IoMT Based Smart Health Care Monitoring System

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Abstract

The present health care system is, for the most part, in-hospital based and incorporates occasional visits that has turned as a monotonous activity for the patients. In this paper, a complete and integrated healthcare model is described enabling Remote Health Monitoring (RPM) patients to daily collect vital signs at home and sending them to caretakers using the Internet of Medical Things (IoMT). This enables doctors to screen patients at a distance and take occasional activities if there should be an occurrence of need. A set of health parameters has been identified i.e. Electrocardiogram (ECG), Pulse rate, Temperature, and Blood Pressure by using wearable sensors. These sensors are connected to an Intel Edison Board. Once the Intel Edison Board is connected to the internet, it collects data from sensors and sends to the server. The vital parameters can be visualized and monitored on any remote smart device including laptops or smartphones which are connected under the same network. The proposed demonstrate empowers users to enhance monitoring of health-related dangers and lessen hospital costs by gathering, recording, breaking down and sharing extensive health information continuously and productively. The possibility of this task came so to decrease the cerebral pain of patient to visit a specialist each time he has to check his pulse, heartbeat rate, temperature and so forth. With the assistance of this proposal, the time of both patients and doctors are saved and doctors can also help in an emergency scenario as much as possible.
Keywords: Internet of Things (IoT), Medical Services, Healthcare, Health Monitoring

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I. INTRODUCTION

The Internet of Medical Things (IoMT) is that assortment of medical devices and applications that hook up with healthcare IT systems through on-line computer networks. Medical devices equipped with Wi-Fi permit machine-to- machine communication that is the premise of IoMT. IoMT devices link to cloud platforms like Amazon Web Services, Microsoft Azure Cloud, Google Cloud Computing or any other customized web services that capture information for storage and analysis. IoMT is additionally called Healthcare IoT.

Services of IoMT embrace remote patient observation of individuals with chronic or long-term conditions. These services track patient medication prescriptions and track the location of patients admitted to hospitals and patients' wearable health devices, which may send each patient's health information to their specific caregiver. Infusion pumps that connect to analytics dashboards and hospital beds rigged with sensors that measure patients' vital signs are medical devices that can be converted to or deployed as IoMT technology.

Internet of Medical Things gains its full potential by utilizing objects, i.e. "Smart" objects, that use numerous sensors and actuators that measure ready to understand information in their context, and via integral networking capabilities, they use to communicate to every available alternative. These devices access open supply network services and move with the human world. This not only makes them globally connected but also strong and comforting. The network of devices within the field of attention plays a serious role in providing comfort and presence of mind to patients and doctors alike. It consists of a system that communicates between network connected systems, apps and devices which will facilitate patients and doctors watching and recording patients' very important medical information. A number of devices embrace tracking positive metrics, wearable health bands, fitness shoes, RFID based watches, and high-end video cameras. Also, apps for smartphones facilitate keeping a case history with periodic alerts and emergency services.

