International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 06 Issue: 05 | May - 2022 Impact Factor: 7.185 ISSN: 2582-3930

IOT Enabled Hospital Beds In Pandemic

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Abstract - *One of the global challenges for humanity is Health. There is a rapid increase of rate in patients who require immediate medical attention due to the recent COVID 19 pandemic. Patients at the Hospital or Elderly people at home require constant Monitoring of health and observation of Practitioners and Doctors. The aim of this project is to create a reasonable budget system which is designed to help guardians and doctors to monitor the health condition of their patients at home even from a distance. This is immensely essential during the pandemics such as the COVID 19, where there is a need to maintain a certain amount of distance from the patient. At hospitals, the current monitoring systems are wired to bulk equipment so the patients are restricted with their mobility. Hence there is an interference in their daily routine and the doctors and nurses will have a lot of trouble keeping the updates of a patients health. This paper presents Internet of Things (IoT) enabled Hospital beds for Pandemics which is a portable system monitoring patients health at all times and also can be fixed to the remote patient without the requirement of being constrained to stay put on their beds all day long. Moreover, the device can measure and display the current health status of a patient which is vital and needed for a better healthcare. IoT consists of physical devices, such as sensors and monitoring devices for patients to connect to the internet and transforming this information from the physical to digital world. The proposed system, with the help of IoT's mentioned features, will help to keep track of the patients health and simultaneously display the data on a web app at any place hence helping the doctor and nurses to give assistance to patients when it is absolutely vital. There is also an alert added to the webapp as the patients condition becomes critical and there is an immediate need of assistance.*

Key Words*: *Heath Care, IOT, Pandemic, Sensors, COVID-19, ICU Beds.

1.INTRODUCTION

Internet of things is a 'network of things' or in more particularly 'network of devices' (having intelligence) that are connected together to attain some excellence in the performance of the entire system. Devices in the network have unique identities so that it is not difficult to use them and to manage the entire network. Gartner's definition of IoT is - "The Internet of Things (IoT) is the network of physical objects that contain embedded technology to communicate and sense or interact with their internal states or the external environment."

Objects in Internet of Things refers to any type of object, it can be a smart device with more AI which can communicate with other objects very efficiently or it can be a dumb object which does not have communication capabilities at all. Objects with such communication capabilities become communicating nodes. Hence IoT is not only a hardware or software concept, it also considers the interaction between the objects. IoT networks have tremendous amount of data.

IoT Layers:
There are five different layers the IOT can be viewed in and each of these have their own functionalities and responsibilities.

1. **Perception Layer**:
This layer includes the sensing devices to collect data through, includes Zigbee, RFID and all kinds of sensors. This layer has the responsibility of gathering the data and transferring it to layers above.

2**. Network Layer**:
This layer takes over the responsibilities of provision of secure data transfer and better communication. It uses technologies that are advanced and standards for wireless communication. Hence the main function is transfer of data between upper layers and lower layers.

3. **Middleware Layer:**
It is responsible to store the collected data safe in some databases that is predefined. It also has certain responsibility like service management.

4. **Application Layer:**
Its functions is to provide all types of services with respect to the corresponding field.

5. **Business Layer:**
The layer which is topmost, is similar to an analysis layer. It is responsible for the detailed analysis. It guides for future actions.

2. Scope

1. This model can be effectively used during the Covid-19 pandemic in hospitals of rural/urban areas which face the scarcity of smart hospital beds during a pandemic.

2. This model can be very useful if we have to face any other major pandemic in the coming times. Using this will help us immensely to avoid facing the same dangerous situations we had to face during Covid-19.

3. The future work of this study will cover more detailed work of the system such as development of recommendation system based on the collected data and also will provide more features and to use more features in our system to provide more capabilities.

4. It could help us to keep track of all the patients health status at a time hence reducing physical touch or excessive contact.

3. OBJECTIVES

1. To help us convert basic beds into smart hospital beds

2. To help us keep a 24/7 watch over the medical status of the patient.
3. To never face scarcity of hospital beds for any future medical catastrophes.
4. To always have previous data to study cases that might occur in the future.

