

IoT based Smart HealthCare Kit

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ABSTRACT -The paper presents the design and implementation of an IOT-based health monitoring system for emergency medical services which can demonstrate collection, integration, and interoperation of IoT data flexibly which can provide support to emergency medical services like Intensive Care Units(ICU), using a INTEL GALILEO 2ND generation development board. The proposed model enables users to improve health related risks and reduce healthcare costs by collecting, recording, analyzing and sharing large data streams in real time and efficiently. The idea of this project came so to reduce the headache of patient to visit to doctor every time he need to check his blood pressure, heart beat rate, temperature etc. With the help of this proposal the time of both patients and doctors are saved and doctors can also help in emergency scenario as much as possible.

The proposed outcome of the project is to give proper and efficient medical services to patients by connecting and collecting data information through health status monitors which would include patient's heart rate, blood pressure and ECG and sends an emergency alert to patient's doctor with his current status and full medical information.

Keywords -Internet of thing (IoT); Medical Services; Health care; Health Monitoring;

I. INTRODUCTION

Capturing and sharing of vital data of the network connected devices through secure service layer is what defines IOT. In simple terms, Internet of Things (IOT) can be defined as the wireless network of devices which are connected to each other to share information and data in order to communicate and produce new information so as to record and analyze it for future use.

Internet of Things gains its full potential by utilizing the key role playing objects i.e. "Smart" objects which use various sensors and actuators that are able to perceive their context, and via built in networking capabilities they could communicate to each other, access the open source Internet services and interact with the human world. This not only makes the world connected

but also robust and comfortable. The Internet of things in the field of healthcare also plays a major role in providing ease to patients and doctors. It consists of a system that communicates between network connected systems, apps and devices that can help patients and doctors to monitor, track and record patients' vital data and medical information. Some of the devices include smart meters, wearable health bands, fitness shoes, RFID based smart watches and smart video cameras. Also, apps for smartphones also help in keeping a medical record with real time alert and emergency services.

These interconnected IoT devices produce large amounts of information and data that should be dealt efficiently by the providers and so is a big challenge. To overcome this challenge of storing and analyzing large data, the technique of Internet of Things Analytics (IoTA) is implemented. The raw data is converted into a useful and medically relevant data using the techniques like data extraction and data analytics. In fact, it has been predicted that by 2020, more than 50-55 percent of techniques used to analyze raw data will make a better use of this influx of data which is generated from instrumented machines and applications. In order to make our health care services robust and vast, the IOT relies on several enabling technologies. Collection of real-time data from various sources, in this case, unlimited number of patients for a large period of time has become very easy and fast using the potential of IOT. The power of IOT for health and medical services are harnessed by smart sensors (sensor and a microcontroller) which accurately measures, monitors and analyze a variety of health status indicators. These can include basic vital health signs such as pulse rate and blood pressure, oxygen and glucose level in blood and heart rate. Smart sensors can be incorporated into medicines and pill bottles that are connected to a network and can generate alerts about whether the patient has taken a scheduled dose of medication.

A lot of advancement and significant changes are occurring in the field of IOT healthcare. The way of interacting and communicating with humans and other devices is changing and getting better day by day. Management of healthcare results and reduction of healthcare costs is enabled by the ever growing

information and communication solutions. The healthcare services are getting better and less costly by collecting, recording, analyzing and sharing new data packets in real time and efficiently. Also, as the world is adopting this ever growing technology of IOT, many of the inefficiencies in healthcare will be reduced. For example, various medical devices like fitness bands, health monitoring systems, medication boxes has smart sensors embedded into them that allows to collect the raw data, store it, analyze it, and conduct tests which are further used by medical experts to take proper decisions.

To take the full advantage of revolutionizing IOT in healthcare, the consumers, patients and other health experts need to think of some innovative and more reliable methods. And with the help of IoT's potential they are now able to collect real-time raw data from unlimited number of patients for a continuous period of time through smart devices connected on an interconnected network. It will take time to fully realize the technology's capabilities. We will be able to see medical experts carrying out diagnosis and critical tasks in a more better and reliable way. This will ensure them not only with reliable results but also time saving which will be of maximum benefit. The possibilities of IOT are truly unlimited and ever growing. This paper proposes an IoT based health monitoring system which would collect all the medical data of a patient including his heart rate, blood pressure and ECG and would send alerts to the patient's doctor regarding his/her full medical information, providing a fast and reliable healthcare service. Moreover, in today's world everyone is busy neglecting their small healthcare problems like high blood pressure, low pulse rate etc. The paper helps to find a better and robust solution to this challenge.