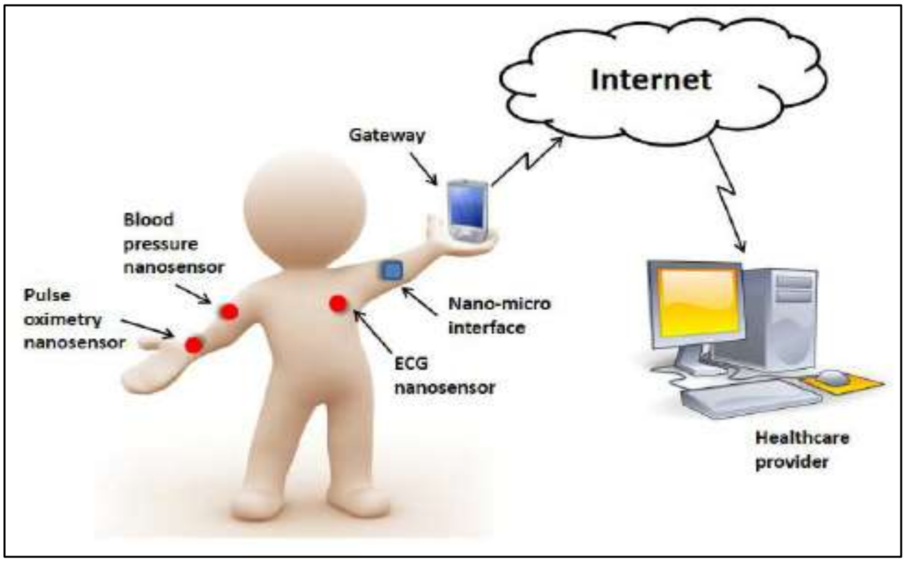

Fig. 1: Internet of Medical Things Model

These interconnected IoT gadgets deliver huge sums of data that ought to be managed productively by the suppliers and so could be an enormous challenge. To overcome this challenge of putting away and analyzing expansive information, the procedure of Internet of Things Analytics (Particle) is executed. The crude data is converted into valuable and restoratively important information utilizing the methods like information extraction and information analytics. In truth, it has been anticipated that by 2020, more than 50-55 percent of techniques used to analyze raw data will make better use of this influx of data which is generated from instrumented machines and applications. In order to manage and care for our wellbeing, the IoT movement depends on a few empowering innovations. Collection of real-time information from different sources, in this case, boundless numbers of patients over an expansive period of time, must become exceptionally simple and quick utilizing the potential of IoT. The power of IoT for health and medical services is controlled by Smart sensors that accurately measure, monitor and analyze a range of health standing indicators. These indicators will embrace basic important health signs like pulse rate and blood pressure, oxygen and glucose level in the blood and heart rate. Smart sensors are often incorporated into medicines and pill bottles that are connected to a network and might generate alerts concerning whether or not the patient has taken a scheduled dose of medication.

A great deal of progression and critical changes are happening in the field of IoT human services. The method of interacting and communicating with people and different gadgets is changing and showing signs of improvement step by step. Appropriate administration of medical services results in a decrease in human services costs, empowered by regularly developing information and corresponding courses of action. Medical services organizations are getting unrivaled and less extreme by gathering, recording, investigating and sharing current data effectively in real time. Additionally, as the world is grasping this regularly creating a development of IoT, various inefficient viewpoints in human services will be diminished. For example, diverse restorative devices like health gatherings, prosperity watching structures, and drug confines will have adroit sensors embedded in them that assemble unrefined data, store it, examine it, and direct tests that empower authorities to take appropriate action.

To take the entire benefit of revolutionizing IoT in healthcare, clients, patients, and other health experts need to consider a few progressive and extra dependable methods. And with the help of IoT's potential, they're now capable of acquiring real-time uncooked records from an unlimited range of patients for a non-stop period of time through smart devices linked in an interconnected community. It will take time to completely recognize the era's competencies. We can expect health workers to provide prognosis and prescribe important tasks in an increasingly more dependable manner. This evolution will drive to more effective and reliable results and provide time savings for both the patient and care provider. The possibilities of IoT are honestly unlimited and ever growing. This paper proposes an IoT primarily based around fitness monitoring which could gather all of the clinical information of a patient inclusive of his heart rate, blood pressure, and ECG and could send signals to the patient's health practitioner regarding his/her full scientific statistics, imparting a quick and reliable healthcare picture. Furthermore, in this ultra-modern world where everyone is busy neglecting their small healthcare troubles like high blood pressure, low pulse rate etc, this paper proposes a simple and effective strategy for this challenge.

II. Available technologies

A. *Overview*

The internet of Medical Things (IoMT) allows a device to device interplay and real-time intervention solutions that have the potential to notably remodel health care as we know it, enhancing delivery, affordability, and reliability in the near future.

