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# Remote Monitoring System through IoT and WSN for Congestion Free Access

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***Abstract:*** ***Many times, due to carelessness of nurses, huge number of patients and inattentiveness of hospital staff, some of the patients go unmonitored, that could lead to pretty serious situation. The IoT is the network of objects embedded with electronics, wireless sensors and network connectivity that enables such objects to collect and exchange data. The IoT and WSN allow objects to be sensed, monitored and controlled remotely using networks. Smart healthcare plays really important role in healthcare applications using wireless sensors. In this paper we have used a system which includes combination of wireless sensor technology and IoT. Using this system one can easily monitor a number of patient data at the same time and cases of emergency can be reported and medication can be provided on time.***

***Keywords: Internet of Things (IoT), Wireless Sensor Network (WSN), MQTT, Pulse SpO2, Heart Rate, Temperature, Real time monitoring, Raspberry Pi, Wemos D1 mini.***

## I. INTRODUCTION

Internet of Things (IoT) is a perfect emerging technology that is influencing the internet and communication with congestion removing technologies . IoT works as an interrelated computing devices and digital machines system that are given unique identifiers (UIDs) and therefore the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction. Wireless Sensor Network (WSN) consists of many sensor nodes which are capable of Sensing, Computing and Providing Wireless Communication. Sensor nodes are deployed in a region of interest to be applied in many applications such as Smart Office Monitoring, Industry and other types of Monitoring Applications. This IoT architecture can be implemented with WSN in healthcare monitoring system to constantly monitor the vitals of multiple patients in real time over a wireless local network such as Wifi.

Currently, these vitals such as heart rate, body temperature and blood oxygen saturation levels are measured at random long intervals of time manually by a nurse or any other medical personnel around the patient. This current implementation has two main boundaries.

Firstly, the involvement of a human in order to manually monitor the sensor readings and to record them in the patient's records and secondly, these readings taken by the nurse are at predetermined times and any fluctuations in these vitals in between those readings goes unnoticed. This can be a considerable issue in certain medical conditions where these vitals should be closely monitored.

This paper aims at solving this issue by automating this process of monitoring and recording these vitals of a patient.

*Key features of this system are:*

- Non intrusive and painless sensing of heart rate, body temperature and blood oxygen levels of a patient through hand worn wireless sensor devices.
- Interactive centralised web page as the front end of the system showing these vitals of all the patients being monitored on a well designed graphical user interface.
- It's easy expandability allows adding or removing multiple patients to the system without too much hassle.
- The vitals of the patients are also recorded on a database with timestamps for further analysis and reference use.
- Ward wise or room wise grouping arrangement of patients on the interface allows easy understanding and manipulation.
- Alert system in case vitals of the patient fluctuate above or below certain values. These values can be preset into the system for every individual patient.

## II. BLOCK DIAGRAM

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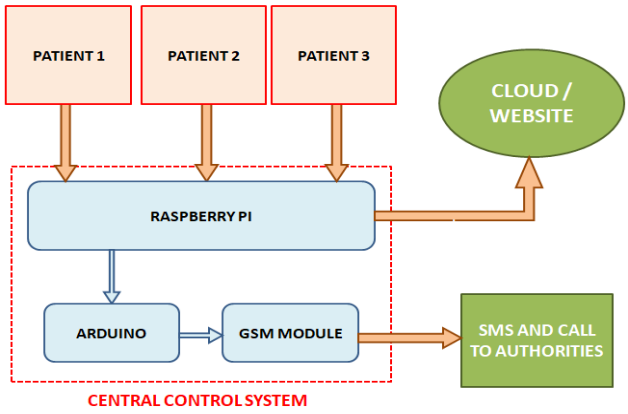
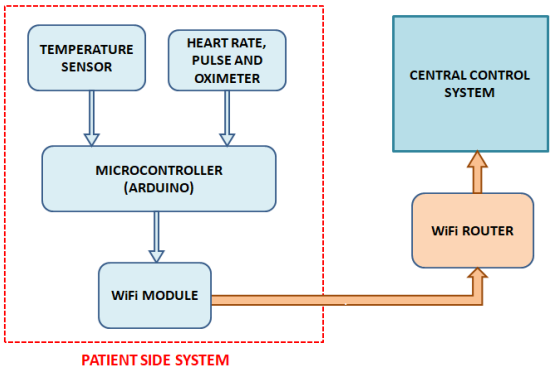



## III. HOW IT WORKS.

The system comprises of two main subsystems, the patient side subsystem also known as the patient node and the central subsystem.