4. LITERATURE SURVEY

Paper[1] **Research Paper on: "A Web-based Information System for the Management of ICU Beds During the Coronavirus-Outbreak"**

In this work, they have presented the strategies and methodology used to develop a web information system to monitor the ICU and semi-ICU bed usage in the state of Rio Grande do Norte during the coronavirus outbreak.

Paper [2] **"Pulse Rate and Blood Oxygen Monitor to help Detect Covid-19: Implementation and Performance"**

This paper presents a device to measure monitor blood oxygen (SpO2) and heart rate has been developed with higher credibility and lower cost. The lower cost and analysis and lower cost validate the accuracy of the sensor.

Paper [3] **"IOT COVID-19 Portable Health Monitoring System using Raspberry Pi, Node-Red and Thing-Speak"**

This Paper presents a portable health monitoring system that has been completely developed for the purpose of monitoring the patient's health through the reading of their parameters, including oxygen saturation level in the blood, body temperature and the heart rate of the patient from devices such as smartphones.

5. PROPOSED SYSTEM

The proposed system aims to Monitor the Health of people at home or at hospitals without being constrained to being in a bed using IoT devices and display the collected data on the IoT server.

A. Objective of Work

• To Provide technological support to make healthcare systems easy, efficient and fast
• To display current and accurate physical parameters of a patient
• To Provide availability of patients necessary data on the internet.
• To Provide faster treatment and assessment.

B. Proposed System Approach

The work-flow of the proposed system consists of four stages - Data Transmission, Data Processing, Data Storage and Data Acquisition.

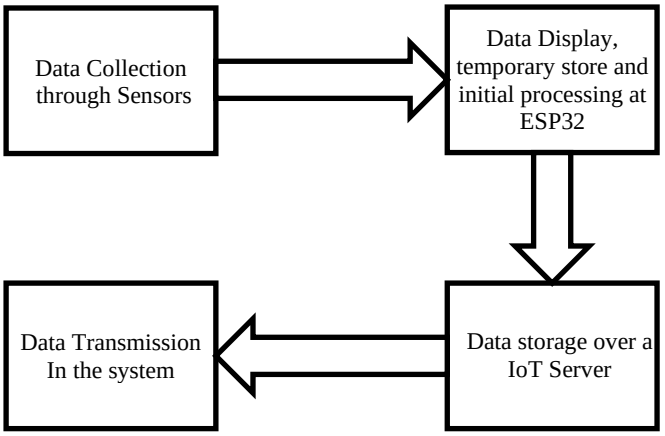


Fig 1: Basic Work-flow of the proposed system

As per the work-flow shown in the above figure, first task in the proposed system is to gather data from patients through sensors. Data here refers to the health parameters of patients which are temperature and ECG. The sensors used in these systems are low power sensors. They gather data from patient on continuous timely basis. With this frequently received data the health condition of a particular patient is observed and required assistance is recommended. This collected data is shown on a web app connected to the ESP32 board, if required the data is processed and then forwarded to IoT server for storage from where it is accessible. Hence this system works on the basic client-server principle of CN. Data collected on the server is stored for the reference of all peers in the system and transmitted to these peers when required.

C. Proposed System Architecture

Basic Blocks:

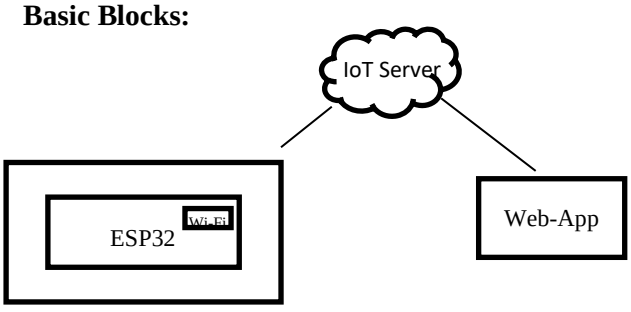


Fig 2: Basic Blocks of the system

The proposed system primarily consists of three main blocks as shown in figure below. One block consists of the ESP32 model in which wireless connectivity is provided within the kit itself and doesn't need external wifi module. The data is gathered at this side and is sent to IoT server. IoT server is the data storage of the overall system. That data is accessible at the doctor's/Nurses side so they can access this information of patients and provide necessary assistance.

