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Design And Development Of Healthcare Monitoring System Using Iot

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Abstract-These days the Medical services sector has driven science and information such that it is influenced by innovations based on wireless-detecting nodes. Patients are going up against a risky condition of unexpected passing in view of the heart issues and attack which is an immediate aftereffect of the nonexistence of good clinical care to patients at the necessary time. Our designed system brings into play the sensors that allow the recognition of the pulse of an individual using the heartbeat detection whether or not the person is at home. The sensor is then interfaced with a microcontroller that licenses checking of pulse readings along with oxygen levels and directs them over the web. The individual may calibrate the upper limit and lower limit of a heartbeat. After the process is done, the framework begins verifying, and it updates about the patient's pulse and oxygen level status over the web utilizing the MQTT convention and cautions the specialists just as concerned clients. On the off chance that anytime the individual signs in for checking the system, in the same manner, it shows the live pulse of the patient. Along these lines, concerning may screen pulse rate along with oxygen level from anywhere and the client can be rescued without any delay.

Keywords: Heart rate monitoring, IoT, MQTT, Personal health care, Node MCU, Pulse Oximetry.

I. INTRODUCTION

A heart-rate monitoring and abnormality detection framework utilizing the concept of IoT is proposed in this paper. The treatment of most cardio-related diseases today needs ongoing and long-term surveillance systems [1]. In this respect, IoT [2] is very useful as it substitutes more effective systems for traditional monitoring systems and offers vital information about the patient's health status that can be conveniently obtained via the internet at any time. It is also useful for hospital-accessible nurses or duty doctors as they can quickly track the patient's heart rate on the serial-monitor via the real-time surveillance device. A warning system is included, in which the doctor receives an alarm message via a mobile application if the patient's pulse falls or rises above a certain figure. The prototype can also store the patient's pulse data and other information, and the doctor employs this information to assess the patient's heart-condition and for other possible objectives. In avoiding further complications in the future, early detection of the disease is very critical.

Both hardware and software components make up the proposed prototype. Node MCU, pulse sensor, and Oled monitor make up the hardware. The programmed consists of a smart phone application, along with an IoT platform. In the cloud, the signals obtained from wearable tracking nodes are present. To do this, a Wi-Fi module is commonly used. With the MQTT protocol, the IoT cloud is supplied. This represents the data and facilitates tracking in real-time as well [3]. The system is based on a compact, cost-efficiently built heart rate monitoring system. The prototype is also trouble-free to access and can also be employed by individuals of various age groups. The real-time details are displayed and preserved for future knowledge of the patient's heart-condition.

II. SYSTEM ANALYSIS

A. Pulse Oximeter

The MAX30100 is a coordinated heartbeat oximetry and pulse display screen sensor. Heartbeat oximetry is an intrusive and handy check that gauges your oxygen immersion degree or the oxygen ranges in your blood. It can quickly understand little modifications in how proficiently oxygen is conveyed to the bounds

of the heart, which include the legs and the arms. The pulse oximeter is a little, reduced like a device that appends to a frame part, just like toes or ear cartilage. It's maximum basically placed on a finger, and it's regularly applied in a simple attention setting like trauma facilities and emergency clinics. A few specialists, for example, pulmonologists, might also additionally put it to use with inside the office.
It consists of a pair of LEDs, a photo-detector and optimized-optics, together with low-noise processing of analog signals which detect pulse and heart-charge signals [4].
In the LED, The former emits red light, and the latter emits IR. For pulse rate, IR is needed.IR and red light are used to calculate blood oxygen ranges. This is the MAX30100's principal function: it reads and stores the absorption ranges in a buffer that may be examined via I2C for each mild source.

B. Oled

OLEDs are typically utilized in gadgets consisting of tv screens, pc monitors, and transportable structures consisting of smartphones, sport consoles, etc., to create virtual displays.

C. Node MCU/ESP8266 module

Node MCU which is an open-source LUA firmware designed specifically for the wireless local area network chip ESP8266. Node MCU code comes with ESP8266 Development Board / Kit. Since Node MCU is an open-supply platform, creating, editing, or changing its hardware design is open. The Node MCU DevKit / Board consist of a Wi-Fi enabled ESP8266 chip. The ESP8266 is an inexpensive TCP / IP-protocol Wi-Fi chip.

