Internet of Medical Things

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Abstract - The advancement in wireless technology and the ability to connect devices to network securely has led to the development of various application specific Internet of Things. Internet of Medical Things is one of them which aims to provide better healthcare services to patients

by connecting medical devices over a successful and secured network. It is basically an effort to connect Healthcare IT systems through online computer networks. This would revolutionize medical aids provided to patients. Use of Artificial Intelligence and Machine Learning enables better medical Internet of Things use cases and solutions.

In this research paper, we will be discussing some of the important applications of IoMT, advantages and challenges faced by IoMT and its classification based on research done by different researchers in this field.

Keywords: application specific Internet of Things, better Healthcare facility, Internet of Medical Things.

1. Introduction

In the context of traditional Healthcare facility, a person has to visit a doctor every time he wants to get his pulse rate or heartbeat rate checked. This activity is time-consuming for both patient as well as doctor. Internet of Medical Things provides an easy access of patient's health situation to doctors. A set of health parameters i.e. pulse rate, body temperature, body pressure and ECG can be collected from the patient's body using wearable sensors and then remotely transmitted for comprehensive analysis and report generation.

This connection of medical devices and internet is transforming the Healthcare Industry by streamlining clinical operations.

According to the latest data published by United Nations for life expectancy in 2019, the life expectancy of people with richest medical facilities is over 80 years and lies between 50 and 60 years for the countries with the worst healthcare facilities. .IoMT provides to be a boon for the countries with fewer healthcare units and provide remote areas with accessibility to the medical devices over large distance.

Now a days people generally use mobile devices to analyze, capture, transmit and store health statistics from multiple resources which includes sensors. Biosensors is an important sales product of the IoMT product marketplace, with market revenue expected to exceed $29 billion by 2024. These devices depend on biological materials and sensors to detect characteristics of body parts such as blood, tissue etc. Non- Biological medical sensors are used to measure body temperature, motion, electrical activity of heart and muscles etc.

Once the data is collected using sensors, it is made accessible by computers and people. A vast array of communication protocols are used to get IoMT data from one point to the onther so that it can be accessed only by authorized party. Healthcare personnel analyze these data to provide care for the patient. AI software is able to intelligently sort through a large amount of data from IoMT devices, and provide medical professionals only with data that needs their attention.[1]

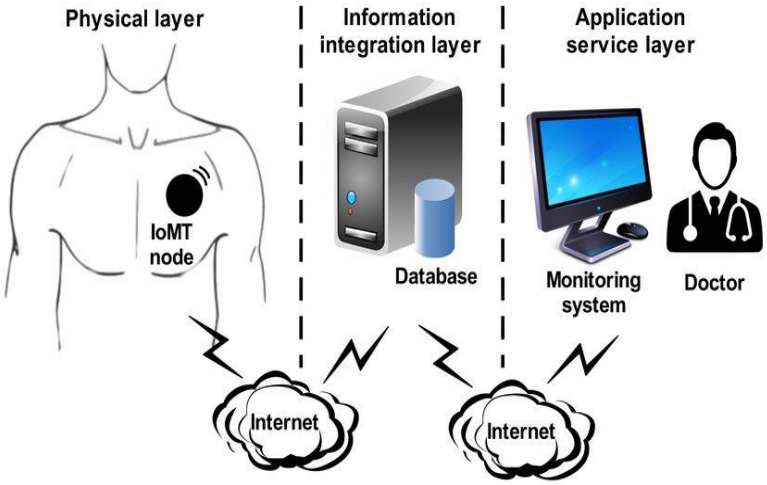

Figure 1: Architecture of IoMT

2. Categorization of IoMT devices

IoMT devices can be broadly classified into seven distinct units.

- Fitness Wearables

These are devices with in-built sensors that consumers can wear. These devices helps to collect the data related to physical activity of an individual. For example- Smartwatches, Smart shoes etc.

