

## IOT BASED ICU PATIENT MONITORING SYSTEM

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**Abstract** - ICU patients are under critical condition so most care should be taken of such patients. For such critical conditions the doctors need to have an all-time update about patient's health related parameters like their blood pressure, heart rate etc.. It becomes literally impossible for doctor to look after each and every patient's status at one time, so for this type of situations we have created an IOT based ICU patient monitoring system which can keep the doctors updated about the patients status using internet on a single screen/monitor.

Our IOT based ICU patient monitoring system is using a Raspberry Pi system which transmits the patient's information to the monitor with the help of few sensors. An inbuilt Wi-Fi module present in raspberry pi is used to communicate this information to the internet. The Blood pressure and heart beat module is electrically connected to the system and physically to be worn by the user. It will check the patients' systolic and diastolic blood pressure and heart rate and will send it to the controller. The Temperature sensor senses the temperature of its ambience and gives the update to the monitor. Thus, the doctor can get access to the patient health status based on some specified parameters over the IOT Gecko web interface using internet. In this way IOT based ICU patient monitoring system is proved to be an enhanced system that helps in monitoring ICU patients without any manual intervention. The use of internet to monitor patients' health status reduces the time required per patient for the doctor which can be used to save more lives on time.

**Key Words:** Raspberry Pi, IOT Gecko, and Blood Pressure and Heart Beat module, Temperature sensor

### 1. INTRODUCTION

The Internet of Things (IoT) is of a global interest over a couple of decades. However, the healthcare industry has just begun to understand the potential and benefits that can be offered through the creation of the new and more advanced type of healthcare systems and services.

For all the intents and purposes, Internet of Things in healthcare has begun to make its path and employed as a practice among patients changing the way patient care was defined in previous decades.

The patients who are admitted in the ICU require critical medical care. Any small changes in their health can also cause major damage or else it can cost their life. So right from the patients' blood pressure to the ambience temperature it should be monitored frequently.

If we try to understand the average time patient spend into ICU the patients have become older by 4.4 months/year. Till 2013

the median age was 66 and 15% of the patients are now  $\geq 80$  years since 1993 there is an increase of 36% [1].

The average heartbeat/min for 25 year old ranges from 140-170 bpm while for a 60-year old it ranges between 115-140 bpm and the body temperature is 37degree Celsius or 98.6 Fahrenheit [2].

There are a number of instruments available in market to check the status of patient's internal body changes. But there are many limits to such instruments considering their maintenance part, high costs, also the size of instruments and mobility of patients.

Rather than having such instruments it is better to use the biomedical sensors all integrated on a single chip. All the real time data of the patient using the sensors would be available on the screen. Which in turn would ease the doctors work, also the ratio of time spend by doctors per patient would decrease which can lead to curing and saving lives of more number of patients.

### 2. LITERATURE SURVEY

Earlier in hospitals the patients were monitored by systems which caused lot of problems to analyze the data from the patient's status. While nowadays, with the advancements in technology, these devices use wireless communication to monitor patient remotely. In addition, new wearable monitoring devices, equipped with the Internet of Things (IoT) technology, are able to communicate with certain devices transferring crucial data through user friendly applications. The current pandemic and the pressure put on hospitals and medical professionals has also helped this topic into more popularity. At UC San Diego Health, patients who are tested positive for the virus but aren't required to be hospitalized were sent home to recover, with the care team members constantly checking the status of patients it became easy to understand for whom additional care would be a necessity [3].

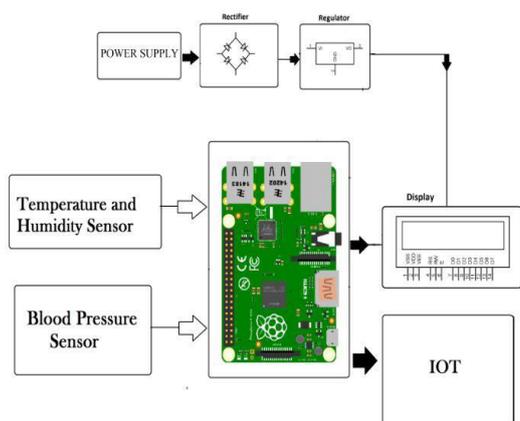
The entire healthcare industry is to undergo a transformation as a result of technology advances and healthcare concerns due to the recent pandemic, which is the COVID-19 disease that has forced hundreds of millions of people worldwide to change their view in terms of how they obtain healthcare services. We see substantial growth in the healthcare industry largely propelled by IoT technology and applications deployed in a service for health status monitoring, wellness, and absolute care. Additional healthcare include high-speed connectivity, embedded sensor solutions, and wearable applications wherein these technologies are anticipated to transform the entire healthcare ecosystem, leading to an improved remote healthcare services along with maximizing patient outreach and minimizing healthcare costs. There is great rise to increase efficiency and effectiveness in treatment, cost reduction, and improving the overall standards for patient care [4].

Internet of Things (IoT) and cloud computing plays an important role in today's remote-monitoring health system. The system keeps track of patient's physiological parameters through collection of data from body sensors' using Raspberry Pi board. The patient's health ID's are created by the doctors and displayed on a webpage of respective site where doctors and patients can access and communicate each other without physical presence [5].

Internet of Things (IoT) based Smart healthcare with the help of smart devices and objects improves the healthcare monitoring system effectively, thus by reducing the inadequacy of existing healthcare system. As new and upgraded technologies comes into existence it's also the reason for more data accuracy. Real-time accessibility of patient's status, maintaining the patients' data smartly through cloud service, or any other app on a webpage [6].