D. Lilypad-Arduino

A microcontroller designed for wearables and e-textiles is the LilyPad Arduino [7]. The cloth and similarly hooked-up energy, sensors, and actuators with conductive thread may be sewn to the LilyPad. The ATmega168V or ATmega328V is the basis of the board.

E. Arduino Nano R3:

One of the littlest but most energizing breadboard-accommodating boards accessible available today is the Arduino Nano. It's gotten extraordinarily main stream with learner software engineers because of its brilliant usefulness and the sheer variety of possible applications. In light of the ATmega328P, this device is incredible for individuals who wish to improve their programming aptitudes and make some fascinating and unordinary ventures. While the thing doesn't accompany a DC power pack, it profits by a small USB link for power, and that implies you can utilize it with any PC or PC gadget

III. METHODOLOGY

A. Measuring Blood Oxygen Saturation

The oximeter utilizes an electronic processor and several little light-transmitting diodes (LEDs) regulating the photodiode through a fingertip or ear ligament. One of the LEDs is red, which has a value of wavelength 660 nm, and the other one is IR and has a wavelength value of 940nm. Retention of light at these areas focuses essentially between blood stacked with and without oxygen.
Oxygenated-hemoglobin acclimatizes more IR light and allows more red lights to go through. Deoxygenated-hemoglobin allows more IR light to penetrate through and holds more red lights.

B. Measuring Pulse Rate

At the point when your heart pulsates, it siphons blood through your body. During every heartbeat, the blood gets pumped into vessels, whose volume increments marginally. Between pulses, the volume diminishes. This adjustment in volume influences the measure of light, for example, the measure of red or infrared light that will pass through the tissue. Despite the fact that this change is little, it tends to be estimated by a heartbeat oximeter utilizing a similar sort of arrangement that is utilized to quantify blood oxygen saturation.

IV. SOFTWARE DESCRIPTION

The Node MCU model used in this work uses the concept of the MQTT protocol to achieve the IoT concept.

A. MQTT (Message Queue Telemetry Transport)

Contrasted with other existing conventions, Message Queuing Telemetry Transport (MQTT) protocol assumes an indispensable function in M2M correspondences. Figure 1 MQTT is an application layer convention that is used to send messages by interfacing gadgets through a compelled approach. It is a lightweight convention when contrasted with every other convention. It depends on distributing and buys in informing designs through the MQTT dealer. The principle bit of leeway of MQTT is that it will cushion the unsent messages during broker connection loss also, and will transmit to the subscriber when it is connected once more [5]. In IoT convention, both CoAP and MQTT (Message Queuing Telemetry Transport) are generally utilized for communicating the information between IoT gadgets and the host worker. Contrasted with CoAP, MQTT has a high unwavering quality and low force and subsequently settled on as a decent decision for IoT organizations. Being lightweight, MQTT is a messaging convention that upgrades the transmission and dissemination of telemetry data between customers in a straightforward way. The convention depends on publishing and subscribes messaging patterns rather than HTTP demand/reaction demonstrates and sends information between machine-to-machine (M2M) too. The principle favorable position of it is to diminish the organization transmission capacity issue, accomplishing high unwavering quality on questionable associations, and guaranteeing message conveyance during disengage.