System Architecture:

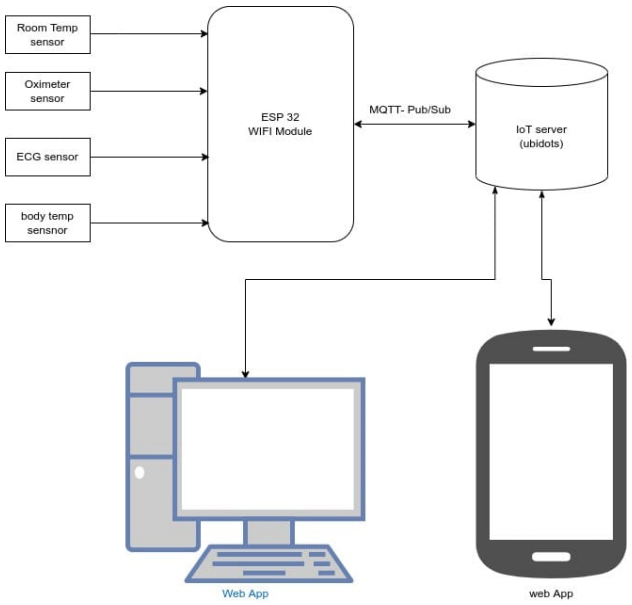


Fig 3. Proposed System Architecture

As we can see in the proposed system architecture, the data from patient is gathered at the ESP32 with the help of attached sensors. The data gathered will be stored onto the IoT server for the patient and then forwarded to Doctor / Nurses for analysis. The Doctor / Nurse will analyze this data and will give assessment accordingly and hence the monitoring of health is successfully done. The protocol used for data transfer and communication is MQTT. Generally used protocols with IoT based systems are CoAP, HTTP and MQTT. HTTP and MQTT are chosen for sensor-based applications and according to the application's requirement while CoAP is used where network performance is the main target to achieve.

D. Implementation:

Devices used:

1. ESP32:

It is a series of low-power system, low-cost on a chip microcontrollers with integrated dual-mode Bluetooth and Wi-Fi. The ESP32 series employs either a Tensilica Xtensa LX6 microprocessor in both single-core and dual-core variations, single-core RISC-V microprocessor or a Xtensa LX7 dual-core microprocessor and includes built-in antenna switches, power amplifier, RF balun, low-noise receive filters, amplifier, and power-management modules. ESP32 is created and developed by Express if Systems, a Shanghai Chinese company, and is manufactured by TSMC using their 40 nm process. It is a successor to the ESP8266 microcontroller.

2. Temperature sensor:

Temperature sensors are of various types. The proposed system uses the LM35 temperature sensor. It is an analog sensor but provides almost accurate readings as desired by the application.

3. ECG Sensor:

Electrocardiogram sensor is used for monitoring ECG. ECG provides more information about the rate of the heart-beat and all other disease indications. Hence monitoring the health will be more useful with the help of this particular sensor. The threshold value set for the sensor is 200 ms and if found value beyond than that, alarm is generated.

4. Oximeter:

Oximeter or MAX30100 is an integrated pulse oximeter solution. It combines 2 LEDs, a optimized optics, photodetector, and low-noise analog signal processing to detect pulse oximetry and heart-rate signals.