IoT along with smart devices increases simplicity and accuracy in the healthcare system. The use of mobile technologies and smart devices on healthcare system is causing huge impact on the world. Apart from regular monitoring of patients conditions the main aim is show the importance of healthy eating habits and effective workout routines for improving their quality of life [7].

### 3. METHODOLOGY



**Fig -1:** Communication between components in IOT based ICU patient monitoring system

The IOT based ICU patient monitoring system consists of the above components as shown in the Fig.1. The power supply required for the circuit is of 12V which is given using a power adapter. The bridge rectifier helps in rectifying the AC input current to DC output current. Further the LM2576 IC help in stepping down the voltage. It is then followed by 2 electrolytic capacitors connected in parallel as a decoupling capacitors. A drum inductor and a resistor of 330 ohm are connected for the LED also called as the LED limiters. DHT11 is the temperature and humidity sensor that is used to sense the ambience temperature. The Blood pressure and heart rate module then measure the patient's blood pressure and heart rate. Both the output of these module are collected and fed to the raspberry pi wherein these data is then sent to the monitor/screen using Wi-Fi module which is also seen on the LCD screen. Thus the status of the patients is available on the screen and the doctors will be able to monitor this data.

### 3.1 TEMPERATURE AND HUMIDITY SENSOR

DHT11 sensor is a commonly used temperature and humidity sensor. This sensor comes with a dedicated negative temperature coefficient to measure temperature and 8 bit microcontroller to send the values of temperature and humidity in serial data. Using a capacitive humidity sensor and a thermistor it is used to measure the surrounding air, and spits out a digital signal on the data pin (no analog input pins needed). The DHT11 sensor used comes in a single row 4-pin package and operates at 3.5 to 5.5V supply. It measures temperature from 0-50 °C with an accuracy of  $\pm 2^{\circ}\text{C}$  and humidity ranging from 20 to 95% with an accuracy of  $\pm 5\%$ . It also has its own proprietary 1-wire protocol. The communication of the sensor and microcontroller isn't possible using direct interface with any of its peripherals.

### 3.2 BLOOD PRESSURE AND HEART RATE MODULE

The working voltage is +5V, 200mA. It has a switching button which starts measuring the blood pressure and heart rate Blood Pressure & Heart rate readings are shown on display. Shows Systolic, Diastolic and Pulse Readings. It has a compact design which fits over the wrist like a watch. Because of the easy to use wrist style it eliminates pumping.. It also has a 60 store groups' memory measurements and can read single or all measures.

### 3.3 RASPBERRY PI 3 MODEL B+

The Raspberry Pi 3 model B + is a low cost, small sized computer which we have used for communication between monitor and the peripherals used in the system. It also has an inbuilt Wi-Fi module used for wireless communication. In this system we have used a laptop so no requirement of any separate keyboard. The Pi is powered by using a USB power supply just like most mobile phone chargers. A good-quality power supply is required that can supply at least 2A at 5V for the Model 3B+. A SD card slot is also available on the raspberry pi and we have used a 16 GB SD card for memory purpose.

### 4. RESULTS

Thus we have achieved the patient's status using biomedical sensors and with the help of IOT based system the data is made available to the doctors. The results are displayed in the table format with respect to their blood pressure, heart rate and the ambience temperature in the following Table-1 given below. The systolic blood pressure is also called as Low BP and for diastolic it is also called as High BP. By inspecting and analyzing the data of the patients the doctors can take the necessary action required.

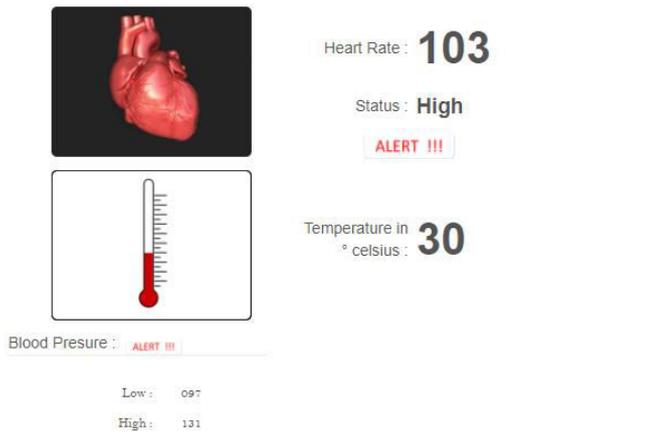


Fig -2: Status of patient such as Heart Rate, Low B.P., High B.P. and ambient temperature

Table -1: Integrated data of patient

ID	Heart Rate (bpm)	Temperature in degree Celsius (°C)	Low Blood Pressure (mmHg)	High Blood Pressure (mmHg)
1	103	30	97	131
2	110	31	123	139
3	94	24	112	132
4	99	34	106	139

5. CONCLUSIONS

As rise in the interaction of Internet of Things also, more during this Covid Crisis has led to a movement in the use of internet in every way. Especially in medical purposes with maintaining distance and observing patient through machines using internet, also a way of IOT. There are limitless ideas for improvising the healthcare industry using IOT as a part of it. The main factor would be reduction in cost from both the side. Increasing the accuracy level, having a better quality healthcare. When we get into understanding of IOT we get to know that there is a lot more of research to be done and yet to be applied in the healthcare industry for information accessibility and analysis. IOT in healthcare is predicted to bloom and overcome its challenges to revolutionize the traditional healthcare models for a longer period.

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