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IOT Based Remote Health Monitoring System for Discharged Patients

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Abstract: In this automated world, biomedical field is not superior.But the rapid advancements in engineering have proven their importance in the biomedical field.Rapid development of technologies such as the Internet and Internet of Things has brought improvements in healthcare. IoT-based health monitoring system has been widely studied and developed in recent years, as they can improve the quality and accessibility of health care services, especially for patients with chronic diseases or in rural areas.The existing IoT-based health monitoring systems have some similarities and differences in terms of their hardware and software components,features, performance, etc. All the systems use sensors to measure the vital signs of patients but they use different types and models of sensors with different specifications and accuracy. This paper presents multiple improvements to the current approach by introducing a system that provides remote and continuous monitoring of patients' health status and enables early detection and intervention of potential health problems. This system utilizes Arduino nano and Wemos D1 Mini, two popular microcontrollers, collect data from various sensors attached to the patient's body and transmit it wirelessly to a central monitoring station. Moreover, the cost of this system is substantially reduced as compared to previous systems.
Keywords: IOT, API Key,Pulse Oximeter,Temperature,Wemos D1 mini,Arduino nano

I. INTRODUCTION

The remote health center is an extension of the medical center that can take care of the important physical aspects of the patients. Traditionally, diagnoses are only available in hospitals and are characterized by large and complex electrical circuits that require a lot of electricity. Continuous advances in semiconductor technology have made sensors and microcontrollers smaller, faster, less power efficient and cheaper. This also encourages the development of remote monitoring of patients' vital signs, especially the elderly. Remote healthcare can be used in the following situations:

1) The patient knows that there is a disorder in which the body's control system is unstable. This is when a new drug is given to the patient.
2) The patient may have had a heart attack or may have had a heart attack in the past. Vital signs can be monitored to anticipate and warn of any signs of the body's condition.
3) Significant physical conditions
4) Life-threatening conditions. This is for older people and may not be good.

Many systems have emerged recently to solve the problem of remote healthcare.

The system has a wireless sensing system that wirelessly transmits sensor data to a remote control. Some even use service models that require premium payment. In developing countries this is a hindrance because some people cannot use it due to the cost involved 2. Some machines still have internet connection problems and a good internet connection is required for real-time connections. Internet access is still a problem in developing countries.

Many systems have been introduced in developing countries that perform well. In general, these systems are suitable for developing countries. To mitigate some of these problems, remote sensing must be designed from the ground up to fit the minimum requirements currently available in developing countries. A simple patient care design can be made with as many things as it can capture. Sometimes, multiple readings can be calculated from a single measurement.

For simplicity, the measurement is as follows:

a) *Single Measurement:* Here, a single measurement, such as an electrocardiogram (ECG) reading, is tracked. Depending on the algorithm used, multiple readings may be taken from an ECG or heart rate monitor. ECG readings can be made on heart rate and oxygen saturation.

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b) *Multi-parameter Monitoring System:* Monitor multiple parameters. An example of this system can be seen in the intensive care unit (ICU), during surgery in the hospital, or in post-operative recovery in the hospital. Many tests include ECG, blood pressure, and breathing. Monitoring of various vital parameters proves the patient is still alive or recovering

II. RELATED WORK

Many researchers have proposed a lot of different models for IOT in the Healthcare field for the detection of various diseases. This part focuses on work done in the same area.

Mohd. Hamim[1] It suggests a prototype of an IoT Based Remote Health Monitoring System for Patients. This prototype consists of three sensors, heart pulse sensor, body temperature sensor and galvanic skin response sensor. All these sensors are merged together into a single system with Arduino Uno and Raspberry Pi combined together. The data acquired from the sensors is transferred to a cloud storage via the Raspberry Pi. The cloud storage is continuously being updated in a real time database.An Android Application was developed using Android Studio which could access the database and show a graphical representation of the health parameters.

Hoe Tung Yew[2] This paper proposes an Internet of Things (IoT) based real-time remote patient monitoring system that is able to generate real-time electrocardiogram (ECG). Message Queuing Telemetry Transport (MQTT) protocol is used for transmitting the real-time ECG from the proposed system to the webserver. The data can be accessed by the web server via smartphone or computer to monitor the real-time or previously recorded ECG data.