The first technology is usually mistaken for IoT. Smart devices, devices connected to a network or different devices that have the power to interact with the Internet (Wikipedia, 2016). As an example, a TV or a refrigerator connected to the network have a perceived 'upgrade' when compared with applications that primarily provide a similar function as an online browser however with a stronger interface for the user. Referring to these devices as IoT is inaccurate as a result of sensible devices are solely a little a part of this idea. It's better to use the term sensible objects or sensible things and not simply devices. Supported the definition of Miorandi, Sicari, DE Pellegrini, & Chlamtac (2012); something with the subsequent characteristics is used for IoT:

- Uniquely identifiable
- Able to communicate (can be discovered, receive and reply to messages)
- Can perform basic computations

A discretionary characteristic is the detecting or potentially incitation capacities (Miorandi et al., 2012). Throughout the most recent couple of years, the noteworthy ground has been gained in the innovation of sensors; they are more practical, simple to introduce and less expensive than at any other time. In short, the ideal opportunity to make any object smarter. This is one reason why IoT turned out to be such a well- known subject as of late. In any case, when utilizing the meaning of Miorandi et al. (2012), detecting abilities aren't an important trademark for smart things.

Secondly, the technology that may support the interaction of the sensible things may be a combination of large wireless networks: Bluetooth, Near Field Communication (NFC), Wireless sensor network (WSN), low-power wide-area networks (LPWA) or long-range wide area networks (LoRa), etc. (Gubbi, Buyya, Marusic, & Palaniswami, 2013; Openshaw et al., 2014; Schatsky & Trigunait, 2011).

The third helpful innovation for IoT applications is a radio- frequency identification (RFID). RFID technology empowers the plan of microchips for remote information communication and is really an extraordinary change of the customary standardized barcode (Gubbi et al., 2013). The RFID reader can read distinctive labels immediately, require no viewable pathway contact and give composing abilities besides the perusing capacities (He and Zeadally, 2015).

The RFID reader gives the important capacity to impart the signal from the RFID tag so no batteries must be installed (Gubbi et al., 2013). These labels can store sensitive information since it distinguishes objects automatically. Be that as it may, enhancing the security of the RFID labels is as yet an essential subject of a considerable measure of research papers since it requires some additional adjusting. Protection and security are more troublesome in the IoT setting in light of the fact that clients, as well as unapproved articles, could get to information (Miorandi et al., 2012).

The fourth technology, cloud computing, is critical to compile and break down all the (huge) information. It's unmistakable this won't be a simple task. The information from the smart things can be of any sort: temperature, pressure, altitude, motion, proximity to something else, biometrics, sound, etc and the system comprises of assorted items with variable information arrangements so the coordination of this information is one of the greatest difficulties for IoT (Davenport and Lucker, 2015). The activities performed by this innovation are a basic piece of IoT.

Cloud computing is a stage that permits on-request access to computing services (Geng, 2017). This platform works in the background and is utilized to get information from the smart things, break down and decipher this information and give online representations to the client (Gubbi et al., 2013). This is an exceptionally fascinating part for organizations since this will make a market with plenty of chances to make an incentive for clients of IoT applications. The investigation of this information in the cloud will commonly be performed by enormous information examination and machine learning calculations (Geng, 2017). Machine learning is a type of man- made consciousness and enables these calculations to enhance themselves by gaining from their information input.

As of late, Big Data has been a hotly debated issue yet the measures of information made by IoT applications is much more noteworthy. These tremendous measures of information initially must be transported from different sources and areas over a system, stored in a concentrated database, and after that examined by the cloud (Schatsky and Trigunait, 2011). This will require some time and a critical increase in off-device storage volumes. There is as of now an innovation that gives an answer for this tedious procedure, edge computing. Enormous organizations, for example, Dell, Cisco and Hewlett-Packard Enterprise have created gadgets; predominantly doors, switches, and servers that utilize this innovation (Schatsky and Trigunait, 2011). These gadgets preprocess information with the end goal that information is exchanged to the cloud rather than data.

B. Connected Wearables

Wearable devices and sensors offer great potential in the collection of richer data and insights to enhance our understanding of the effects of treatment. They enable the collection of objective measures of intervention effects both in-clinic and in remote free-living settings. However, implementing wearables and sensors brings new challenges to clinical trial conduct, data management, and interpretation. Wearable innovation can make Remote Patient Monitoring (RPM) significantly more sensible for both patients and healthcare providers. For instance, a wearable gadget can quantify a patient's pulse, blood pressure, temperature, breathing and more, which would then be able to be monitored remotely by specialists and medical caretakers. On the off chance that a patient is having breathing issues, an alarm can be sent to the individual observing the gadget, who would then be able to take essential action, for example, sending a rescue vehicle. Envision the ramifications of this innovation for elderly patients or patients who live alone.