II. RELATED WORK

Research is going on in the field of IOT-healthcare which gives a clinical evidence that the raw data received from wireless network connected devices has contributed in managing and preventing chronic diseases and monitoring patients. Therefore, various health monitoring systems are getting wearable today's, including glucose monitors, ECG monitors, pulse audiometers, and blood pressure monitors.

Similarly, research is going on for the advancement of iot and various products and services based on them, pertaining to one or more domains among those of Automation, Artificial Intelligence and Intelligent systems for energy conservation, Green Technology, and the likes.

1. Coeey Smart Health

Coeey[1]Smart health lets you automatically log your medical data through Bluetooth entitled devices. It takes note of your health by storing, analyzing and sharing your medical records. It also advices you on the smart tips and services based upon your health analysis. It also give you alerts and messages about your health risks. It enables you to remotely monitor the health reports as well as also has the option of connecting yourself to various health service providers like pharma, labs, homecare and teleconsulting.

It consists of three different health monitoring systems:

Smart Blood Pressure Monitor, Smart Body Analyzer, Smart Glucometer. Coeey is lengthwise health monitoring IOT platforms which help the providers in collecting, storing and analyzing of raw medical data so as to provide provide alerts of vital signs for patients beforehand. It lets you choose and customize your personalized services based upon your health condition. For customers, it is a health management application with personalized services. It is personalized solution for chronic health management. No other product and app is able to provide a last mile connection of a patient with his health experts. But, through the help of #rd platform services, Coeey is able to interconnect and provide focused services to its customers. Some of the 3rd Platform services that Coeey provides:

- Measure and Monitor: Smart devices like Bluetooth entitled BP monitor and Weighing Scale lets you automatically record the medical data and lets your medical health experts to remotely access this data.
- Engage: Different data including the profile of patient, his health vitals, his medication and medication history are collected and on that basis health tips are provided in order to improve health management
- Fulfilment: The data collected so is also used to create dynamic profile of the patient according to his current health condition so that on further analysis this profile can be used by other medical experts

Coeey smart services target mainly on Chronic patients and Antenatal care offering:

- Devices which are used to record share your medical data and let it go through analysis.
- Smart assist: Provide personalized advices and recommendations based on the smart recommendation engine using smart algorithms
- M-Assist: Provides with mobile API for personal health management.

- W-Assist: Internet connected web based portal that works on mobile devices like laptops and tablets..

2. Health Vault by Microsoft

Microsoft Health Vault[2] assists you to gather, store, use, and share health information for you and your loved ones. You can sustain all your health records at one place that's organized and available to you online (E-Book Keeping)in case of medical emergencies, it is able to keep track of all the details so that you are always alerted about your wellness. It records the data once, and use it with new data to get frequent updates about your health. Health Vault-connected apps include websites, computer software, and mobile apps that can help you analyze more out of your captured health information. It also features multi-app connectivity so that the information can be shared with anyone you want.

It features:

- Up-to-date medication and allergy lists
- Latest home health readings (such as blood pressure, blood glucose, and weight)
- Your health history

HealthVault not only helps you store, organize, but also give this information to your doctor.

It can keep your details at your fingertips and access it from anywhere using Internet connection on a PC, smartphone/tablet. It can record and store your diagnostic results, prescription history, and visit records from an increasing list of connected labs, medical institutes, hospitals and clinics which can send details to your HealthVault and record it. You can transfer your medical logs and can easily keep these track records in HealthVault, for future reference.

Medical images can be easily saved and shared to your medical consultants and keep them handy for future reference. Statistical graphs, patterns and trends are drawn from the so collected data in the HealthVault which help your medical experts to make efficient and better health decisions. It can easily share information with people your healthcare consultants so that they can guide and advice you on proper health management. Weight management dashboard helps you succeed in your fitness goals by keeping a track of your weight, your daily diet, daily activity and tracing the progress.