III. METHODOLOGY

Our proposed solution is divided into three basic parts 1. Sensor Modules 2. Microcontroller and Wi-Fi Module 3. IoT Server

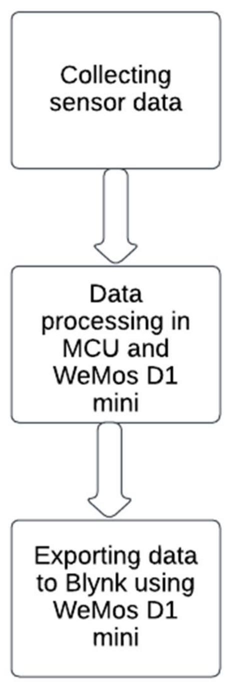

Fig 1. Methodology flow chart

A. *Collecting Sensor Data*

This module comprises the hardware components of the system that makes it IoT enabled and is used to record the health parameters of the patient using various sensors such as Pulse rate sensor, Temperature Sensor, ECG sensor, Oxygen saturation sensor. These generate some raw values when checking vitals which are to analyzed in next stage.

Sensors draw power from MCU units only.

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B. Data Processing in MCU and Wemos D1 mini

The data generated by the sensors is raw and is of no use if not properly analyzed and made meaningful sense out of it.
We calibrate the sensors by viewing sensor output for accuracy.The analog output is given by sensors to the microcontroller , which is then analyzed and results are displayed on the local LCD used. And further the datastream is given to WeMos D1 mini for exporting on the Internet.

C. Exporting data to Blynk using WeMos D1 mini

For remote viewing the data is then given to WeMos D1 mini, The D1 Mini is incredibly versatile because it is inexpensive, Wi-Fi-enabled, The D1 Mini has an ESP8266 at its core, which means that it can do many of the things an Arduino board can do. The Wi-Fi communication enables the D1 Mini to act as a local server and send data to the Blynk app.

IV. IMPLEMENTATION

In this paper, we have proposed a wearable system in which a patient's body temperature, heart rate, oxygen saturation and ECG reading are being monitored by the system. The various sensors are placed on the patient’s body and they take the readings and send the corresponding signal to the arduino nano. Here, various sensors are used to measure the patient’s body temperature, heart rate, Blood oxygen saturation, ECG and their respective results are sent to the database via WemosD1 mini and can be monitored from anywhere worldwide through the internet.

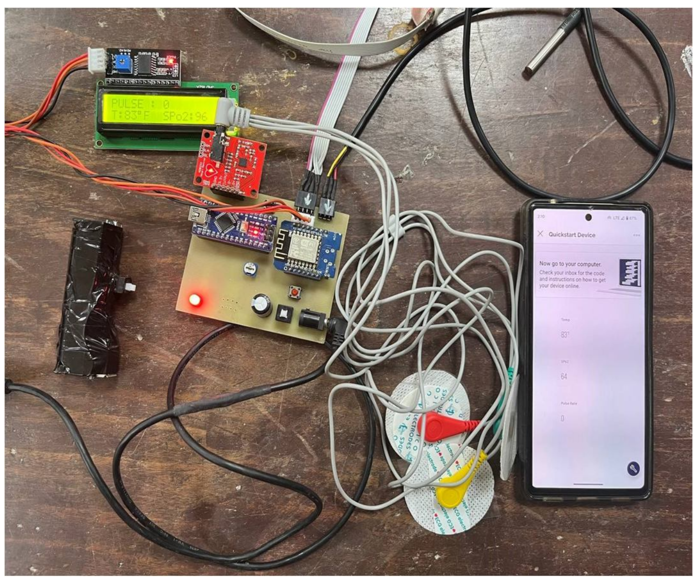

Fig 2. Experimental Setup

The various Components to be used in system are-

A. Arduino Nano

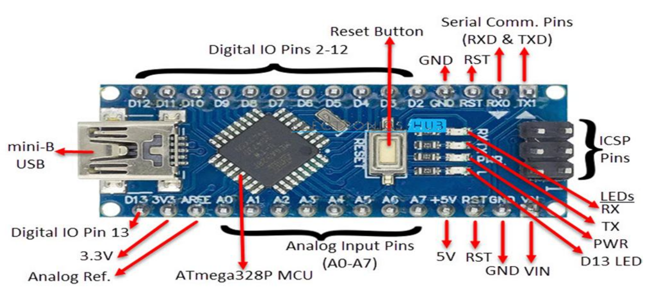

FIG 3. Arduino nano

Arduino Nano is a small, complete, and breadboard-friendly board based on the ATmega328P microcontroller.The board has an operating voltage of 5 V, an input voltage range of 5 to 20 V, a clock speed of 16 MHz, a flash memory of 32 KB, an SRAM of 2 KB, and an EEPROM of 1 KB.The Arduino Nano can be programmed using the Arduino Software integrated development environment (IDE), which is common to all Arduino boards and running both online and offline. The board can be powered through a type-B mini-USB cable or from a 9 V battery.