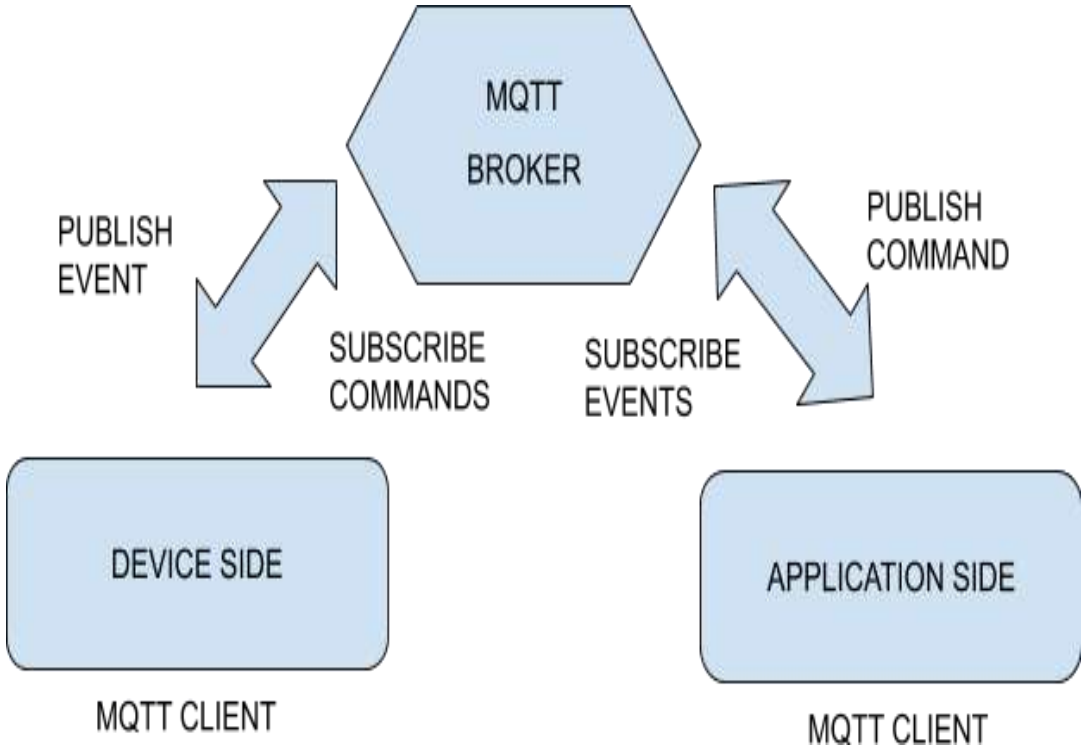


Figure 1. MQTT System

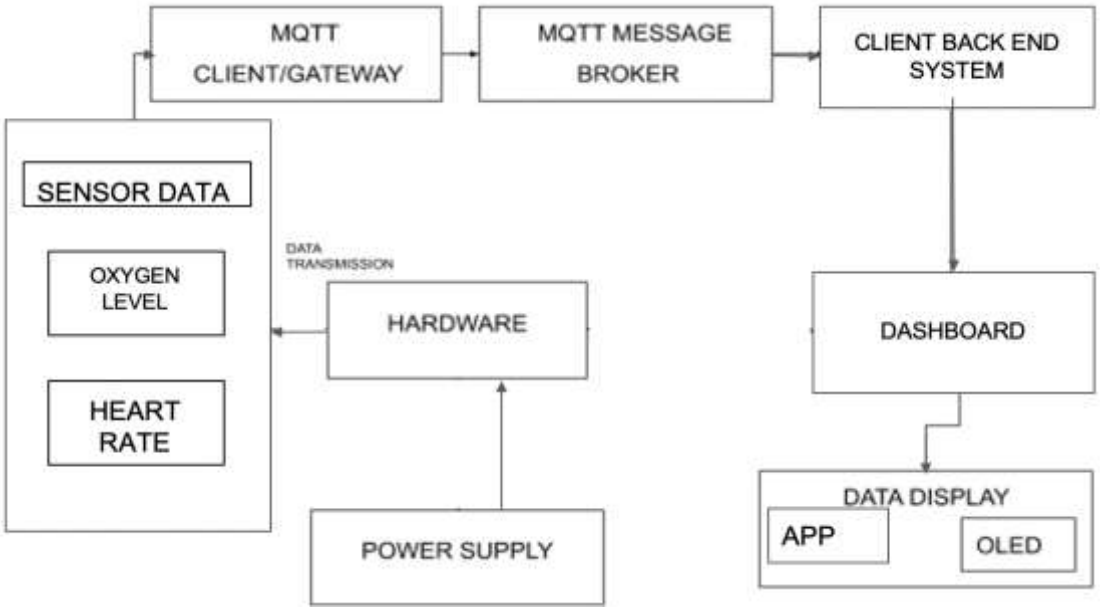


Figure 2. Heart rate Monitoring System

In the proposed system, the continuous information from the sensors can be gathered through sensor technologies and communicated by means of MQTT and distributed to the MQTT customer [5]. Blynk server is utilized for message correspondence, between the customers. At that point, the gathered information is put away in the back-end customer information base for additional examination in the clinical cycle to anticipate the sicknesses early and give medicine. Figure 2 shows Heart rate Monitoring System.

