

Internet of Things and Healthcare Systems

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IoT is an emerging and main technology which connects everyday objects and physical devices. The Internet of Things (IoT) is a system with physical devices and embedded systems, with sensors, electronics, software and network connectivity, which are used to remotely monitored and controlled various events. IoT device application covers home automation, environment monitoring, transportation, Industrial applications, Energy management, Medicine and Health care. IoT in healthcare is used for the purpose of data collection, analysis, research, monitoring

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I. INTRODUCTION

A growing interest of body wearable sensors has recently grown as powerful tools for healthcare applications. Different devices are now available commercially for multiple purposes including personal healthcare monitoring, fitness and activity awareness. Fetal activity monitors, electrocardiograms, body temperature monitors, blood glucose levels monitor, tracking such health information's are very important for some patients. Even though many of these measures required follow-up interaction with a healthcare professional. The IoT devices are lively in sending real time data's to doctors and ease the need for direct patient-doctor communication. These wearable devices along with mobile apps are integrated with telemedicine to construct the medical Internet of Things. A telemetric system with IoT which can be used to track bed-ridden patients. Early contributions of IoT includes smart beds that detect to ensure appropriate to the patient without the contact of nurses. Another region where smart technology rapidly became an positive feature in healthcare is when joined with smart pills dispensers. Few researches had proved that the global IoT in healthcare market is likely to reach more than 500 billion by 2025. The materialization of the IoT is in which devices and data are directly connected to each other, is important for the following reasons: 1. In healthcare, collect patient data over time which can be used to

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aid permit preventive care, agree to timely diagnosis of healthcare problem and support understanding of how a treatment is helpful to make patient better by improving the physical parameters. These are feasible because of advances in sensor and communication technology with connecting networks which allows a devices to gather data, record data and analyze data that was not available before. 2. The advancement in devices such that it collects data by itself without human interference or removes the limitations of human-entered data. The automation reduces the risk of error. It literally means in healthcare because it's between life and death. The growth of the Internet of Things ensuing in some exciting advancements in the next century like Auto Bed concepts to reduce the admission waiting times. It's is an example for extremely effective system that points the most innovative and exciting applications of the IoT. Some of the e-Alert system was already available in the market to alert the usage of hospital major equipments and its conditions during the emergency time. One of the most popular applications of IoT in healthcare is remote patient monitoring which used to minimize the cost, avoid the repeated visits to hospitals, it improves patient worth of living by avoiding the inconvenience of travelling to the hospitals.

IoT is shining with its spark in the area of drug management a new type of medications with pills containing microscopic sensors which send signals to an external device that is a part wear on the body, to make sure about proper dosage. The IoT will reach all human on the earth at least once in their life..

III. BODY SENSOR NETWORK

Body sensor network is a group of sensors fixed to body to measure various physiological data. Body sensor network is also referred as body area network, medical body area network.

Wireless sensor network has the following properties like it Cover the environment, it covers Large number of nodes from few to thousands with single to Multiple dedicated sensors, Resistant to weather, Resistant to noise, Wireless sensor network (WSN) refers to a group sensors for monitoring and recording the physical parameters of the environment which groups the collected data at a mid location. Wireless Sensor Networks measure environmental parameters like temperature, moisture, humidity, sound, air pollution, wind pressure etc. Data's can be transported wirelessly like wireless ad hoc network. Most of the modern networks are bidirectional networks which enable to control the activities of the sensors. These networks are used in various industrial and consumer applications nowadays.

Where in previous cases it were used in military applications. while BSN Cover the human body, Fewer sensor nodes comparable to WSN connected to Single multitasking sensors.

The body sensor network (BSN) technology is the important core of IoT Healthcare development ,where a patient can be monitored using a collection of very small and low power sensor nodes. [1]

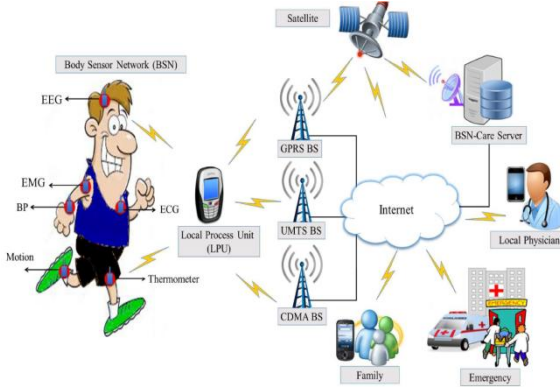


Figure (1) Secure IoT based body sensor network [1]

In this paper different BAN sensors for monitoring different physiological parameters like temperature, respiration rate, Oxygen saturation in hemoglobin, blood pressure, pulse rate etc are discussed.

A. Temperature sensor

Digital temperature sensors provide leading 0.1°C accuracy. The optimized microcircuit design of Temperature System Sensors (TSYS) are available in miniature packages which respond quickly to changes in process temperature with very low power consumption. Thermistor is most commonly used temperature sensor to measure body temperature ,in [2] and [3] NTC type thermistors are used. The temperature is measured in the range of +25 °C to +45 °C . The IC operating temperature in the range of -40 °C to +125 °C with precision of 0.1 °C [3].