*Patient Side Subsystem or Node:*

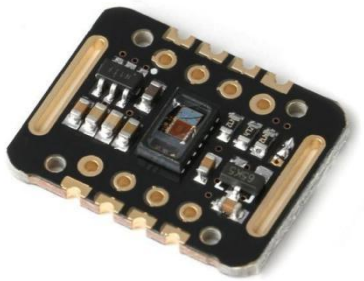
- This subsystem is in the form of a portable wearable device consisting of a MAX30102 heart rate and pulse oximeter module, an LM35 temperature sensor and a Wemos D1 mini Wifi board.
- The wireless sensor records the patient data and sends them to the Wifi board. This wifi board then sends this acquired data over wifi to the central subsystem along with the unique patient id on the specified topic through MQTT protocol.
- There can be as many nodes as there is the number of patients to be monitored and each will have its unique id.

*Central Subsystem:*

- The central subsystem consists of only a Raspberry Pi as the main computing board.
- Raspberry pi runs the Mosquito MQTT Broker on it. This broker acts as the Mqtt server and handles all the data coming from the patient nodes.
- The Pi also hosts a local web page which is designed to display the incoming MQTT data graphically in the form of charts and graphs. The page is sectionally divided into groups based on rooms or ward numbers for easy understanding.
- The Pi also manages and maintains a local database which stores the vitals of all the patients systematically with included timestamps for future analysis and reference.
- In case of emergency (rapidly fluctuating vitals) it sends message and audio notifications indicating the same.

## IV. HARDWARE COMPONENTS

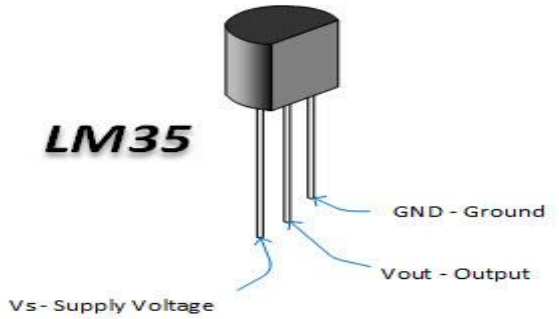
### *A. MAX30102 module:*




The MAX30102 works as an integrated pulse oximetry and also as a heart-rate monitor biosensor module. It has internal LEDs, photodetectors, optical elements, and low-noise electronics with ambient light rejection. The MAX30102 provides an entire system solution to ease the design-in process for mobile and wearable devices. The MAX30102 operates on one 1.8V power supply and a separate 3.3V power supply for the interior LEDs. Communication is through a standard I2C-compatible interface. The module are often pack up through software with zero standby current, allowing the facility rails to stay powered in the least times. This simple test doesn't require a blood sample and is named non-invasive. This sensor is used in making Pulse oximetry, that majorly is a test used to measure what proportion of the oxygen-carrying molecules within the blood (called haemoglobin) are literally carrying oxygen. This is known as oxygen saturation or SpO2. A pulse oximeter may be a medical device that obliquely measures the oxygen saturation of a patient's blood (as against measuring oxygen saturation directly through a blood sample) and changes in blood volume within the skin, producing a photoplethysmograph.

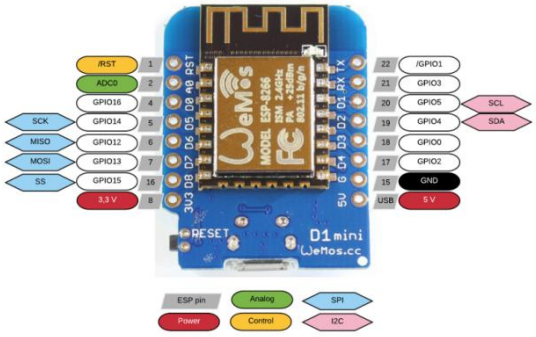
It is often attached to a medical monitor so staff can see a patient's oxygenation in the least times. Portable battery-operated pulse oximeters also are available for home blood-oxygen monitoring. Oxygen saturation is that the fraction of oxygen-saturated haemoglobin relative to total haemoglobin (unsaturated + saturated) within the blood. The physical body requires and regulates a really precise and specific balance of oxygen within the blood. Normal blood oxygen saturation levels in humans are 95–100 percent. If the extent is below 90 percent, it's considered low and called hypoxemia. Arterial blood oxygen levels below 80 percent may compromise organ function, like the brain and heart, and will be promptly addressed. Continued low oxygen levels may cause respiratory or asystole.