The end-client Dashboard can be set up by subscribing to the gathered information from the MQTT customer and displayed in an intelligent mode where everybody can comprehend the wellbeing status without any problem. The Dashboard can be seen on a web server called Blynk and Mobile API. The Patients' well-being status can be followed through the Dashboard on the customary premise to improve the medical issue of the patients. The day by day wellbeing tip can be given depending on the medical issue of the patients.

The coding is done on the Arduino IDE platform and the code is uploaded to the microcontroller/Node MCU in both the models. The Blynk app is used to view the results of the patient. The app displays values of the Heartbeat in BPM and oxygen level in SpO2(%) format.

B. Blynk

An IoT platform to link the devices to the cloud, plan apps to regulate them and manage the information sent at scale. It controls the gear indirectly, shows data from the sensor, stores the data, and does various tasks. Its features include joining a device to device correspondence through various stages using cloud using Wi-Fi, Bluetooth, Ethernet, etc.

C. Arduino

Arduino is an Open-Source Microcontroller developing stage. The Arduino language is a lot similar to C++. Along with the Arduino IDE, The Arduino language can be utilized to program a huge assortment of microcontrollers even outside the authoritatively upheld Arduino sheets. This empowers us to rapidly create code explicitly to our application by including open-source libraries that empower conventions like MQTT.

V. PROPOSED METHOD FOR MODEL 1

The basic criteria that are regularly monitored by medical professionals to achieve the state of human health are heart rate, oxygen saturation level (SpO2). One of the most widely used and precise methods for heart rate calculation is ECG [8]. But for poor people, ECG is not an inexpensive process. So keeping

this in mind we are making this work which is easily affordable to everyone irrespective of rich and poor.

The system was fabricated with components that include Node MCU ESP8266, Pulse Oximeter, and OLED Display. Sensors cannot be directly interfaced with Node MCU, so to use passive components with Node MCU it is important to connect such passive components externally. By eliminating three 4.7 K breakout board resistances, MAX 30100 is now ready to be used with Node MCU. Then the 4.7 K resistances are related to 3.3V externally in the middle of SCL, SDA, and INT. Arduino platform is used to build this electronic machine. From online sources, appropriate libraries have been downloaded for both the sensors and OLED. The code was created and submitted to Node MCUU on the Arduino platform.
Using the pulse oximeter module, the heartbeat signals were obtained from the finger Amplified to convert them to an visible scale. The Node MCU board Esp8266, based on the Wi-Fi module, connects the network to a router that gives the code and transmits online sensor data that can be retrieved from anywhere on the internet. The linked OLED display will also show the pulse at the level of SpO2 in BPM and oxygen level [6].

The pulse sensor must be operated by 5v DC outsourcing control. D0 is attached to the Pulse Oximeter interrupter and the Node MCU pins D1 and D2 are sequentially attached to the Serial clock(SCL) and Serial Data(SDA) of the OLED display. Block Diagram in Figure 3 represents the prototype.

