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# Healthcare And Patient Monitoring In Remote Areas Using Iot

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**Abstract-**

Today wireless communication technologies and the Internet of Things (IOT) have spread across various regions of the world due to the increase of Internet services almost everywhere. These technologies can be used in various developing and demanding application areas such as Healthcare. Remote Patient Monitoring would allow the observation of the patients who have no access to any medical resources nearby. With the help of IOT, providing medical services in remote areas would be easier and it would also be beneficial for elderly care by identifying diseases and providing customized medication. This research focuses on IOT technologies that can be used in the healthcare sector and some future trends in its development. In the healthcare scenario, it is important to monitor the essential signs of patients for which the WBAN (Wireless Body Area Networks) can be used. WBANs are small wireless devices that can be placed on the body of the patient, to monitor the signs of disease.

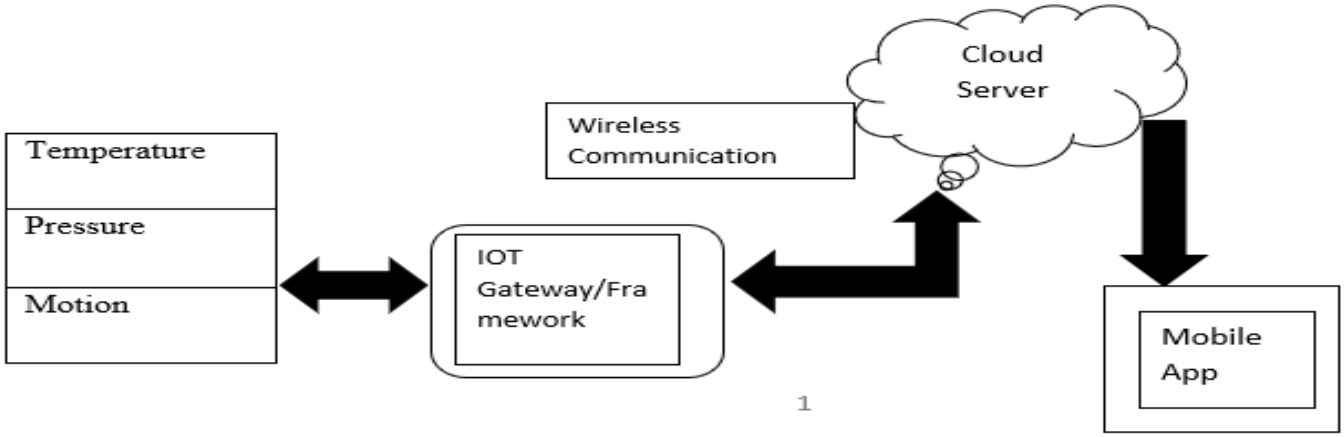
**Keywords:** IOT, Medical sensors, Healthcare sector

## 1: Introduction-

### IOT-

IOT stands for Internet of Things. It is the network of physical objects or things embedded with electronics, software, sensors, and network connectivity, which allows these objects to collect and exchange data.

### IOT Architecture-




The architecture of IOT comprises four building blocks, which are also known as IOT architecture layers.

- **Sensors:** These are used to collect the data in IOT. Sensors are used to sense and collect data from the surroundings, for example- a temperature sensor will sense the temperature of a room. The information collected by a sensor may vary, such as about a particular location, a machine, weather conditions, and so on [1].
- **IOT Gateway/ Framework:** It is a path or a gateway to the internet for all the things or devices that we need to connect with. These are used to communicate the information collected through the sensors. A gateway is a bridge between the internal network and the external network (or World Wide Web) [2].
- **Cloud Server:** The data is stored and processed here. This data is analyzed for decision-making.
- **Mobile applications:** These are designed for the end-users to keep a track of their devices from far-off locations. These applications collect information from the cloud server and we can access that information with the help of our smartphones or tablets [3]. This information can be in the form of-graphs, diagrams, and so on, hence it is user-friendly.

Technologies like biosensors, wearable devices, home virtual assistants, mobile applications, etc. are giving a new direction to healthcare today. The sensors and wearable devices can be connected to mobile devices, which would help in interpreting and transmitting the patient's information to the medical centers easily [4]. Many automatic systems are being worked upon for such scenarios, like- Automated physiological signal monitoring for elderly sick patients, which would not only help in fast access of data but will also get reliable service by an accurate prediction by healthcare service provider. There are also reports about the development of smart medical devices for diabetes mellitus patients like- smart inhalers, CGMs (Continuous glucose monitors), insulin pens, and so on [5]. Biosensors are suitable for common surveillance applications like- diabetes glucose surveillance and diagnostics such as maternity and fertility testing. So in all these ways, healthcare providers can control patient treatment and monitor results outside the walls of the hospital.

Now another important task of remote healthcare systems would be "communicating results" after monitoring the health status of the patient. For this, various Patient Health Portals are being developed to establish a link between the patient and the healthcare chain online, for providing services and patient

satisfaction [6]. Patients would be able to consult doctors and specialists online, get reports, make payments, and communicate with other patients too. With the use and widespread of IOT, not only the patient monitoring systems but also the ways of medication delivery have changed.