Wearables imply that patients don't have to go to the doctor's facility when it's redundant in light of the fact that specialists and medical caretakers can track symptoms remotely. This permits clinic staff to chip away at all the more squeezing and earnest cases. Moreover, when the patients to go to the specialist for a development, staff can audit information gathered by the wearable for a precise determination.

C. *Remote Patient Monitoring (RPM)*

Remote patient monitoring (RPM), additionally called homecare telehealth, is a sort of ambulatory medicinal service that enables a patient to utilize a portable therapeutic gadget to play out a normal test and send the test information to a healthcare professional progressively. RPM innovation incorporates every day checking gadgets, for example, glucose meters for patients with diabetes and heart or pulse screens for patients getting cardiovascular consideration. Information can be sent to a doctor's office by utilizing a telehealth PC framework, by utilizing an extraordinary programming application introduced on the patient's network-connected PC, cell phone or tablet PC.

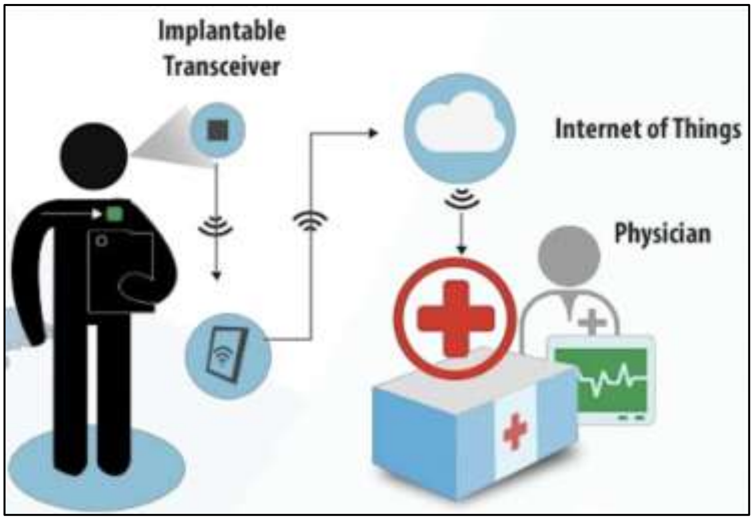

Fig. 2: Remote Patient Monitoring Model

As per the National Broadband Plan drafted not long ago by the Federal Communications Commission (FCC), the utilization of remote patient observing innovation related to electronic health records (EHR) could save the social insurance industry $700 billion or more in 15 to 20 years.

III. PROPOSED MODEL

We have proposed a Remote Patient Monitoring (RPM) framework that is adequately savvy to screen the patient normally using IoT that assembles the status information through this framework which would fuse patient's heartbeat, ECG, body temperature and Blood Pressure and send a crisis alarm to patient's caretaker with his/her present status and full remedial information. This would help the caretaker with checking his/her patient from wherever and save the patient from having to send his health status and particularly without having to visit the facility. Our model can be passed on at various health facilities and doctor's facilities. The system uses body sensors that produce crude data accumulated from each sensor and send it to a database server where the data can be inspected and truly kept up to be used by the therapeutic experts. Maintaining a database server is a critical need so that there is a track record of past helpful data from the patient giving a predominant and improved view of past health conditions.

