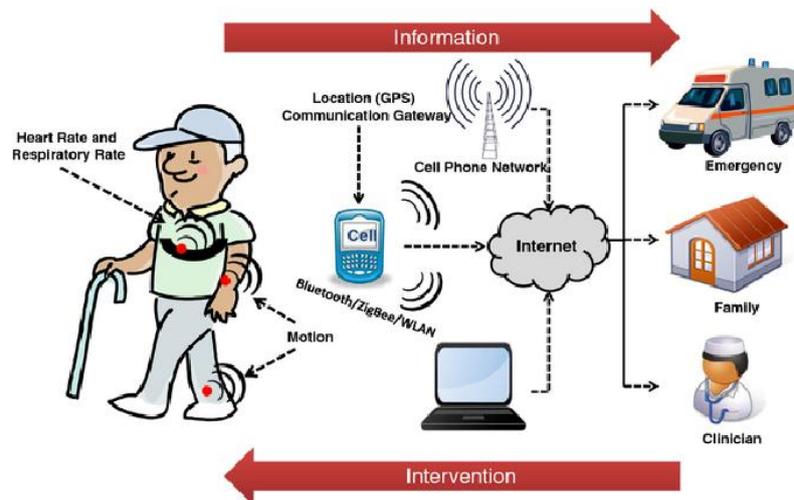


Fig. 1 IoT in Remote Health Monitoring

B. Smart Medical Box

A medical box which has been programmed to sense what kinds of products are being stored inside it and keep a track of the stock through barcode or RFID (Radio Frequency Identification) scanning. It will alert the user as well as pharmacist on their cell phones to replenish the stock time to time. The patient non-compliance is an imperative issue which puts an earlier significance to the strength of a great many patients. The Medicine Box offers a solution to the patient non-compliance problem. The Smart Medicine Box keeps track the number and time of pills the patients have taken. This innovation is along these lines fit for enhancing patient's wellbeing radically.

The functions of the Medicine Box are based on a LEDs and a microprocessor keeping track of time and amount of pills left in the Medicine Box. Patients schedule for taking his medication is also stored. The Medicine Box utilizes this data to construe whether the patient is agreeing to his treatment.

- 1) *Medication Support:* The device can hold more than one tablet/pill because the elderly and sick usually are prescribed with more than one medication to make them fit. The normal number of medications by each patient over the age of 60 years was greater than 5 per day.
- 2) *Dispensing Scheme:* The medicine box has three LEDs of different color, Green, Yellow and Red. Green LED indicates the ON mode of the medicine box. At the times of Medicines/Pill to be taken according to the scheduled program respective LED indicator will give red glimmering signal with a beep sound. This will indicate that the person had taken the prescribed tablet. If the box is opened after red signal then the yellow flashing LED will glow continuously no beep sound, indicating that the person is talking the pill. When the patient opens the medicine box, the light falls on the light sensor and it reads the value greater than (some value) by flashing a yellow LED. If the pill box is closed, the value given by the sensor will be less than (some value) at the same time respective LED indicator will give green flashing signal. Medicine Box records that pill has been consumed and sends the data to output system (mobile application). The total count of the tablets in each slot will be stored in the system and each time when the patient consumes a medicine the number will be decreased from the total count. Once it is recorded that the pill has

been taken the LED indication in front of the pill will glow continuously green till the next pill taken time as per schedule program. If the person tries to take the already consumed medicine within scheduled program time then medicine Box will give on the alert to the patient that this medicine/pill is not to be taken. Lastly when the next programmed time has been reached, the corresponding LED automatically flash the green signal with an audible alarm. The device has both sound and visual signs in light of the fact that the patient may have either a hearing or sight impairment.



Fig. 2 Mobile Application for Smart Medical Box

- 3) *Software Approach:* Programming can be done in the Arduino IDE by using several flags and conditions. The medical box will be linked to the mobile application of user and the pharmacist on their cell phones which will notify each and every activity of the user and the pharmacist to replenish the stock periodically. Hence considering all the facts an android and iOS mobile application must be developed.

C. Fitness Devices

This mostly includes wearable devices. Recent example is fitness tracking devices like fit bit and apple watches. Sensors measure the acceleration, frequency, duration, intensity and patterns of your movement and convert this data accordingly. It gives accurate readings and helps you to maintain your fitness.

About the most conspicuous impact that the Internet of Things has had on our day by day schedules is changing the way we exercise and maintain a healthy lifestyle. Activity trackers and fitness applications are turning into our own mentors, helping us completely with both guideline and inspiration. Savvy sportswear permits us to decipher body information into training advice, and all kinds of sports equipment are increasingly capable of measuring our performance and reporting it to our smartphones.