*B. LM35 Temperature Sensor:*



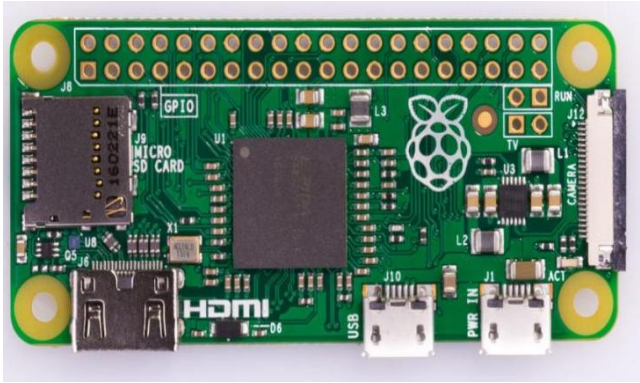

The LM35 Temperature Sensor can measure temperature more correctly compared with a thermistor. This sensor generates a high output voltage than thermocouples and should not need that the output voltage is amplified. The LM35 has an output voltage that's proportional to the Celsius temperature. The LM35 is one quite commonly used temperature sensor which will be wont to measure temperature with an electrical o/p comparative to the temperature (in °C).

*C. Wemos D1 Mini:*




The Wemos D1 is an ESP8266 Wifi based board that uses the Arduino layout with an operating voltage of three .3V. The reason for choosing Wemos is being the size and the cost of the microcontroller. Even in its small form factor, it provides enough computational power and wifi capabilities at reasonably cheap prices. This board also acts as the Mqtt client and connects to the server over wifi using Mqtt protocol. The temperature sensor LM35 connects to this board on its analog input pin whereas the MAX30102 module connects to this board via an I2C connection.

*D. Raspberry Pi Zero W:*




The Raspberry Pi Zero W is a single-board computer with a dedicated processor, RAM, ROM, storage, inputs and outputs. They are also known as credit card sized computers. Just like our home desktops and personal computers, they also have an operating system of their own. With a size of 65mm by 30mm, the Pi Zero has a 1GHz BCM2835 single-core processor with 512MB RAM, wireless LAN, Bluetooth and an unpopulated 40-pin GPIO. The Raspberry Pi Zero W is a suitable choice for creating embedded Internet of Things (IoT) projects.

Here, the Raspberry pi is used as a server to our system. It runs a MQTT broker; it hosts a local web page and maintains a local time based database of all the incoming data.

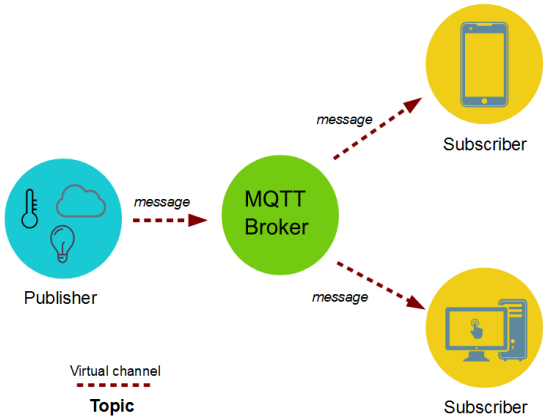
## V. THE MQTT PROTOCOL

MQTT also known as the Message Queuing Telemetry Transport is one among the most commonly and widely used protocols in IoT projects. It's designed as a very light messaging protocol that uses publish/subscribe services to exchange data between clients and the server. Its small size, low power usage, minimized data packets and simple implementation make the protocol ideal of the "M2M" or "Internet of Things" applications. Like many other protocols used over internet, MQTT is also based on clients and a server.