Hardware Requirements:

1. Flex Sensor E508538
2. Node MCU E391
3. LM35
4. 5mm Red LED
5. 5mm While LED
6. Glass PCB
7. Pulse Sensor E249
8. Max30100 pulse Oximeter
9. Temperature Sensor
10. M to m Jumper
11. Urw E68 Chip

Circuit connections of the System:

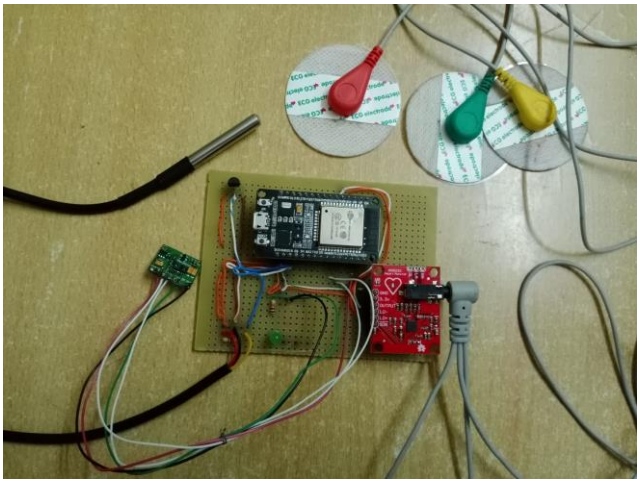


Fig 4: Circuit of the system

For Login:

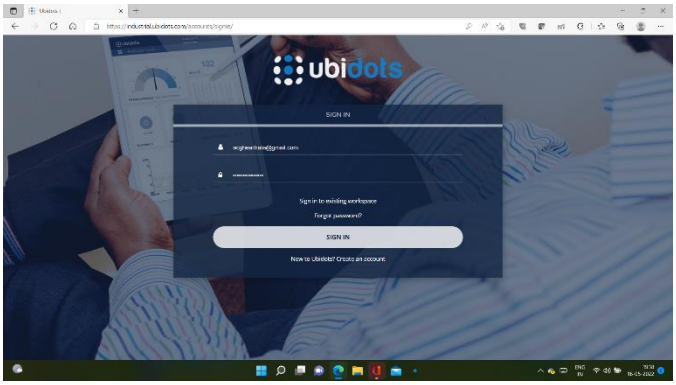


Figure 5: Login Page

E. Results:

Alert Notifications:

This system sends sms alerts to the targeted users (Health professionals / Doctors) of the system if particular sensors value is beyond the predicted range / threshold value so that user will be aware of their health and can be taken care accordingly.

Decision Making of Health condition (on Doctor's side):

Number or sms alerts	Health Status of Patient
Alerts<=3	Unhealthy
Alerts>3	Critical

Table 1: Health Status Predictions

Advantages:

1. This is an affordable device which can be used by any doctor/nurse at the hospital as well as any individual at home.
2. It gives an alert if the reading of the patient's health crosses a particular threshold.
3. This device does not constrain the patient from moving around the house all day.

Limitations:

1. The use of this device is limited to then use of a single patient at a given time
2. The storage of the patient's readings is stored for not more than 6 months.
3. The readings of the patient's health is not as accurate to the actual readings. There might be a difference of 1 to 1.5 plus-minus.

Flow Chart:

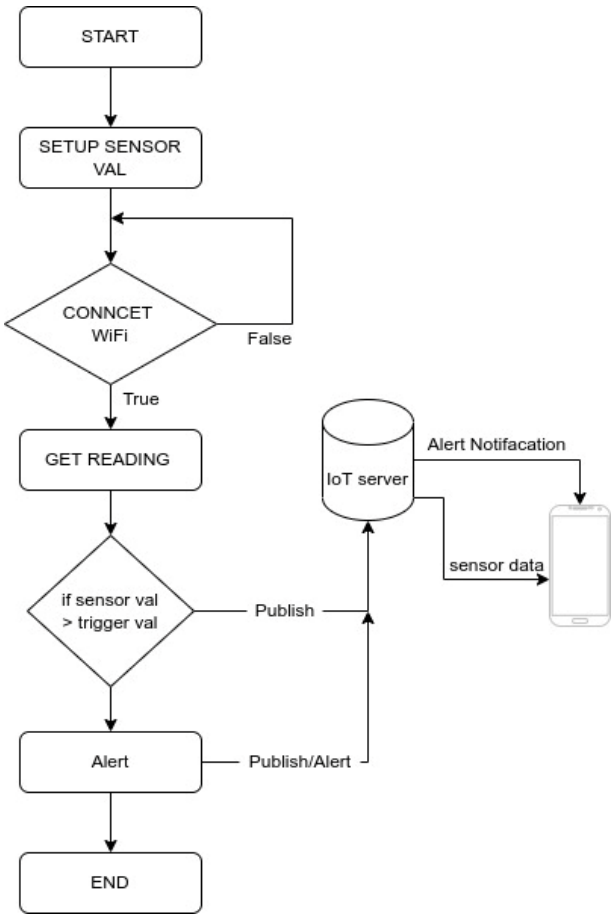
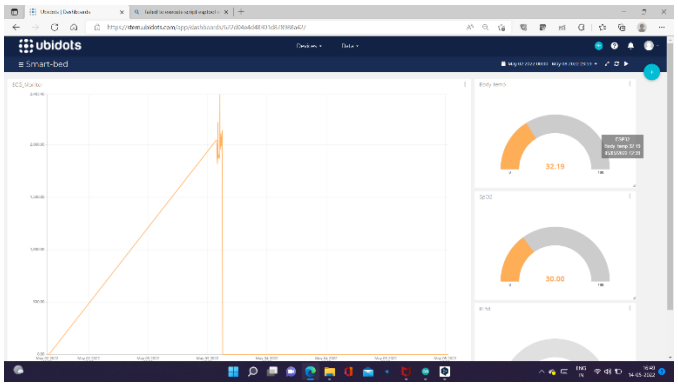
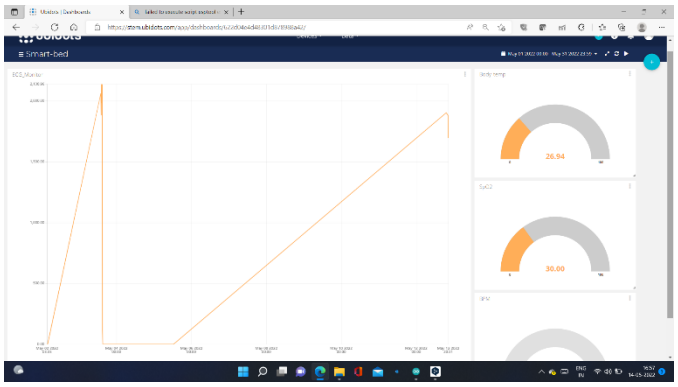


Figure 6: Flow Chart

Output:





Conclusion:

Keeping in mind the COVID-19 Pandemic we have developed a device that is a health monitoring system based on concept of IoT with implementation of it on ESP32 with sensors. It follows the basic IoT MQTT protocol for alert messaging purpose and it is an application of remote health monitoring. It helps for better diagnosis of the patients with immediate need assistance. This system helps to monitor health of people who cannot be admitted due to the scarcity of Hospital beds. Hence Primary health checkups are also made easy. Patients' history is saved on the web-app hence it benefits the ongoing monitoring. As it uses IT for the assessment, human errors are reduced hence giving a better performance.

Acknowledgement:

We would like to express our gratitude towards our college, "*Progressive Education Society's Modern College of Engineering"* and our college staff for constantly providing inputs and help whenever necessary. Our project guide and our project Co-Ordinator have been an immense support for our cause and project, providing us with much needed inputs and constant help whenever required. We would also like to thank all the professors around us for shaping our minds and setting our vision, all the teachers and professors who were working in the background to provide us the knowledge required to execute this project. We would also like to thank all our classmates for helping us giving valuable feedback, the college support staffs for providing us with all the required resources. We express our sincere gratitude for various industry experts who constantly checked our progress and provided us with suitable suggestions and changes. Lastly, we would like to appreciate the constant support of our friends and family.

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