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NAAC Accredited Autonomous Institution
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A Minor Project Report

On

ARDUINO BASED FITNESS MONITORING SYSTEM

Submitted in partial fulfilment of requirements for the award of the

Degree of

BACHELOR OF ENGINEERING

in

ELECTRONICS AND COMMUNICATION ENGINEERING

Under the guidance of

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M.KUMARASAMY COLLEGE OF ENGINEERING

(Autonomous)

KARUR – 639 113

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M.KUMARASAMY COLLEGE OF ENGINEERING, KARUR

BONAFIDE CERTIFICATE

Certified that this **18ECP104L -** Minor Project II report **"ARDUINO BASED FITNESS MONITORING SYSTEM"** is the bonafide work of **"VISHAL S R (19BEC4234), SURYA T (19BEC4215), SATHISHKUMAR S B (19BEC4188), SATHEESH KUMAR N (19BEC4185)"** who carried out the project work under my supervision in the academic year 2020-2021.

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INSTITUTION VISION AND MISSION

Vision

To emerge as a leader among the top institutions in the field of technical education.

Mission

M1: Produce smart technocrats with empirical knowledge who can surmount the global challenges.

M2: Create a diverse, fully -engaged, learner -centric campus environment to provide quality education to the students.

M3: Maintain mutually beneficial partnerships with our alumni, industry and professional associations.

DEPARTMENT VISION, MISSION, PEO, PO AND PSO

Vision

To empower the Electronics and Communication Engineering students with emerging technologies, professionalism, innovative research and social responsibility.

Mission

M1: Attain the academic excellence through innovative teaching learning process, research areas & laboratories and Consultancy projects.

M2: Inculcate the students in problem solving and lifelong learning ability.

M3: Provide entrepreneurial skills and leadership qualities.

M4: Render the technical knowledge and industrial skills of faculties.

PROGRAM EDUCATIONAL OBJECTIVES (PEO'S)

PEO1: Graduates will have a successful career in academia or industry associated with electronics and communication engineering.

PEO2: Graduates will provide feasible solutions for the challenging problems through comprehensive research and innovation in the allied areas of electronics and communication engineering.

PEO3: Graduates will contribute to the social needs through lifelong learning, practicing professional ethics and leadership quality.

PROGRAM OUTCOMES (PO'S)

PO 1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO 2: Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO 3: Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO 4: Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO 5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO 6: The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO 7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO 8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO 9: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO 10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO 11: Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO 12: Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSO'S)

PSO1: Applying knowledge in various areas, like Electronics, Communications, Signal processing, VLSI, Embedded systems etc., in the design and implementation of Engineering application.

PSO2: Able to solve complex problems in Electronics and Communication Engineering with analytical and managerial skills either independently or in team using latest hardware and software tools to fulfil the industrial expectations.

MAPPING OF PROJET WITH POs AND PSO

Abstract	**Matching with POs , PSOs**
Pulse Oximeter Sensor, Node MCU, Arduino IDE software	PO1,PO2, PO3, PO4,PO5,PO6,PO7,PO8, PO9,PO10, PO11, PO12, PSO1,PSO2.

ABSTRACT

In this Project, we will try to make a Fitness Monitoring Device that can measure SpO2 (percentage of oxygen in the blood) and heart rate in BPM (Beat per Minute).This wearable device can be used by athletes to monitor their heart rate and blood oxygen levels during a workout.The Best part of this project is that you can connect this device to a application -Blynk that will record and regularly update the data for both SPO2 & BPM on the internet.Even anyone can monitor the data from any part of the world as data are uploaded on server.As there is an availability of online data, so this project can be used to monitor the health of a worker online. The pulse oximeter available in the market is very expensive, but with this simple & low-cost pulse oximeter module, we can make our own device,A pulse oximeter is a medical instrument that indirectly measures the saturation oxygen level of a patients' blood, i.e what proportion of the oxygen-carrying molecules in the blood (called hemoglobin) are actually carrying oxygen. This is known as oxygen saturation or SpO2. In our paper we proposed to develop a pulse oximeter to measure the saturation point oxygen level and the same would be stored in the cloud .The pulse oximeter is designed using infrared and visible (red) light detection from light that passes through a patient's finger from an emitter. The absorption will tell when blood is moving through the finger and how much of this is oxygen-rich. The output of this analog circuit will be fed into a Node microcontroller, which computes the pulse and oxygen level from these numbers. The values are uploaded to a cloud computing web host called Thingspeak or Blynk from where it can be viewed.