B. WeMos D1 mini

Fig 4. WeMos D1 mini

Wemos D1 Mini is a small and low-cost WiFi board based on the ESP8266 chip, released by Lolin in 2015. It is compatible with Arduino, MicroPython, and NodeMCU. The Wemos D1 Mini has 11 digital I/O pins, 1 analog input pin, a mini-USB port, and an I2C port. The board can be powered by a 5V USB adapter or a 12V power supply.
The Wemos D1 Mini has an on-board switching power supply that regulates the input voltage to 3.3V for the ESP8266 chip. The ESP8266 chip provides WiFi connectivity and supports various protocols such as TCP/IP, UDP, HTTP, MQTT, etc. The ESP8266 chip also has a flash memory of 4 MB and a clock speed of 80/160 MHz.

C. Temperature Sensor

Fig 5. DS18 Temperature Sensor

The Temperature Sensor (DS18B) is a one-wire digital temperature sensor that can measure temperature from -55°C to +125°C with an accuracy of ±0.5°C12. It can be powered by an external power supply or by the data line (called "parasite mode")1. It has a unique 64-bit serial code that allows multiple sensors to share the same data line12. It can communicate with an Arduino board using the One Wire library and the Dallas Temperature library1. It has a programmable output resolution from 9-bit to 12-bit and a conversion time of 750 ms at 12-bit2. It is available in different packages, including a waterproof version.

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D. MAX 30102 Pulse Sensor

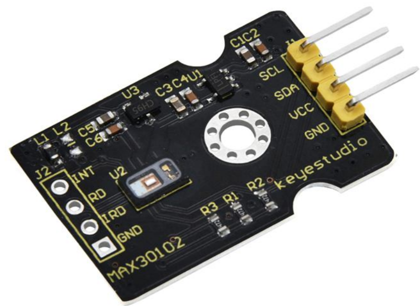

Fig 6. MAX30102

Pulse Sensor (MAX30102) is a device that can measure the pulse oximetry and heart rate of a human subject. Pulse oximetry is the measurement of oxygen saturation in the blood, which indicates the health of the respiratory system. Heart rate is the measurement of the number of heartbeats per minute, which indicates the health of the cardiovascular system.Pulse Sensor (MAX30102) consists of a module that contains internal LEDs, photodetectors, optical elements, and low-noise electronics with ambient light rejectionThe module uses two LEDs, one red and one infrared, to emit light of different wavelengths into the tissue. The photodetector receives the reflected light and converts it into an electrical signal. The signal is then processed by the low-noise electronics to filter out the ambient light and noise. The signal is then sent to a microcontroller unit via an I2C interface.

E. ECG Sensor

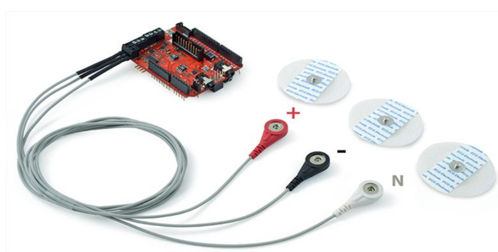

Fig 7.AD8232 ECG Sensor

The AD8232 is an integrated signal conditioning block for ECG and other bio-potential measurement uses. It is designed to sense, amplify, and filter small bio-potential signals in the presence of noisy conditions, such as those created by motion or remote electrode placement. This design allows for an ultralow-power analog-to-digital converter (ADC) or an embedded microcontroller to retrieve the output signal easily.

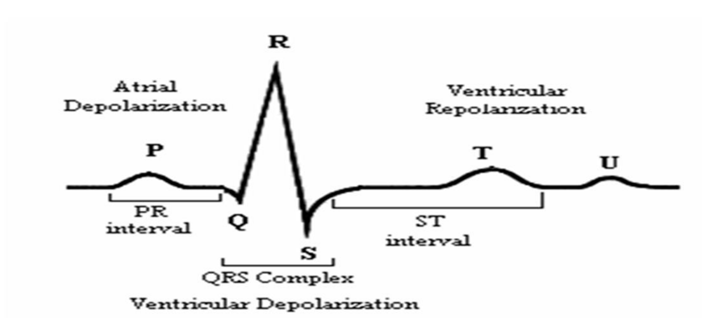

Fig 8.Heart Pulse waveform

V. RESULT AND DISCUSSION

The planned system is implemented and real-time information of patients is provided through the Blynk cloud channel. When the equipment is connected to patients, doctors of participating hospitals can monitor and diagnose the patient. The previous information of the patient is kept in the database; It helps doctors to treat patients properly. The system sends the data in real time to the cloud channel at a specific time. As our

System is a prototype, it shows various health conditions in near real time and simulates how these measures would be used in the real world.