- Remote Patient Monitoring Devices

These devices are used to monitor patient with acute or chronic diseases remotely. This helps the medical practitioner to have continuous and frequent observation of patient's condition and also helps to track the progression in disease and rate of recovery.[2]

- Clinical Grade Wearables

These wearables can be used only when a physician prescribe it because they are certified and approved for use by regulatory authority. They are used to improve chronic conditions and ailments. For Example – QadrioCore, Smartbelt from Active Protect etc.

- Smartpills

These are pills with ingestible sensors which gets activated on coming in contact with stomach fluids. The sensor is ultra-thin. It gets discharged naturally via the patient's GI tract.

- Point of care Devices

These devices can provide preliminary screening procedures thus eliminating the need to visit laboratory setups to have the test done.[3]

- Clinical Monitors

It consist of smart devices used by the physician in their clinic. For Example – Digital Stethoscope, Rijuven's Clinic in a bag etc.

- Hospital Devices

All digital devices in the hospitals becomes a part of IoMT when they are connected over internet to ensure timely updates and remote accessibility of records.

3. Applications of IoT in Medical domain

- Monitoring of patient with OSA (Obstructive Sleep Apnea) disease-

OSA is a disease in which the patient has an uncontrolled breathing disorder during sleep. Polysomnography must be done in order to examine the condition of the patient. But it is very expensive and consumes a whole lot of time. A portable sleep apnea detector using one Sp02 sensor was formulated for estimating the heart rate and oxygen-level in blood simultaneously. The data could then be transmitted through cloud-based system architecture to diagnose the condition of the patient and provide necessary healthcare facilities to patient at remote location by using proposed algorithm tested by the database of sleep apnea patient's at St. Vincents University Hospital / University college Dublin [4].

- System for kidney using Ultrasound imaging –

Lack of sonographers in remote location makes it difficult for patient to detect any abnormality in kidney. Computer Aided Automatic Detection helps to reduce the time for report and makes diagnosis independent of sonographers.

First of all, the kidney is classified as normal and abnormal kidney. Then the kidney region is segmented to extract intensity histogram features and Haralick features from Gray Level Cooccurence Matrix. These features are calculated from a large set of data containing normal and abnormal cases. This helps to detect kidney stone, cyst and bacterial infection in kidney without the help of radiologists and sonographers [5].

- ECG monitoring system remotely (based on cloud) –

ECG is monitored and the data is gathered using wearable monitoring node and are then transmitted directly to the IoT cloud using Wi-Fi.In order to provide visual and timely data to users, both the HTTP and MQTT protocols are employed in the IoT cloud . Based on the experimental results carried out on healthy volunteers, it has been revealed that the proposed system is reliable in collecting and displaying real-time ECG data, which can aid in the primary diagnosis of certain diseases [6].

- AbilifyMyCite Smartpill –

It is the first smart pill to be approved by FDA for use in United States. The smartpill contains an aripiprazole tablet for treating Schizophrenia, and a smart ingestible sensor. Once the pill is

swallowed, the sensor sends a signal to a smartphone app, indicating when the pill was taken. From that point, with the consent of the patient, the data can be accessed by the patient's doctor or caregivers via a mobile portal.