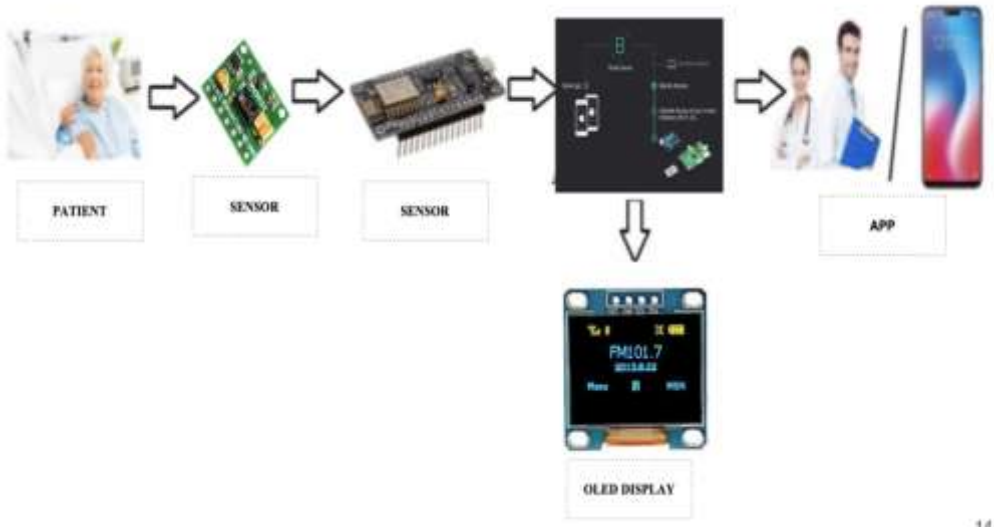


Figure 3: Block Diagram Representing the prototype

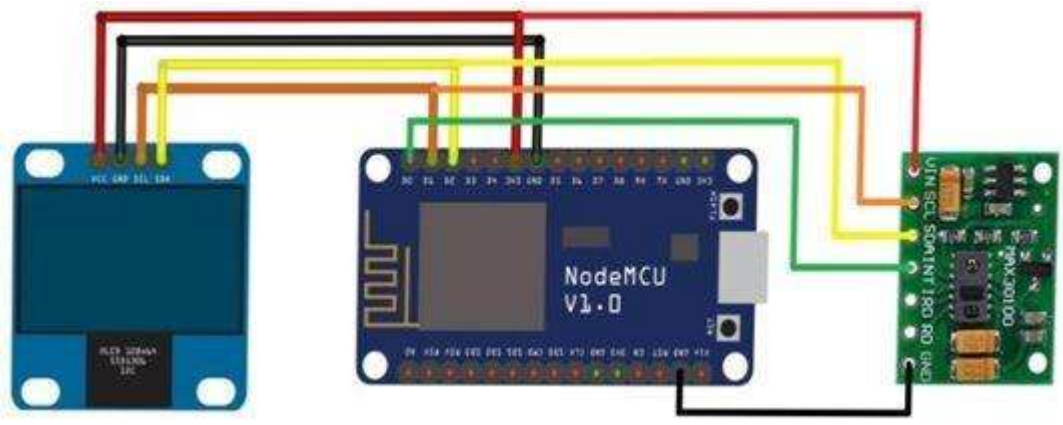


Figure 4. Circuit diagram 1

As shown in Figure 4 Circuit diagram 1 and Figure 6 Circuit diagram 2

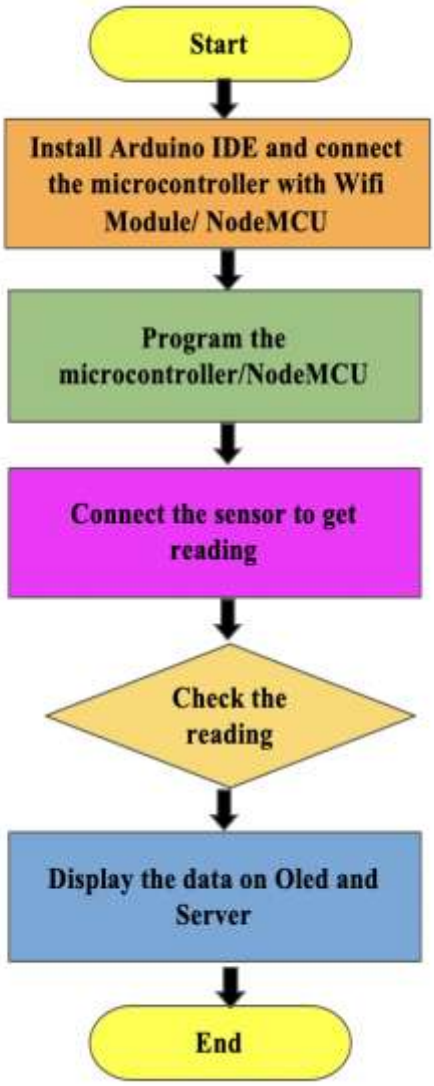
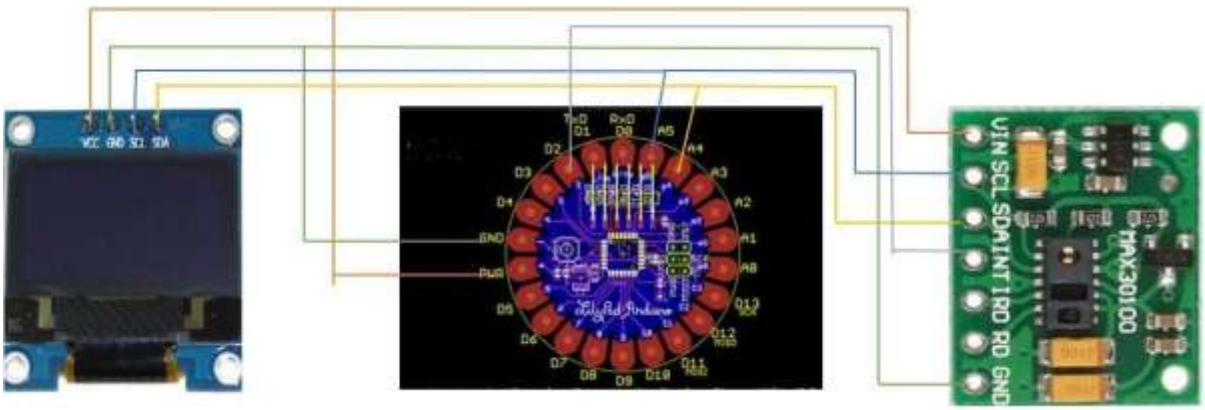