B. Respiration Rate Monitoring

A wearable respiratory sensor measures respiration rate and volume changes with high reliability was introduced by Michael Chu [4]. The strain of the ribcage and abdomen is measured using the disposable respiration sensor during breathing. During respiration there are periodic changes in volume of thoracic and abdomen area in inhalation and exhalation.

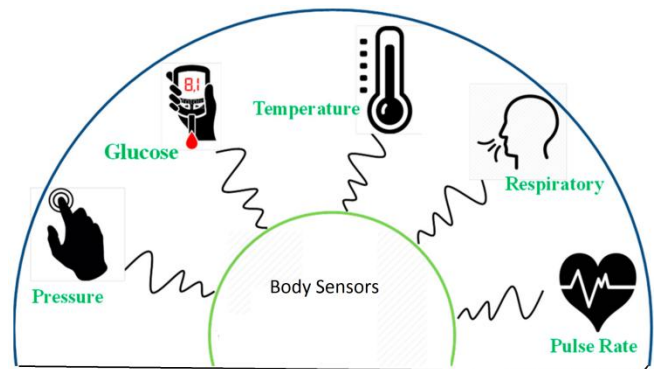
The devices like accelerometers, gyro meters, radars , WiFi devices, imaging, and various sensors based on electromagnetic, piezoresistive, piezoelectric, and optical mechanisms are used for measuring respiration rate.

Different Wearable's Body Sensors are used in health care applications today, several sensors found in WBAN applications and the corresponding signal type, data range ,frequency requirements for the wireless connectivity is represented in this survey .Glucose concentration measurement sensor Data range 0-20mM,frequency range 0-50Hz, data rate 480-1600bps ,with resolution of 12-16bits.In Respiration rate measurement ,normal

respiration rate 2-50 breaths/min with signal frequency 0.1-20hzand 240bps data rate. Pulse Measurement the range will be 0-150 BPM ,frequency 4 Hz, data rate is 48 bps. Body Temperature Measurement ,the range is 32-40 °C ,frequency range 0-1 Hz , data rate 120 bps.

C. Pulse Sensor

Pulse sensor used to detect pulse rate, Pulse rate is used to detect various emergency conditions related to cardiac arrest, pulmonary embolism, pulse rate indicates the amount of blood to supply oxygen for body needs. Pulse rate can be read from wrist, Finger tip ,earlobe, chest etc.Pulse sensor are widely used for both medical diagnosis and for fitness tracking..Pulse sensor based fitness tracking wrist watches, chest straps are commercially available in the market. These devices cannot directly used for serious health monitoring. Many researches has been done so far to select suitable method for sensing pulse rate .In recent works/sensors based on pressure ,photo plethysmographic ,radio frequency sensors and ultrasonic sensors are used. photo plethysmographic sensor works based on the light emitted by LED and transmitted into the artery and it is received by the photodiode .Change in the amount of light received by the photodiode determines the pulse rate. when there is motion artifacts the sensor goes into low power state and stops recording pulse, this is overcome by two different light intensity LED's and comparison is done based on the light received by the photodiode's. Pressure sensor is used to detect pulse rate for clear pulse reading .Both photo plethysmographic and pressure sensor together used to sense the pulse in combination. Few of the works are based on RF array module to sense pulse. Based on all studies it is highly preferable to photo plethysmographic sensors for pulse sensing.



IV.COMMUNICATION TECHNOLOGIES

IoT (Internet of Things) shares data using advanced communication technologies. IoT offers multiple potential benefits to today's digital world. Health care is one of the popular area to look at the benefits of IoT. This paper examine recent upcoming health care applications, with detailed technical aspects for each application.

IoT base architectures has four subsystems

Sensors / Transducers

Gateway

Communication Network

Cloud Services

A. Gateway

Recently fog nodes, are acting as an connecting node between devices and the cloud. This provides data connectivity, data security and manageability. In IoT health care application like monitoring the patient body temperature, respiration rate crossing its threshold limit, immediate corrective measure should be taken to the patient. But if there is any delay in communicating the data from device to the cloud for processing, this will letdown the possibility to help the patient. So analysis of the data to the devices/ sensor which will be the data could help more. The new computing technology like Fog computing are introduced to perform complete data analysis.

The major key issue in IoT based applications is sharing information. This requires suitable communication technology, specifically for sharing the real time data, the technologies must be secure and reliable. The fixed line solutions are available but it is too limited and expensive. The cost effective alternative solution is wireless communication networks. The short range communications such as Zigbee, Bluetooth, Wi-Fi . The long range communications technologies like satellite or 3G/4G cellular systems are taken for considerations in wireless networks.

B. Cloud Infrastructure

It consists of server and storage together. This cloud infrastructure run application based on Artificial Intelligence of Machine Learning that analyse data from the devices and gives useful information for decision making.

Artificial intelligence and machine learning algorithms can analyse large raw data and able to give prediction of the events in real time. With such capabilities, it supports health care system for continuous monitoring of medical treatment and to optimise the whole process of hospital management.