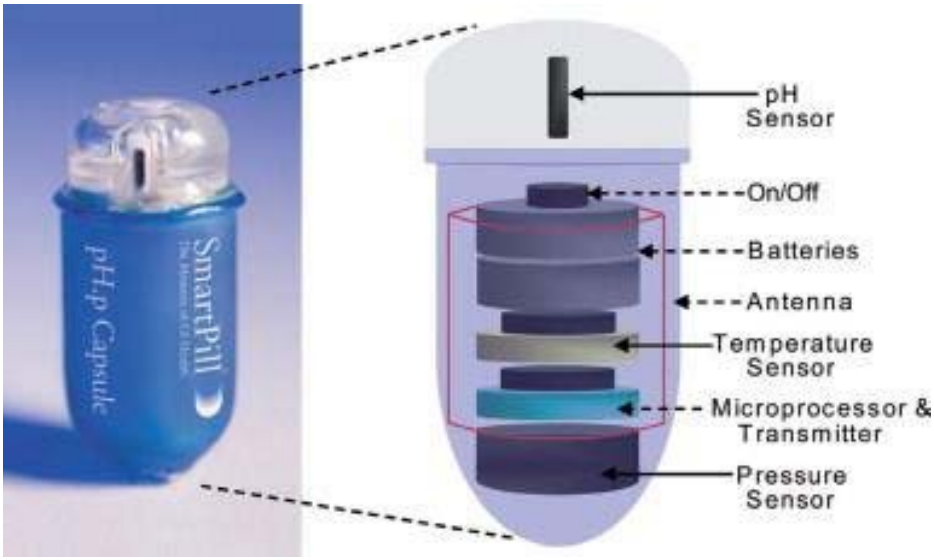

Figure 2: Smartpill components

- PillCamTM, by Medtronic –

It is a line of swallowable capsules that allow visualization of the esophagus, stomach, small bowel and colon. The external viewers can view the imaging data transmitted for analysis by the physician.

- Aarogya Setu app –

This app helps people in tracking the Coronavirus infection by using the smartphone's GPS system and Bluetooth. It provides the information that will help the users in determining if they have been near a COVID-19 infected person or not. It asks user a series of questions to determine if the person has any symptom of COVID-19.

- Medical Chatbots –

Patient can get in touch with physicians or nurses or medical professional with every one of their health questions answered through chatbots. If the medical helper cannot comfortably respond to the raised issue, then the care will be transferred to real-life doctors. Northwill Health launched one chatbot "No-Shows" for colonoscopies a procedure elemental in colorectal cancer diagnosis.[7]

Figure 3: Medical Chatbots

- Inexpensive cardiac arrhythmia management –

Smartphones or wearable sensors extracted photoplethysmogram (PPG) is the physiological signal that is considered the characterize the anomalous events of the cardiac. It helps to detect l fatal cardiac conditions like asystole, extreme bradycardiac, extreme tachycardiac, ventricular flutter. InfoBionic's MoMe Kardia provides remote monitoring of cardiac arrhythmia [8]

- Home based medical health monitoring –

It is important to monitor the health of every individual on daily basis to increase life expectancy which is not possible in remote areas like North America. Thus, Biometric wearables have become popular as these wireless devices can be used at home to monitor health of individuals and provide report and suggestions based on proposed algorithm tested using database of various hospitals. There are many telemedicine platform that enables doctors to conduct examination and prescribe remedies for the patient remotely [9].

4. Advantages of IoMT

- Makes Healthcare facility more affordable.
- Makes Healthcare facility easily accessible.
- Makes Healthcare facility cheaper.
- On-time medication.[10]
- Continuous collection of patients health data.
- Increases life-expectancy.
- Saves time of both medical professional and patient.
- Makes management of patients record easy.
- Connects remote area such as North America to healthcare units.
- Offers better control over diseases.

5. Challenges faced by IoMT

- Safety of patients data-

According to the 2019 HIMSS Cybersecurity survey, 82% of healthcare organization experienced significant security incidents in 2018 [11]. Health IT teams must take charge of handling all situations that could lead to breach of patient's data and pose serious threat to their lives.[12]

- Maintaining connectivity with internet 24*7-

A recent study from HIT infrastructure evaluated medical devices connectivity and found that about 45% of connections initially fail [13]. When it comes to health and life of people, it is important to maintain 100% connectivity, all the time.

- Storing and managing large volume of data –

Various interconnected devices share large and busty medical data to be processed using proposed algorithms for early diagnosis of medical issue. But managing this large volume of data is a challenge.

- Incorporating IoT in old infrastructure –

Most of the devices used in hospitals are old. Incorporating IoT in them is a challenge in itself [14].

- Interoperability of data –

The data collected via various IoMT devices is a mere waste if it fails to collate and compute to provide meaningful information and clinically relevant results. Thus, interoperability of one device with another is must which is difficult to attain.[15]

6. Conclusion

IoMT is a vey powerful weapon in the field of medical science. It helps to provide relevant and vital data to healthcare professionals for monitoring the condition of patient remotely. It also helps to minimize human generated errors. We need to further expand in this field in order to increase life expectancy by improving health of individual

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