Doctors may also use the motor of the patient's body to study and determine the effect of drugs or the like.

A. Readings on Blynk Android App

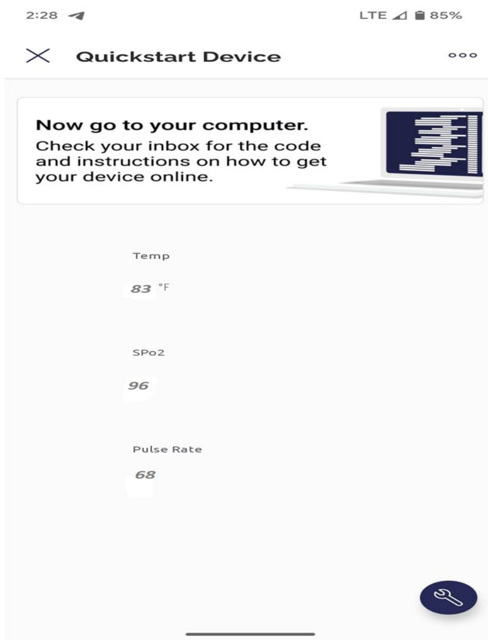

Fig 9. Blynk App

B. Readings on Blynk Web Portal

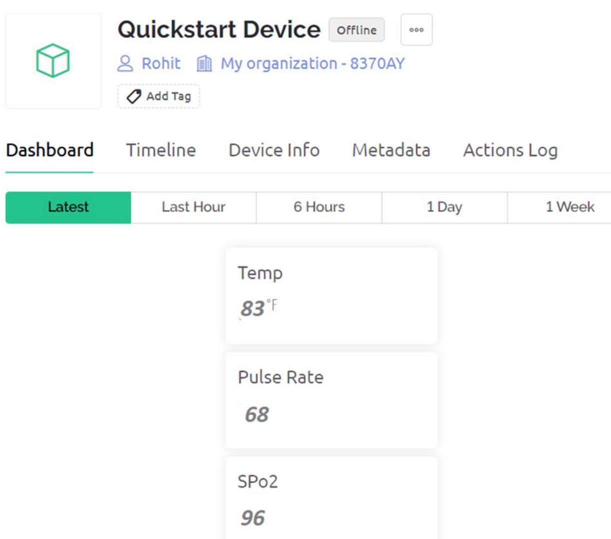

Fig 10. Blynk Web Portal

To get readings on the App we use API keys and Authentication tokens in the code uploaded on WeMos D1 generated by blynk web portal during initial set up

```
#define BLYNK_TEMPLATE_ID "TMPL3DFfbRcHB"
#define BLYNK_TEMPLATE_NAME "Quickstart Template"
#define BLYNK_AUTH_TOKEN "gc_U68yPZ7GilyMtWaz9q8lO3vLVbxbb"
```

Fig 11. Blynk generated Authentication token

C. Calculation of BPM from ECG graph

Fig 12. ECG graph

Speed of ECG graph paper is 25mm/s.

Distance traced in 10 seconds = 25x10= 250mm.250 SMALL squares = 50 LARGE squares = 10 seconds.No of R peaks in an interval of 10 seconds when multiplied by 6 , gives total R peaks in 60 seconds.9 R peaks in the interval of 10 seconds, gives 9x6 =54 peaks in 60 seconds. Hence BPM=54.

VI. CONCLUSION AND FUTURE SCOPE

In this paper, we presented our system IoT based health monitoring system using Arduino Uno and Wemos D1 mini, which aimed to measure and transmit the vital signs of patients, such as body temperature, heart rate,Spo2, to the cloud for analysis and alerting.It presents an efficient and scalable solution for healthcare providers to remotely monitor and track patients' vital signs. By leveraging IoT technology, real-time data transmission, and cloud-based analysis, the system enhances patient care, enables proactive interventions, and reduces healthcare costs. With further advancements and integration with other healthcare technologies, this system has the potential to revolutionize remote patient monitoring and improve healthcare outcomes. We described the hardware and software components of our project, such as the sensors, microcontrollers, communication modules, cloud platform, web application, and mobile application. We also presented and discussed the results of our project, such as the accuracy, reliability, efficiency, and usability of our system. We also discussed the limitations, challenges, and future work of our project, such as improving the security, scalability, interoperability, and functionality of our system. The main contributions and findings of our project were that we developed a low-cost, easy-to-use, and effective IoT based health monitoring system that can improve the quality and accessibility of health care services, especially for patients with chronic diseases or in rural areas. We also demonstrated the potential and benefits of using IoT technologies in health care applications.The project's scalability allows for future expansion and integration with other healthcare technologies, making it a valuable tool in modern healthcare settings.