Figure 5. Flow Chart of the Microcontroller and server

VI. PROPOSED METHOD FOR MODEL 2



OLED Display Lilypad Arduino Pulse Oximeter

Figure 6: Circuit diagram 2

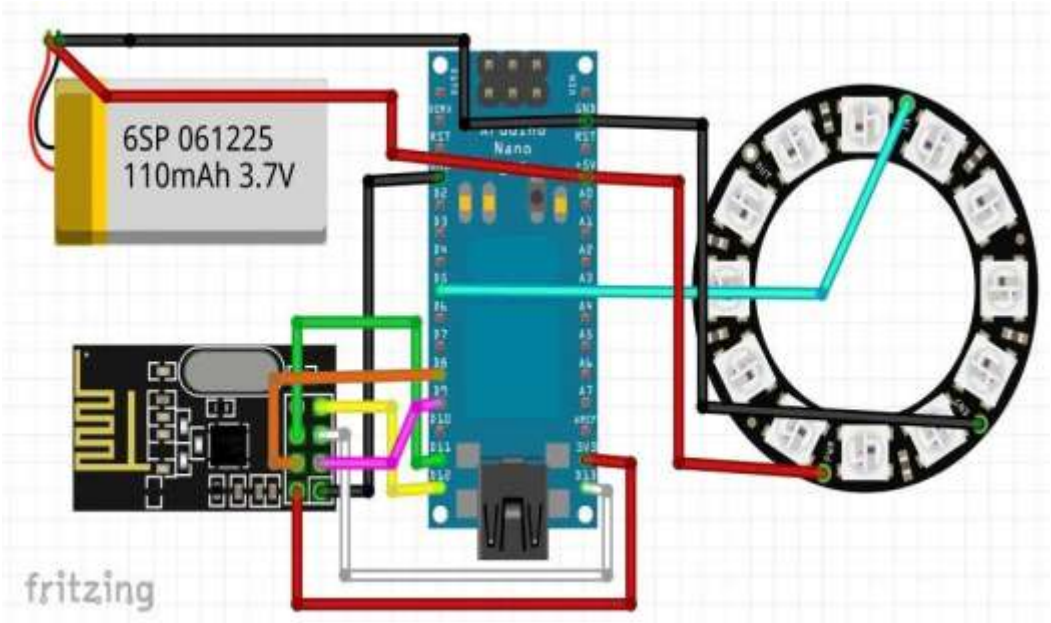


Figure 7. Circuit Diagram 2

Figure 8. Wearable Health Monitoring System

In this task, we will manufacture a Health Monitoring Wearable Glove which can be worn and used to show the pulse and oxygen level of any person [7]. Figure 5 shows Flow Chart of the Microcontroller and server.