Since the data in health care industry is very huge, So Sharma S [3, 9-10] has proposed a cloud service model to handle such a huge data. Author has also discoursed various type

of cloud service model and classification of the services provided by cloud service providers.

HealthVault features:

- **Authentication** by connecting it with Windows Live ID, Facebook, and OpenID credentials.
- **Authorization** by providing user authorization before enabling any data sharing between an application and a user's HealthVault account data.
- **User control** by giving them the control to authorize data shares and providing them a feature to stop application access at any time, and can change or delete information in their history.
- **Data provenance:** by intelligently taking decisions on how to treat data from different sources. Optional digital signatures allow for independent verification of data integrity and source.

III. PROPOSED MODEL

We have proposed a robust health monitoring system that is intelligent enough to monitor the patient automatically using IOT that collects the status information through these systems which would include patient's heart rate, blood pressure and ECG and sends an emergency alert to patient's doctor with his current status and full medical information. This would help the doctor to monitor his patient from anywhere and also to the patient to send his health status directly without visiting to the hospital. Our model can be deployed at various hospitals and medical institutes. The system uses smart sensors that generates raw data information collected from each sensor and send it to a database server where the data can be further analyzed and statistically maintained to be used by the medical experts. Maintaining a database server is a must so that there is even track of previous medical record of the patient providing a better and improved examining.

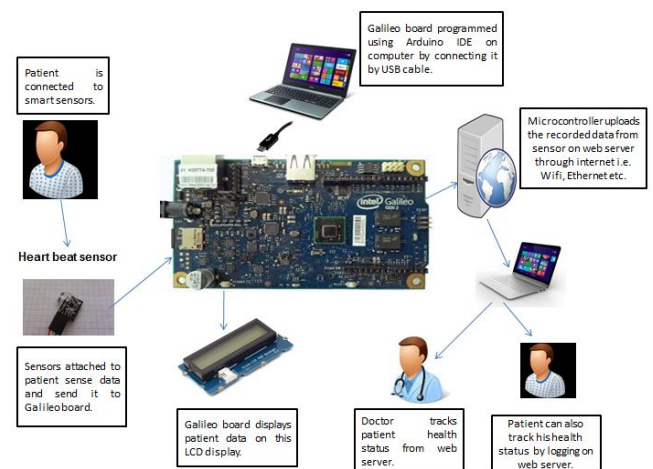


Fig. 1. System Architecture

Hardware: The brain of our model is the 2nd generation Intel Galileo board, a single board which is based on the Intel Quark SoCX1000, a 32-bit Intel Pentium processor- class system on a chip (SoC). It is Arduino-certificated and designed to be hardware, software, and pin compatible with large range of Arduino Uno R3 shields. Intel Galileo board is preferred over Arduino because this provides a Linux platform with high processing and computing power with in build Ethernet shield and SD card support. It gets the information. This brain collects the data from all the sensors connected to the patient and uploads this data on the web server via Ethernet. The doctor can keep track of all the patient's data through the web client.

The sensor attached to the patient is a Heartbeat sensor (XD-58C Pulse sensor) takes +3.5V - +5V at VCC, 50Hz – 60 Hz frequency and temperature sensor which maintains the record of the patient's overall health, for temperature we have used LM-35 temperature sensor (DHT 11). Heart beat sensor is designed to give digital output of heat beat when a finger is placed on it. When the heart beat detector is working, the beat LED flashes in unison with each heartbeat.



Fig 2 Components used

This digital output can be connected to microcontroller directly to measure the Beats Per Minute (BPM) rate. It works on the principle of light modulation by blood flow through finger at each pulse. Various other sensors like blood pressure sensor, ECG sensor and many more can be added to the patient kit in response to the patient's medical condition. Software: The software part includes an Arduino IDE which is needed to program our Intel Galileo Board which was used to upload our final code of maintaining a database. All the data connected to the sensors is sent to an Xampp based data base server to log the patient timely record or sensed data, which will help the doctor for better consulting and prescription to patient. More over these datasets stored in database are used to plot graph for each of the sensors are shown. The server has an option for uploading the database of the patients with their details and their medical history. The data server can be accessed any time by the doctor

and the doctor can also see the current live feed of the patient's medical condition. A track of patient's health record is also maintained for future reference on the web portal. The portal also has the option to maintain and track the 24-Hour records of multiple patients. The patient can also see his/her medical details on the web portal. Thus this system proves to be an efficient and robust way to maintain and analyze one's medical record and live track.