One of the key inventions in the field of health monitoring systems is the UbiMOn (Ubiquitous Monitoring Environment for Wearable and Implantable Sensors) Project which focuses on people with arrhythmic heart disease with the help of wearables or portable sensors for tracking the heart rate [7]. There is an increasing need for continuous monitoring of patients so that life-threatening abnormalities can be detected and treated in the early stage. UbiMon is a systematic combination of various facilities. It brings together various skills like- bioengineering, computing, electronics, and medicine. There is also a ZigBee-based system that is drafted to collect the ECG data of the patient by keeping a record of their number of steps. This system uses a transmitter that is placed on the collar of the patient and the receiver is located on the PDA (Personal Digital Assistant) of the healthcare worker. PDA is not only used for keeping track of appointments but is also now used in healthcare systems by combining PDA connectivity into their computer networks to access patient records.

The section aimed to focus on the important trends in IOT systems in the medical and healthcare sector.

**2: Internet of Things in the healthcare sector-**

IOT is widely used in the healthcare field today which benefits the patients, hospitals, families, and insurance companies. IOT devices can gather and convey health data like- blood pressure, ECGs, weight, blood sugar level, etc [8]. It has helped in achieving healthcare mobility by automating the patient care process. Healthcare workers can now easily spot the symptoms of any disease in a patient using connectivity protocols like- ZigBee, Wi-Fi, Bluetooth, and so on.

Medical devices integrated with IOT can collect important information and transfer it to the doctor for real-time tracking. This information can also be in the form of notifications, which would be beneficial in the case of a patient with a chronic disease [6]. Hospitals can also make use of IOT devices to track the location of medical equipment like- oxygen pumps and wheelchairs, with the help of sensors. Technologies like- M2M (Machine To Machine) communication and NFC (Near Field Communication) also allow wireless communication which plays a major part in IOT.

**IOMT-**

IOMT stands for Internet of Medical Things. It is the collection of medical devices, hardware, and software applications, which are used to connect to healthcare information systems.

**IOMT Architecture-**

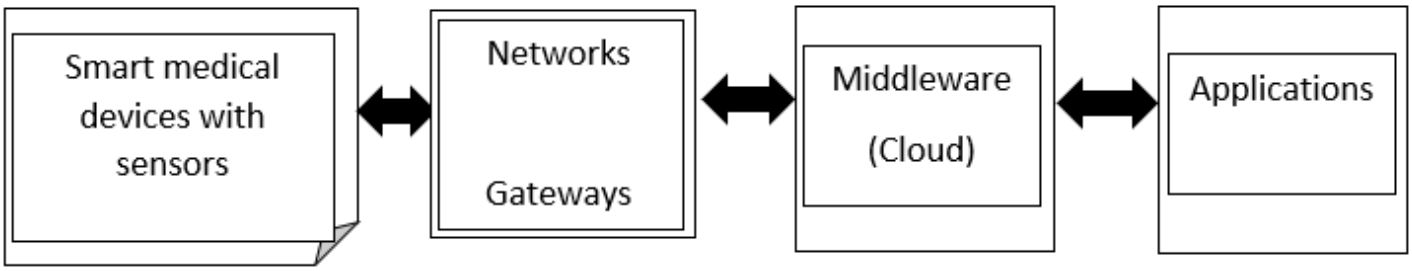



Fig 1: IOMT architecture

- **Perception Layer:** It consists of a range of medical devices which have sensors or trackers. These devices will help in collecting all the health data.
- **Connectivity Layer:** It consists of networks and gateways which are used for the transmission of data.
- **Processing Layer:** It is represented by a cloud that stores the data.
- **Application Layer:** It represents all the applications that can be used by the end-user to monitor the devices accordingly.

**3: IOMT patient monitoring system use cases-**

**1- Glucose monitoring:**

Glucose monitoring is usually done for patients suffering from diabetes mellitus. It is difficult to monitor the glucose levels manually by doing tests, and also the report would only provide the information on glucose levels that were tested earlier and not the present glucose level, because it may fluctuate with time. Hence, there is no accuracy. If the levels vary widely, periodic testing might not be enough to identify the problem [9].

IOT devices can help overcome these challenges by providing automatic and continuous tracking of glucose levels. These devices can keep the record automatically, without us needing to keep the track manually.