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List of Abbreviations

Acronym	Abbreviations
WHO	World Health Organization
IOT	Internet of Things
CVD	Cardio Vascular Disease
HMS	Health Monitoring System
GPS	Global Positioning System
WSN	Wireless Sensor Network
SMS	Short Message Service
GUI	Graphical User Interface
WF	Wireless Fidelity
MCU	Micro Controller Unit
TCP	Transmission Control Protocol
IP	Internet Protocol
IDE	Integrated Development Environment
VCC	Voltage Common Collector
ADC	Analog to Digital Converter
IR	Infrared
LED	Light Emitting Diode
BPM	Beats per minute
ODE	Ordinary Differential Equation

1. INTRODUCTION:

Pulse oximetry is a widely used medical measurement instrument and it is a non-invasive and painless test that measures oxygen saturation level in our blood that can easily detect small changes in oxygen. In the current Covid-19 situation, it has become important to track the oxygen level of multiple patients at the same time remotely without getting into contact with the patient. So, in this project, we build a pulse oximeter using MAX30100 Pulse oximeter and ESP32 that will track the Blood Oxygen level and send the data via internet by connecting to a Wi-Fi network. This way, we can monitor multiple patients remotely by maintaining social distance with the patients. The obtained data will be shown as a graph which makes it easier for tracking and analyzing the patient's condition. Previously, we have also built other heart rate monitors using pulse sensors.Pulse oximeters have been used in medical settings for many years. In many cases, such as during an operation, in intensive care, the emergency room, even an unpressurized aircraft, a person's oxygen level may be unstable and needs monitoring. In addition, from these readings, the person's heart rate can also be determined. This project is an attempt to construct a working version of a pulse oximeter from a relatively cheap set of parts – including a microcontroller. An offthe-shelf microcontroller has enough processing power to perform the tasks required for this design; however, in any commercial application, specialized hardware will be designed that is specifically suited to the task. The sampling portion of this design requires an infrared emitter (around 940 nm wavelength) and a red light emitter (around 660 nm wavelength. The absorption of oxyhemoglobin and the deoxygenated form differs significantly between these wavelengths. Therefore, using the ratio of the two absorption values gives the percentage of arterial haemoglobin for oxyhemoglobin.

The detectors do not give a very high voltage, so the output from the detector needs to be amplified using op amps before passing into the microcontroller for analysis. If not, the relative change will not be seen when the microcontroller makes the input a discreet value. This attempt at a pulse oximeter is fairly crude and does not take into consideration some important facts if it were to be used in a serious situation. For instance, it does not take into account other gasses in the blood stream. If a person has been rescued from a burning building, they may have carbon monoxide poisoning. In order to distinguish the difference between CO and O2, absorption at additional wavelengths must be performed. Another example is a person suffering from poor gas exchange in the lungs. Their blood may have a 100% oxygen level, but may still be suffering from too much carbon dioxide (CO2) that cannot be exchanged and exhaled. The microcontroller is required to perform a discrete Fourier transform to determine the pulse. This transform will take a collection of data over time and extract the amplitude of each of the frequencies it contains. In the case of our data, there should be a pretty distinct pattern of when there is blood movement. Therefore, we should obtain one frequency where the amplitude is much higher than any other frequencies detected. This should correspond to the frequency of the pulse of the person using the device. In most design projects, there is a trade off to what should be done with hardware or with software. In our paper, there is not much of a design comparison. The sampling and amplification must be done in hardware with analog values to obtain the correct results. For the calculations and the video generation, we need a device with enough processing power and features to perform meet all the timing requirements. In this case, the Node MCU is a good fit at a low cost.

1.1 Background

A Remote health monitoring system is an extension of a hospital medical system where a patient's vital body state can be monitored remotely. Traditionally the detection systems were only found in hospitals and were characterized by huge and complex circuitry which required high power consumption. Continuous advances in the semiconductor technology industry have led to sensors that are smaller in size, faster in operation, low in power consumption and affordable in cost. This has further seen development in the remote monitoring of vital life signs of patients especially the elderly. The remote health monitoring system can be applied in the following scenarios:

1. A patient is known to have a medical condition with unstable regulatory body system. This is in cases where a new drug is being introduced to a patient.
2. A patient is prone to heart attacks or may have suffered one before. The vitals may be monitored to predict and alert in advance any indication of the body status.
3. Critical body organ situation
4. The situation leading to the development of a risky life-threatening condition. This is for people at an advanced age and maybe having failing health conditions.
5. Athletes during training.

To know which training regimes will produce better results. In recent times, several systems have come up to address the issue of remote health monitoring. The systems have a wireless detection system that sends the sensor information wirelessly to a remote server. Some even adopted a service model that requires one to pay a subscription fee. In developing countries, this is a hindrance as some people cannot use them due to cost issue involved. There is also the issue of internet connectivity where some systems to operate, good quality internet for a real-time remote connection is required. Internet penetration is still a problem in developing countries. Many of the systems were introduced in the developed countries where the infrastructure is working perfectly. In most cases, the systems are adapted to work in developing countries. To reduce some of these problems there is need to approach the remote detection from a ground-up approach to suit the basic minimal conditions presently available in developing countries. A simple patient monitoring system design can be approached by the number of parameters it can detect. In some instances, by detecting one parameter several readings can be calculated. In developed countries, they may move to assisted living group homes. This is where a remote health monitoring system can come in handy**.**