Wearable innovations are currently a basic aspect of our day by day lives. They live in our wrist, our glasses, track exercises, and bring us into a virtual world. Wearable innovation gadgets are only gadgets that can be worn by anybody which shows pertinent data on the wearer. Wearable innovation has an assortment of utilizations that develop as the field itself grows. The wearable innovation gadgets use advancements that are extremely imaginative. Future society will rely fundamentally upon shrewd innovation for ideal working, particularly in the field of medical services industry. The need for wearable innovation in medical services emerges because of the requirement for observing patients throughout a broad timeframe The beat and the oxygen level of an individual are detected utilizing a Pulse Oximeter, which sends data to the Lilypad Arduino board and it thus measures the data and orders the OLED to show the pulse. An individual need not be an expert to check the beat.

The system above in Figure 7 has been constructed using the above hardware components. The SCL of both OLED and Pulse Oximeter is connected to the A5 pin of LilyPad providing the Inter-Integrated circuit clock input, the SDA is connected to the A4 pin of the LilyPad providing the clock data, the active-low

interrupt of a pulse oximeter is connected to the D2 pin of the LilyPad.

The system above in Figure 8 with the ESP8266 module along with an Arduino Nano R3.Connecting the WIFI module is not simple. The SPI wires, chip enable wire and power supply must be connected. All pin headers need to be removed and soldered to the pads directly. The lilypad requires one data and two power wires along with another two power wires that are connected to the battery. Both the hardware connectivity combined contributes to the wearable innovation

This interrupt is triggered after every data sample is collected. Each data sample is collected from our index finger after placing it on the pulse oximeter. The LilyPad needs to be provided with a Wi-Fi module in order to connect the network to a router that will pass on the data of the sensor online that can be reached from anywhere over the internet. Outsource power of 5v DC is supplied to the LilyPad Arduino [10].

VII. SIMULATION AND RESULTS

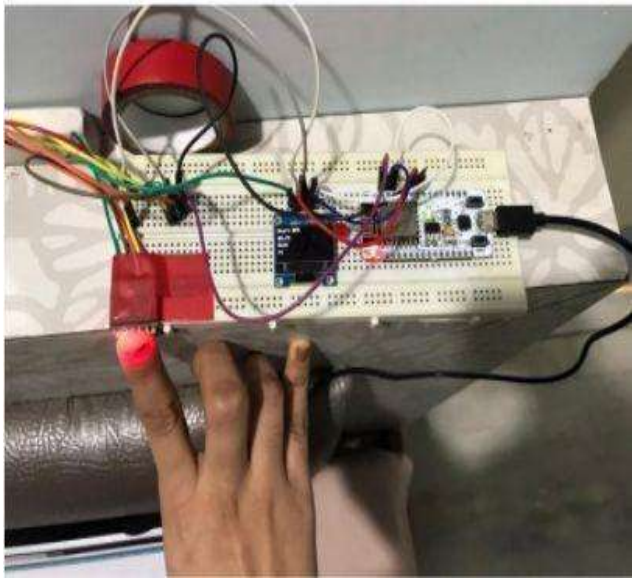


Figure 9. Hardware Setup of Node MCU

Figure 10. Final output of Simulation

For Figure 9 when the power is supplied to the Node MCU board, initializing the pulse oximeter message is displayed on the OLED. Once the pulse oximeter is initialized we place our index finger on the sensor and the readings are then displayed on the OLED.

The same data collected by the microcontroller is then transmitted online and is displayed on the Blynk App as shown in Figure 10.

In this work, the design and development of a Health Monitoring System are presented. The system is ergonomic and hard-wearing. The system is efficient and easy to use. The results for the parameters were directly displayed on the PC and Server. Heart rate was one of the parameters that we have displayed in our work. The MAX30100 was used to obtain the result. For adults, if the heart rate is between 60 to 100 beats per minute it is considered a normal resting heart rate. All the heart rate results were obtained between the specified range. A few fluctuations in the readings were also observed due to the mispositioning of the finger on the sensor which was then rectified.

The second parameter that was displayed in this work was the oxygen level in the human body. To obtain the oxygen levels, the MAX30100 used for obtaining the heart rate was used for this parameter as well. This step was taken to make the device compact by using one single component instead of two. The ranges of SpO2 from 95 to 100 percent are accepted. When the device has tested the results obtained were pretty accurate concerning the acceptable range mentioned above. The above-mentioned results were obtained by measuring changes in light absorption in oxygenated or deoxygenated-blood. The heart rate readings and oxygen level readings were further used to interpret various health conditions of the device used on the PC or mobile phones. The health conditions may include chronic obstructive pulmonary disease (COPD), pneumonia, anxiety monitoring, and other health conditions related to heart rate and oxygen levels. This device could be used in both clinical and non-clinical environments. It can also be easily used by individual users like athletes in sporting events. Variations of readings may be observed in a person's beat count if the readings are taken at different places of different fingers. The result varies from person to person. The use of IoT in our work makes it more advanced and approachable to everyone.