These devices may work as follows:-

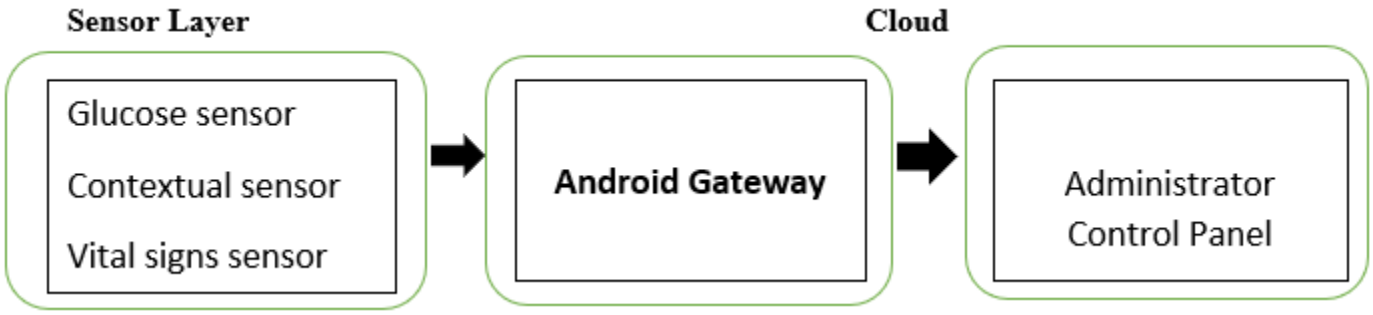



Fig 2: Glucose monitoring flow chart

There are a few challenges in designing an IOT based glucose monitoring device which:

- Is small and portable to continuously monitor the glucose level without causing any problem or disturbance to the patient.
- Does not use electricity so much, that it needs to be charged quickly only after using it a few times.

**2- Heart-rate monitoring:**

Just like glucose monitoring, heart-rate monitoring can also be a difficult task. Patients who go through frequent heart-rate fluctuations, need to be monitored continuously, and hence need to be attached to wired machines all the time [8].

Nowadays, many small IOT devices for heart-rate monitoring are available which allow the patients to move freely, hence such devices can be used as remote healthcare services, which would help in tackling the symptoms related to cardiac arrest.

**3- Ingestible sensors:**

These devices are used to collect data from inside the human body. These are so small that they can be swallowed easily and can detect the sources of symptoms internally, like- information from digestive systems, an area where internal bleeding is happening, and so on.

**4- Hand hygiene monitoring:**

The patients, as well as the healthcare workers, need to keep their hands clean, to prevent diseases from spreading. Today there are many IOT devices available that can be used to remind people to wash or sanitize their hands, before entering the hospital rooms.

**5- Connected inhalers:**

Patients suffering from conditions like- COPD (Chronic Inflammatory Lung Disease) or Asthma, may face sudden attacks. These IOT connected inhalers can keep a track of the frequency of attacks and can also collect data from the environment, to sense what can trigger the patient's health. It can also notify the patients if they forget to take their inhaler with them, because it may be needed during an emergency.

**4: IOMT Challenges-**

- **Standardization issues-** The medical industry has faced huge growth in all these years and hence many manufacturers want to market their products conveniently [9]. There is a certain level of sameness in all these products, so this is one of the major issues today. This also affects the interoperability of medical devices.

- **Interoperability of data-** There is a large amount of data that is collected in IOMT. This data is of no use if it cannot be collected and compared critically, to provide meaningful outputs [9]. Thus, the devices must be interoperable to receive and pass on data to everyone.

- **Data security threats-** Healthcare industry is likely to encounter data breaches by cyber-attacks and hence the data is always at risk. Adding the data to an already existing data pool may increase this risk. If we keep on connecting more and more devices to the system, there is an increase in the risk of data theft [5].

- **High infrastructure cost-** On one hand, IOMT aims to reduce the cost of healthcare, but on the other hand, it is very costly to build an enormous Healthcare IT infrastructure. This includes the cost of hardware, cloud maintenance, the creation of an application, and many more things. This acts as a barrier to IOMT [10].

- **Regulatory challenges-** Medical devices need to be approved by FDA (Food and Drug Administration) before their launch in the market. There are only limited laws governing medical devices.

**5: Advantages of IOMT in rural areas-**

- It allows the patients to access new and better healthcare devices and medicines at a lower cost, which reduces the overall expense.
- The medicine intake of a patient can be monitored easily with the help of IOMT devices, even in remote areas.
- The IOMT devices are easy to use and maintain.
- There is better control over diseases as the monitoring can be done continuously with IOMT devices, without any need to visit the hospital.
- The treatments of patients can be tracked easily with the help of applications installed on a smartphone, connected to a device (like- a glucose monitoring device, heart-rate monitor).
- Since there is a way of continuous monitoring of the patients, better results are provided.
- The devices can track important health statistics easily, which provides more accurate diagnostics.
- With the help of continuous tracking of symptoms, there is early intervention in the cases like- diabetes and heart conditions. This allows the doctors to take action in the early stage even before the patient requires hospitalization.
- Since most of the work can be done virtually, this reduces the burden on healthcare chains or hospitals.
- With the combination of health-tracking wearables, AI and machine learning, and virtual appointments; there is an availability of better care to the patients.

**6: Conclusion-**

This paper focuses on the implementation of IOT technology in the healthcare sector, especially in remote areas. It discusses the benefits of IOT as well as the latest technology trends being used for the betterment of the IOT systems in today's time. Moreover, an example of IOT based glucose monitoring system is discussed, along with the challenges faced in designing it. It also discusses the various ways in which IOT integrated devices are useful to the hospitals as well as the patients.

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