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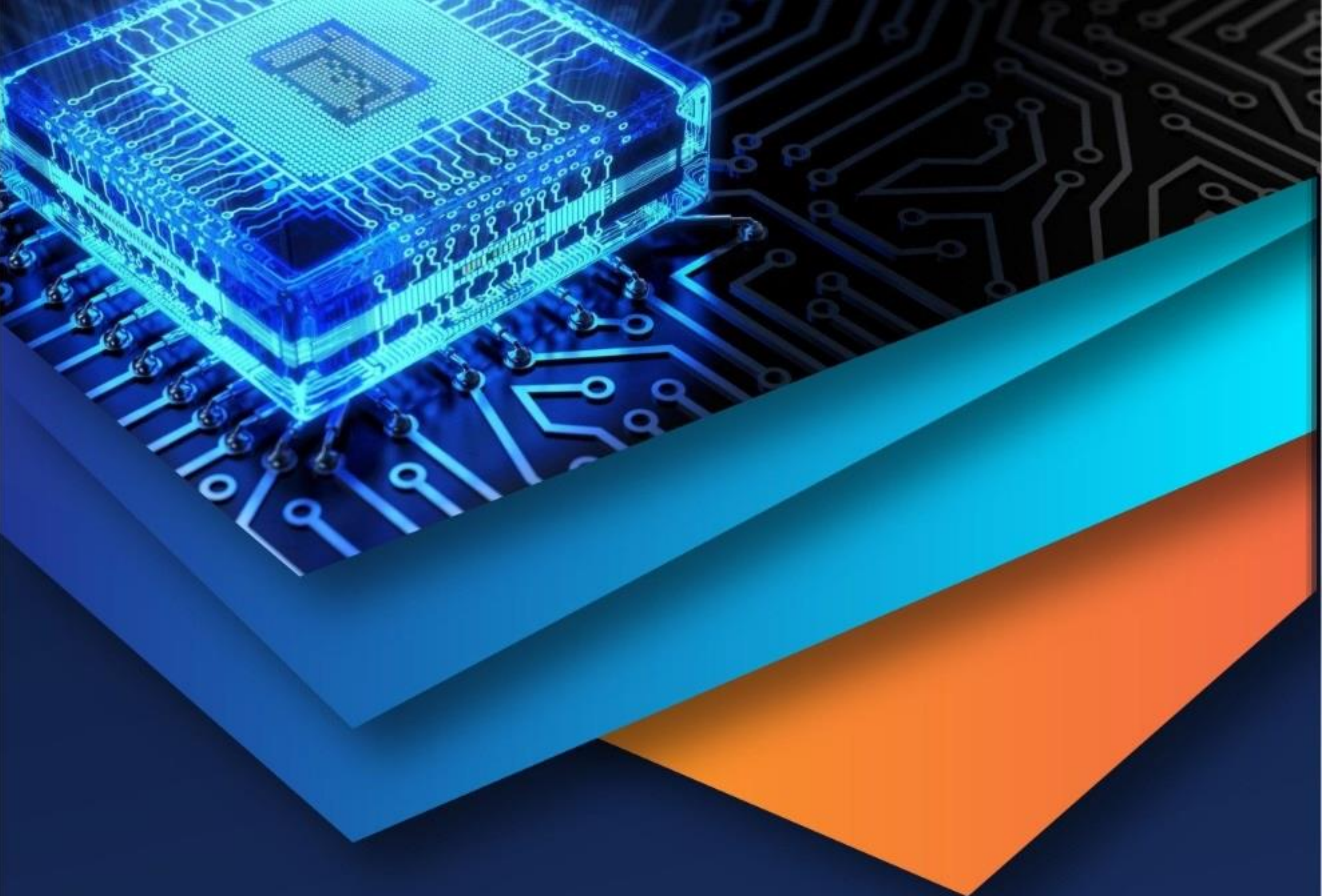

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