C. IoT Networks

Nano -networks is a set of small devices used for sensing, computing, storing and actuation. NFC is Near field communication network ,this is a low speed network connected with a device at a distance of 4cm each other. BAN is Body area Network which consist of sensor or devices wearable or fixed in the body surface or implanted inside the body. PAN-Personal Area Network link up to short distance upto 50 to 100 metres, other networks are Local Area Network, Campus Area Network, MAN ,WAN are also been connected to IoT Networks. The most famous IoT protocols, standards and communication Technologies are discussed below. MQTT- Message Queue Telemetry are supposed to transport simple light weight protocol for transferring data from sensors/devices to application sectors and

middlecore. This protocol includes subscriber, publisher and broker, this protocol functions on the topmost of TCP/IP. MQTT is suitable for small, low memory, low power devices and cheap.

DDS-Data Distribution Services developed by object management group ,it is an real -time High performance machine to machine communication IoT standard.

AMQP-Advanced Message Queuing protocol for message oriented middleware environments, AMQP is an application layer of protocol.

Exchange Message Queue ,binding are three components includes in the processing chain of the AMQP protocol.

Bluetooth is a short range communication technology usually integrated with many mobile devices and smart phones. Bluetooth technology plays major role in advancement of personal products and as well as wearables. BLE (Blue tooth Low Energy) is a real foundation for the IoT. BLE is so far designed to reduce the power consumption. The Bluetooth 4.2 standard, with 2.4GHz, covers range of 50-150m with data rate 1Mbps.

Zigbee 3.0 is a low data rate ,short range wireless network ,It is also low-power network .Dot dot -Zigbee Alliance created universal language which helps smart objects to work on any network securely. Zigbee 3.0 standard is based on IEEE 802.15.4 with 2.4 GHz, cover range 10-100m with data rate of 250 kbps .

Wi- Fi is for fast data transfer and also for large data processing. Standard based on IEEE 802.11 is most popular with frequencies 2.4GHz and 5 GHz bands, cover range of approximately 50m, with data rate 15.-200Mbps,600Mbps of maximum data rate.

Cellular technology is suitable for IoT apps for functioning over a long distances. This technology take advantage of GSM,3G,4G and 5G in future . This is suitable for application which use small amount of information. Standards are GSM/GPRS/EDGE (2G),LMTS/HSPA (3G) ,LTE (4G) with frequencies 900/1800/1900/2100MHz which covers range of 35km(GSM) ; 200km(HSPA) Data rates are 35-170Kbps for GPRS,120-384 Kbps for EDGE,384 Kbps-2Mbps for UMTS,600 Kbps -10 Mbps for HSPA ,3-10 Mbps for LTE.

LoRaWAN-long range wide area network which covers large networks with thousands and low-power devices with various frequency range, distance range 2.5km,15km with data rates 0.3-50 kbps. choosing correct connectivity for any IoT project is essential.

LoRWAN is for low-data rate applications with unlicensed spectrum, with frequency regional sub GHz bands 433/480/868/915MHz.



V. SECURITY IN HEALTHCARE SYSTEM

Security is the most important aspect of any system. Security is safety to the system as a whole. In IoT based health care system generally wireless in nature .nowadays more threats are there to these types of systems. Healthcare devices are certainly dealing with important private information's such as personal health related data's and connected to global networks for access at anytime and anywhere .cyber criminals targets on stealing electronic health records for black market value .The possible risks in IoT healthcare is attack on other systems, privacy risks, Risk to personal safety.

Data Eavesdropping ,the data of the patients should be available only to caretakers who is an authorized person. sometimes such data can be eavesdropped from wireless links while transferring /flowing of data .A famous IoT based insulin delivery system uses the links of wireless communication, which used to open for privacy attacks ,so it is needed to protect the transferred data. Many countries has laws for protection of patient data's. The data's collected and tracked in the case of fitness wearable's etc are been think that it is protected by legislation, but in most of the cases it is not protected.

Some of the security issues are Distributed denial of service which is an attack, in which multiple systems are targeted a single system and crash that system by making data unavailable.

Med jacking is hacker can have easy access to steal medical data from healthcare provider's system.

In cloud different users are there using different applications , the effective authentication technology is need to prevent illegal involvement .Also access control is need to prevent unauthorized entities from accessing to system's resources.

End-users/Employers who is handling the medical devices should educated to realize that medical devices having a browser should not be use for surf websites etc.

Healthcare organizations must look out for potential hazards and malware propagation when the medical device is reacted through internet. need to ensure the security of the devices.

cloud service providers should also ensure that they have control over the security of the data stored in a cloud. adequate and consistent legislation should be provide by the regulatory bodies.

Authentication encryption and Integrity are the fundamental security actions can be taken at the stage of design in production of medical linked devices.

VI. CONCLUSION

In this paper a systematic overview Body sensor network was presented with details of wearable sensors like blood oxygen, pulse, respiration rate sensor, Temperature sensor used in recent works were presented. IoT communication standards like long range and short range communication standards were presented . The most important problem of using cloud is the security risks. Several works are highlighted about Security in health care system by improving cloud security.

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