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IV. EXPERIMENTAL RESULTS

The proposed intelligent health monitoring system is being deployed and tested over a patient whose personal details are entered into the web portal. The patient is connected with uor health monitoring system which consists of a heart rate sensor and a temperature sensor. The live graph of the patient's heart rate and temperature is being monitored on a Xampp based database server. The IOT device used here is Intel Galileo board. The system architecture of the proposed model is explained by the given below figures which includes a server connected Intel Galileo board that uploads the data received by the sensors onto the database and statistical graphs are being plotted for further analysis and recording

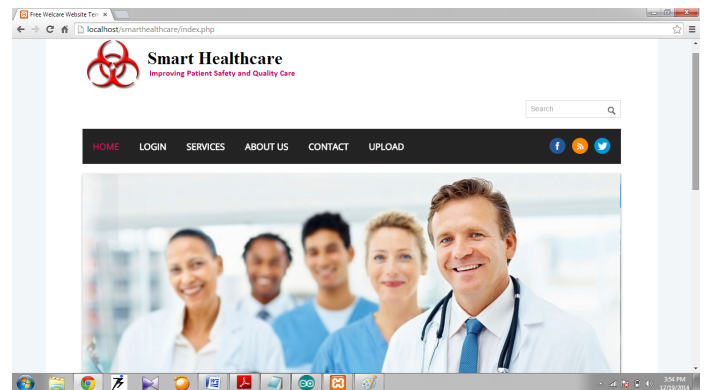


Fig. 3. Sytem web portal design

The index or the Home page of the the web portal consists of various tabs including the Login, Services, About Us, Contact and Upload.

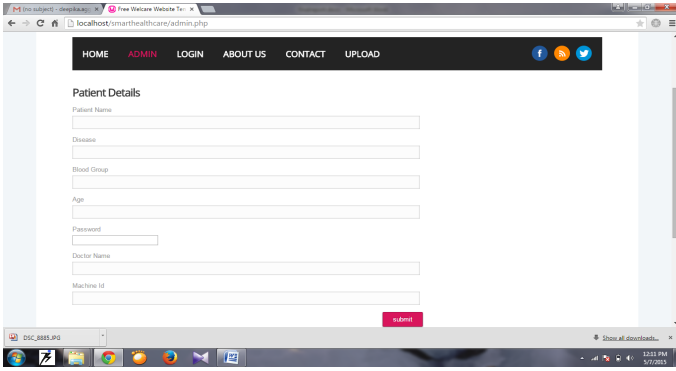


Fig. 4. System web portal Admin Page

The Admin page of the web portal allows the user to enter the personal details of the patient including his name, age, blood group and various other essential details in order to maintain the records systematically.

In the Upload tab, the doctor can manually upload the blood pressure and the temperature of a patient with a specific machine id so as to maintain the records for future purposes.

mid	pmin	pmax	temp	time
m1	80	103	36	16:19:55.000000
m1	80	103	36	16:20:18.000000
m1	80	103	36	16:20:41.000000
m1	80	103	36	16:21:04.000000
m1	80	103	36	16:21:27.000000
m1	80	103	36	16:21:49.000000
m1	80	103	36	16:22:12.000000
m1	80	103	36	16:22:35.000000
m1	80	103	36	16:22:56.000000
m1	80	102	36	16:23:18.000000
m1	80	103	36	16:23:40.000000
m1	80	103	36	16:24:03.000000
m1	80	102	36	16:24:26.000000
m1	80	103	36	16:24:52.000000
m1	80	103	36	16:25:14.000000
m1	80	103	36	16:25:36.000000
m1	80	103	36	16:25:59.000000
m1	80	102	36	16:26:20.000000
m1	80	103	36	16:26:42.000000
m1	80	103	36	16:27:04.000000
m1	80	102	36	16:27:27.000000

Fig. 6 System web portal uploading data

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.