MQTT has 5 main components, which are as follows:

- Broker, also known as the MQTT server, is a tool that manages all the messages being sent to or from devices.

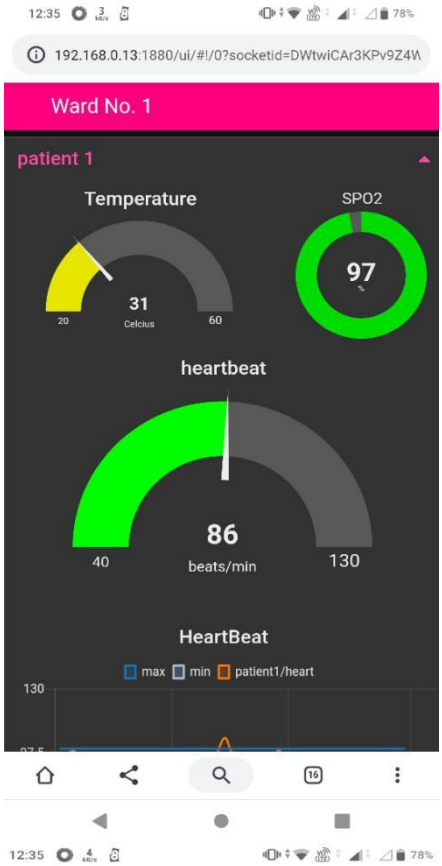
- A topic, which is a series of string, can be thought of as a place where clients can send their messages or can receive them.
- The message, it is the complete frame of data being sent to or from clients. It contains the payload which is the actual useful data along with message id, topic and quality of service.
- Publish is a service through which a client can send a message on a particular topic.
- Subscribe is a service through which a client can retrieve any messages which are send to any particular topic.

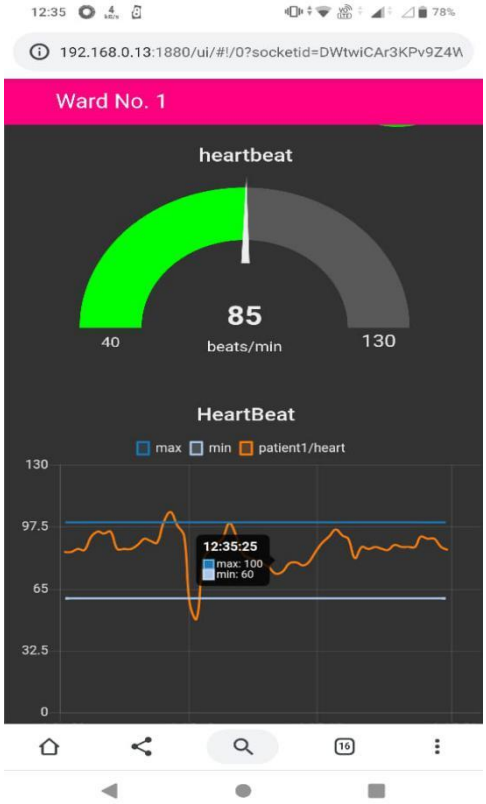



## VI. RESULT


As a result of this system we were able to design the web interface for the monitoring and display of patient vitals in real time. The above screen shows the demo user interface for 3 patients only. The readings shown in the above image are only dummy readings and are not real. Same interfaces can be readily replicated for as much number of patients as required. Due to cost constraints we only could implement one properly functioning node measuring the actual vitals of the patient.

The real reading of the vitals of that node displayed on one section of the user interface which is opened on a Smartphone is shown in the images below.




## VII. CONCLUSION

Our project currently, works for patient monitoring using IoT and WSN. But with further advance in Technology, it can be joined with hospitals and medical facilities for emergency services.

This project can be extended for use by hospitals to monitor people in hard to reach areas for providing uninterrupted medical services. It is cost effective setup and is also accurate and efficient. The future operation of this project can be to store each patient data and easily checking their health with respect to their medical history and proper medication could be provided with respect to it. The only constraint we might face in the project is network connection with raspberry pi. The working prototype can successfully monitor few patients and display their real time health parameters on the screen, and if any anomaly is detected alarm for the patient can be raised.

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