VIII. EXISTING METHODOLOGY

A lot of people are using the conventional method of Pulseoximeter which displays the Heart rate value in BPM and Blood oxygen level in SpO2 format [4].The finger pulse-oximeter has extended the accessibility of pulse-oximetry to incorporate at-home patient checking. Individuals with heart or breathing issues can depend on close-to-home finger beat oximeters to assist them with dealing with these conditions under a doctor's direction.

Many such health monitoring devices use different wireless mediums to communicate with each other. The widely used ones incorporate Bluetooth medium to establish connectivity.

There are gadgets that are incorporated with the SPHERE IoT system. SPHERE (a Sensor Platform for Healthcare in a Residential Environment) is an IoT foundation of off-the-rack and custom sensors that assembles an image of how individuals live in their homes for clinical applications [9].

A wearable device for checking health through parameters of ECG, Pulse Rate, and Temperature is available in the market [9].

IX. CONCLUSION

This implementation of electronic and communications technologies have a significant role to play in the field of health-care and its important applications are studied through this work. Modern Technology in the industrial field has led to rapid advancements and increased technologies. When these technologies deal with IoT it helps the maker to track the user and also helps to know the present condition of the user. This modern technology has made the working simpler than before and is also cost-efficient. This paper proposes a real-time monitoring system that monitors the subject's vital parameters such as Heartbeat, Saturated Oxygen level and transmits the data to the display. The proposed technique empowers the clinicians to streamline the utilization of accessible clinical assets and limit the expenses of observing the patients particularly heart patients.

REFERENCES

1. F. Patlar Akbulut and A. Akan, "A smart wearable system for short-term cardiovascular risk assessment with emotional dynamics", *Measurement*, vol. 128, pp. 237-246, Nov. 2018.
2. P. K. Gupta, B. T. Maharaj and R. Malekian, "A novel and secure IoT based cloud centric architecture to perform predictive analysis of users activities in sustainable health centres", *Multimedia Tools Appl.*, vol. 76, pp. 18489-18512, Sep. 2017.
3. Nusrat Jahan Farin, S.M.A Sharif, Iftekharul Mobin "An Intelligent sensor based system using Real Time Heart Rate Monitoring(HRM)" Intelligent Control and Automation, Vol.7, 26 May 2016, pp-55-62.
4. P. J. Chacon et al., "A Wearable Pulse Oximeter With Wireless Communication and Motion Artifact Tailoring for Continuous Use," in IEEE Transactions on Biomedical Engineering, vol. 66, no. 6, pp. 1505-1513, June 2019, doi: 10.1109/TBME.2018.2874885.
5. B. Mishra and A. Kertesz, "The Use of MQTT in M2M and IoT Systems: A Survey," in IEEE Access, vol. 8, pp. 201071-201086, 2020, doi: 10.1109/ACCESS.2020.3035849.
6. TV Sethuraman (2019). "IoT based system for Heart Rate Monitoring and Heart Attack Detection."International Journal of Engineering and Advanced Technology (IJEAT), Volume-8 Issue-5, June 2019.
7. T. Sravani (2020). "Health Monitoring Wearable Glove" Juni Khayt, UGC Care group 1 listed journal, vol. 10, Issue-5, No.3, May 2020.
8. B. Mishra and A. Kertesz, "The Use of MQTT in M2M and IoT Systems: A Survey," in IEEE Access, vol. 8, pp. 201071-201086, 2020, doi: 10.1109/ACCESS.2020.3035849.
9. T. B. Garcia and N. E. Holtz, 12-Lead ECG: The Art of Interpretation, Boston, MA, USA:Jones & Bartlett, 2013.
10. C. Beach et al., "An Ultra Low Power Personalizable Wrist Worn ECG Monitor Integrated With IoT Infrastructure," in IEEE Access, vol. 6, pp. 44010-44021, 2018, doi: 10.1109/ACCESS.2018.2864675.