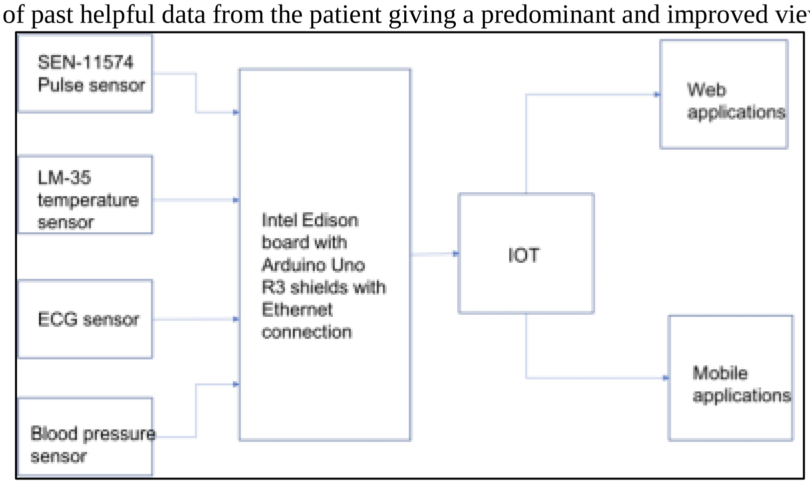

Fig. 3: Block diagram

A. *Hardware*

The brain of our model is the Intel Edison board, a single board which is based on the Intel Atom-dual core, a 32-bit Intel Quark Micro-controller running at 100 MHz. It is Arduino-certificated and designed to be hardware, software, and pin compatible with a large range of Arduino Uno R3 shields. Intel Edison board is preferred over Arduino because this provides a Linux platform with high processing and computing power within and includes Ethernet shield and SD card support. This brain collects the data from all the sensors connected to the patient and uploads this data to the web server via Ethernet. The doctor can keep track of all the patient's data through the web client or mobile application. The sensor attached to the patient is a Heartbeat sensor (SEN- 11574 Pulse sensor) takes +3.3V - +5V at VCC and temperature sensor which maintains the record of the patient's overall health. For temperature, we have used LM-35 temperature sensor (DHT 11). Heartbeat sensor is designed to give the digital output of the heartbeat when a finger is placed on it. When the heartbeat detector is working, the beat LED flashes in unison with each heartbeat.

This digital information can be associated with microcontroller straightforwardly to quantify the Beats per Minute (BPM) rate. It deals with the guideline of light balance by blood coursing through the finger at each heartbeat. Different sensors like circulatory strain sensor, ECG sensor, and numerous others can be added to the patient unit in light of the patient's restorative condition.

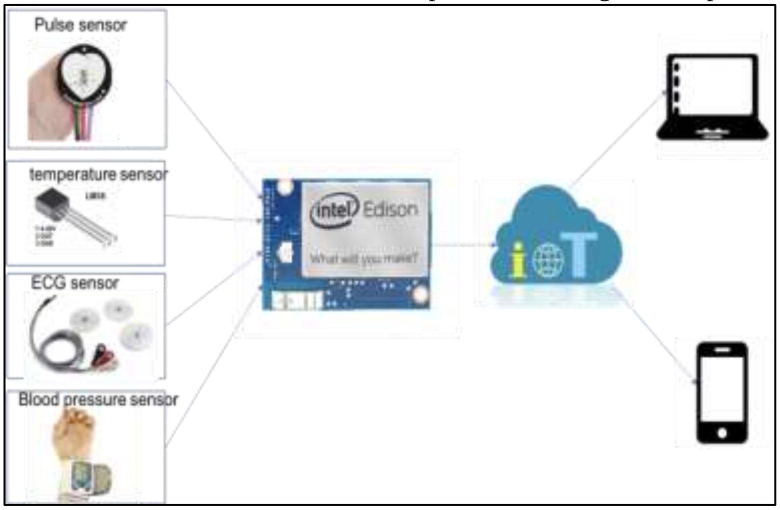

Fig. 4: Hardware components

B. Software

The program portion consolidates an Arduino IDE which is required to program our Intel Edison Board which was used to exchange our last code of keeping up a database. All the data related to the sensors is sent to a WAMP-based database server to log timely data, which will help to provide more informed consulting and prescriptions for the patient. Moreover, these datasets stored in the database are used to plot graphs to identify patterns for every one of the sensors are showed up. The server has a decision for transferring the database of the patients with their unobtrusive components and their restorative history. The data server can be accessed whenever necessary by the administrator using the web or mobile application and the provider can, in addition, see the current live feed of the patient's therapeutic condition. A track of patient's health record is furthermore kept up for future reference on the net section. The section too has the decision to safeguard and track the 24-Hour records of various patients. The patient can also observe his/her therapeutic results.

IV. MONITORING RESULTS

A. Secured login page

On this screen, the health specialist or guardian enters their login credentials. Once the credentials are verified, the system will show a rundown of patients assigned to the specialist. The specialist will choose the patient whom he needs to screen. Here the specialist or guardian can fundamentally observe essential readings reported by the patient's monitoring devices. The specialist practices extraordinary care here in order to protect classified information and maintain patient confidentiality.