Fig. 3 IoT Fitness Devices

The **Kaa** IoT Platform delivers all these capabilities into your smart sport & fitness products as production-ready features. With **Kaa**, you can automatically collect data from virtually any sensors, fitness trackers and smart sporting gear, then analyze it and visualize on equipment consoles and mobile devices, in this way delivering end-to-end training solutions for the customer.

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III. FUTURE OF IOMT

What role will the internet and all its devices ever smaller and ever closer to us, play in this great evolution?

Within the next decade the internet could connect as many as 200 billion things and not just machines such as cars or household appliances, but anything that you can fit a chip or sensor into including humans. These devices, collectively known as the Internet of Things, should make life simpler, even healthier.

A. E-Man

How the internet is changing the way we experience our world.

- 1) Remote Health: Computers the size of sand grains can allow doctors to access information about your body without surgery. They organize themselves inside the body and carry out tasks such as attacking early cancer cells, bringing relief from pain due to internal wounds, or storing vital personal information.
- 2) Ingestible Diagnoses: Researchers have developed the world's first implantable chip that can continuously monitor and record the concentration of molecules such as glucose and cholesterol, as well as pH levels and body temperature.
- 3) Inside Surveillance: Pills can be developed with microprocessors in them that can text doctors directly from inside your body. The pills can share the information to help doctors know if you are taking your medication properly and if it is having the desired effect.
- 4) Smart Diet: Ingestible capsule-sized circuits can monitor fat levels in obese patients and generate genetic material that makes them feel "full."
- 5) Feel the burn: A device strapped to the thigh which uses sensors to track what's going on deep inside the leg muscles. It provides information on things like lactic acid, hydration, muscle intensity, and coordination. It warns the user if there are signs of injury.
- 6) Augmented reality: Wireless headphones having a drop-down augmented reality display. The display lets you watch music videos, take photos, join a video conference, and access GPS navigation.
- 7) Making tears count: A smart contact lens which helps people with diabetes monitor their glucose levels. The lens has a miniature sensor that measures glucose in tears and a wireless chip to transmit the reading to a smartphone or other device.
- 8) Injury Prevention: A device which can detect when a cyclist has been in a collision, by monitoring changes in velocity and angle of travel and automatically inflates the airbag to protect the cyclist's head from injury.
- 9) Workout Report: Earphones can also be heart rate monitors. While you listen to music, a smart device can monitor your pulse and send information to an app on your phone. You can get data on how your heart rate changed during a run, find out how far you ran, the number of calories you burned, and how hard your heart worked.

IV. ISSUE OF IOMT

Though IoMT offers so many benefits, its increased flow of information also brings risks, patient's safety and health, loss of PHI (Protected Health Information) and unauthorized access to devices. Device's entering hospitals through a variety of channels with some of these avenues being unknown. When this happens it can be difficult to figure out the lifecycle management of that device and identify the operating system.

A. *Emerging Challenges of IoMT*

- 1) Managing device diversity and interoperability
- 2) Data integration
- 3) Scale, data volume and performance
- 4) Flexibility and evolution of applications
- 5) Data privacy
- 6) Need for medical expertise

These problems can be solved using encryption and authentication of data.

V. BENEFITS OF IOMT

The key benefits of IoMT applications in healthcare are as follows:

A. *Lowered cost of care*

By utilizing IoMT frameworks, the health of patients can be checked on a real time basis, avoiding unnecessary doctor visits. Home care is possible, further lessening doctor's facility remain. Parental figures can address normal use cases and reach out to doctors just when required.

B. *Improved patient outcomes*

By referring to a comprehensive knowledge base compiled from previous disease outbreaks and proven research, caregivers and doctors can use evidence-based medicine for improved patient outcomes. The real-time data can give timely care and address issues at an early stage.

C. *Real time disease management*

In a connected healthcare environment with continuous remote monitoring, patients can get treated proactively before their condition worsens. This not only helps patients' health, but also reduces the cost of care. The focus is shifted from 'treatment' to 'wellness'. Improved quality of life: For the critically ill, pediatric and aged populations, IoMT offers an easier life. The elderly can live independently at any location of their choice while getting their medical condition monitored.

D. *Improved user experience*

For patients and in addition guardians, IoMT makes it conceivable to have a wealthier and more close engagement with each other. Automation of data collection makes it possible to collect data accurately, on time and with minimal human intervention. All stakeholders get better visibility regarding the patient's condition, advancement and results of treatment.

VI. CONCLUSION

IoMT will drastically change the face of healthcare monitoring and treatment outcomes. IoMT is the bright future of Medical and Health care. By providing personalized and optimized services, it will promote a better standard of living. Nations across the world are struggling to improve patient care and IoMT provides a timely and cost-effective response to this critical imperative. Moreover, recent developments in sensor, internet, cloud, mobility and big data technologies have led to affordable medical devices and connected health programs, vastly increasing the potential of IoMT to influence further changes. Right now IoMT facing some security issues but with right approach this issues will be solved soon.

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