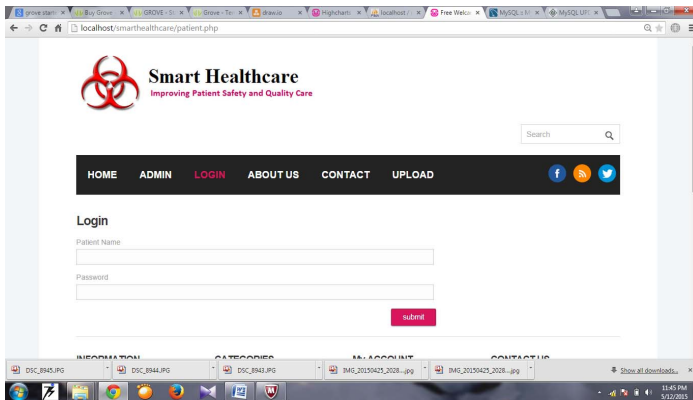


Fig. 5 System web portal Login Page

In the Login tab, the user can login into the web portal as a patient or as the doctor as per the credentials given.

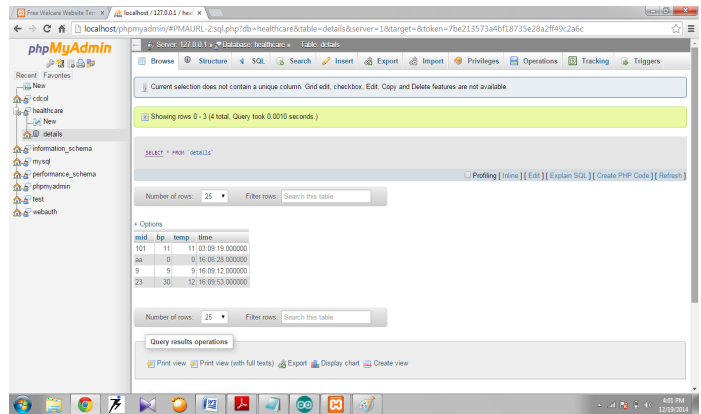


Fig. 7 System web portal database server

This figure shows the full structure of the database which is being hosted currently on the local host and further can be connected to the whole world via IOT. The database has full details and record history of each and every patient through which a statistical graph is plotted in real time which is used for patients further analysis and tracking.

The model is finally deployed over a normal fit person and her heart rate and temperature details are plotted on a real time graph. An example output of a proposed health monitor device is shown in which the patients personal details are shown and

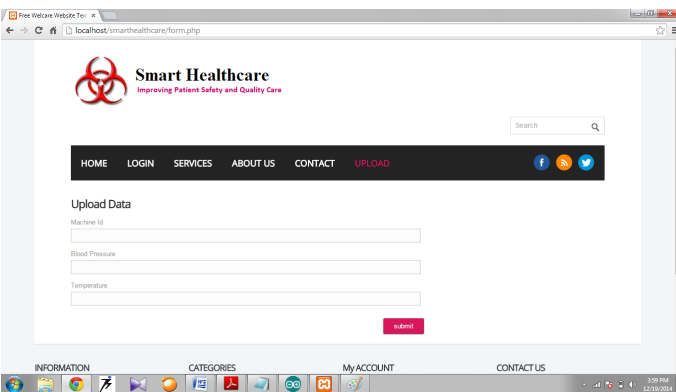


Fig. 5 System web portal upload data tab

alongside her live heart rate and body temperature is being traced in real time.

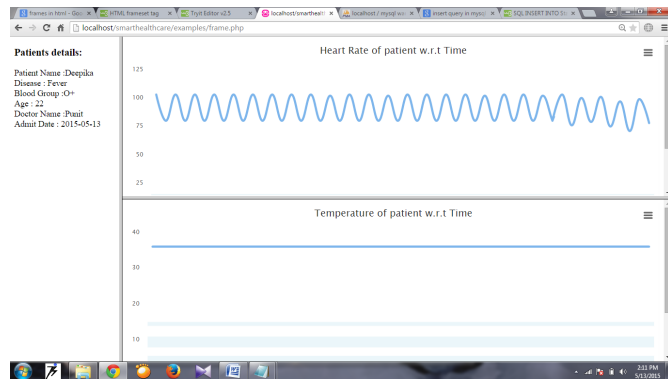


Fig. 8 An Example Health Monitor graph

V. CONCLUSION

The main idea of the proposed system is to provide better and efficient health services to the patients by implementing a networked information cloud so that the experts and doctors could make use of this data and provide a fast and an efficient solution.

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

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

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