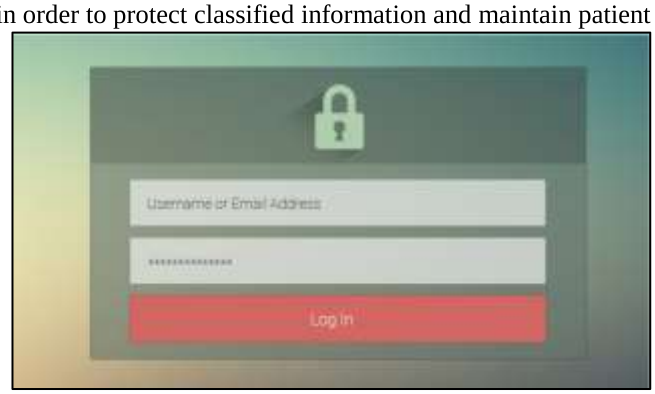

Fig. 5: Web portal login

B. Patient's Health Monitoring Page

After specialist or guardian logs in successfully, either can easily see live patient health data which incorporates temperature, heartbeat, ECG and so forth. Keeping in mind the end goal to ensure the security of the patient's information, transferred data is encrypted while sending it to the database server and is decoded while transferring the same information on the site page.

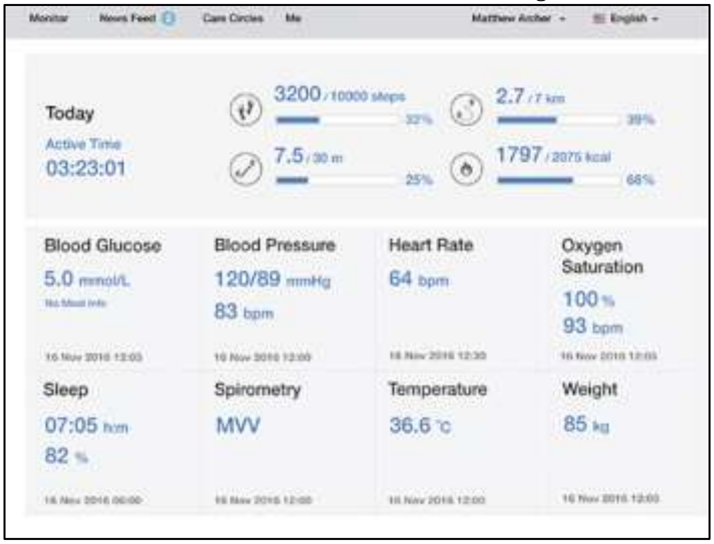

Fig. 6: Patient's health monitoring page

In picture subheadings, providers glean insight from the current readings of the patient when communications with devices complete without error. In the event, that gadget isn't associated or any of the sensors isn't attached to the patient, at that point every one of the readings would be reported as zero so as to avoid an erroneous diagnosis. On the off chance that gadget is turned off then this page would show gadget disconnected error.

The data from various sensors are being uploaded into the database server from which the data is further used to plot graphs and analyze the health reports.

V. CONCLUSION

Remote patient checking is of incredible help for patients as well as for healthcare experts. Be that as it may, RPM is as yet not accessible for all impacted individuals relying upon their area and remote access abilities. Moreover, specialists need to expend effort with a specific end goal to draw in patients and spur them to utilize RPM. Lastly, the fundamental disadvantage of this innovation is the unproved precision of gadgets. For whatever length of time that the likelihood of imprecision exists, the viability of RPM will stay dubious to many.

The fundamental thought of the proposed framework is to give accurate and efficient health statistics to wellbeing administrators and to the patients by executing an organized data cloud so the specialists and patients can make use of this information and determine quick and effective action.

The final model will be well equipped with the features where a doctor can examine his patient from anywhere and anytime. Emergency scenario to send an emergency signal or message to the doctor with the patient's current status and full medical information can also be developed.

The proposed model can also be deployed as a mobile app so that the model becomes more mobile and easier to access anywhere across the globe.

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