1.2 Problem Statement

Remote health monitoring can provide useful physiological information in the home. This monitoring is useful for elderly or chronically ill patients who would like to avoid a long hospital stay. Wireless sensors are used to collect and transmit signals of interest and a processor is programmed to receive and automatically analyze the sensor signals. In this project, you are to choose appropriate sensors according to what you would like to detect and design algorithms to realize your detection. Examples are the detection of a fall, monitoring cardiac signals. Using a single parameter monitoring system an approach to a remote health monitoring system was designed that extends healthcare from the traditional clinic or hospital setting to the patient's home. The system was to collect a heartbeat detection system data, fall detection system data, temperature data and few other parameters. The data from the single parameter monitoring systems was then availed for remote detection. During design the following characteristics of the future medical applications adhered: a) Integration with current trends in medical practices and technology, b) Real-time, long-term, remote monitoring, miniature, wearable sensors and long battery life of a designed device. c) Assistance to the elderly and chronic patients. The device should be easy to use with minimal buttons.

1.3 Objectives

In order to overcome the aforesaid problems in health monitoring, the goal of this project has been to implement an IOT based E-health monitoring system which monitors the patient's body parameters such as pulse rate, oxygen level in blood regularly, and also send the data over the internet which will be retrieved by the doctors for diagnosis and close family members, receiving regular updates as well. Thus, the patients will be able to manage the task of taking care of their health simultaneously along with their busy life schedule. The system is also cost-effective, portable, and easy to operate with no complex circuitry involved which adds to its advantages, being highly user friendly for the common and elderly people.

2. LITERATURE REVIEW

The project prototype has been developed after a systematic survey on the reviews of some previous work in the wireless sensor network area and the use Internet of Things in cardiac health monitoring. Many applications are now-a-days available where use of smart phones in health monitoring is experimented. Such system consisted of a wearable device comprising of Temperature and Pulse sensors. The device will send its data to the server through the android application. This data will be available to the doctor using his android application. While few authors presented the development of a microcontroller based system for wireless heartbeat and temperature monitoring using ZigBee. The system is developed for home use by patients that are not in a critical condition but need to be constant or periodically monitored by clinician or family.

In any critical condition the SMS is send to the doctor or any family member. So that we can easily save many lives by providing them quick service. Some of the authors proposed a remote mobile health monitoring system with mobile phone and web service capabilities. It provides doctors and family members with necessary data through a web interface and enables authorized personnel to monitor the patient's condition and to facilitate remote diagnosis. In some papers, the authors have proposed an initial prototype development for wireless transmission of ECG signals using AD8232 sensor and raspberry pi based on IoT. In some papers, a Smartphone based remote health monitoring system using body temperature and heart beat sensors to continuously monitor body parameters of cardiac patients, has been proposed using GPS to track location and wireless communication. The link is established between the patient's Bluetooth enabled Mobile device and sensors via a Bluetooth modem, this helps in continuous monitoring. An IoT-based ECG monitoring system was developed consisting of three main parts, i.e., the ECG sensing network, IoT

cloud, and GUI. Through a wearable monitoring node with three electrodes, real-time ECG signals can be collected with satisfactory accuracy. The gathered data were transmitted to the IoT cloud using Wi-Fi, which supports high data rates and wide coverage areas . A paper developed a portable, low cost ECG data acquisition system with overall less complex circuitry. Results were presented using MATLAB and Raspberry Pi.

3. METHODOLOGY

3.1 Existing Method

The smart system contains the required materials such as pulse sensor, temperature sensor (LM 35) , Bluetooth module and Arduino Uno board. Telecontrolling system through WBAN is developed for the requirement of personalised medicine healthcare. WBAN can accumulate the data from sensor also stores the Information of a patient. The stored output information is shared to controller through the source IOT. Zigbee is utilised in communication and also in WBAN technologies due to its warranty delay condition in health telecontrolling.

3.2 Proposed Method

To examine whether elimination of fatal diseases will increase healthcare costs. The report for tie up system, trackers, sensors, telecontrolling, and wireless technology and also traces the real time device and their applications. By developing smart wearable sensor in order to maintain the relationship between physician and patient more health care is maintained. To develop the liberty and participation of the patient in regard to their maintain their health chart and will provide for basic remote controlling technique. The important technological development in mobile communication has a inbuilt feature of high speed internet service and makes our life comfortable to detect an object based on real time image, which is a huge advantage of smartphones. The unique blood pressure is represented in terms of diastolic/stolic. For instance 120/80. The top range of blood pressure in terms of systolic symbolise the pressure of arteries, as walls of heart attracts the pulse and the heart is pumped. Similarly the bottom range of blood pressure in terms of systolic, of a arteries as walls of heart loses its contraction and pulse is relaxed.

3.3 BLOCK DIAGRAM

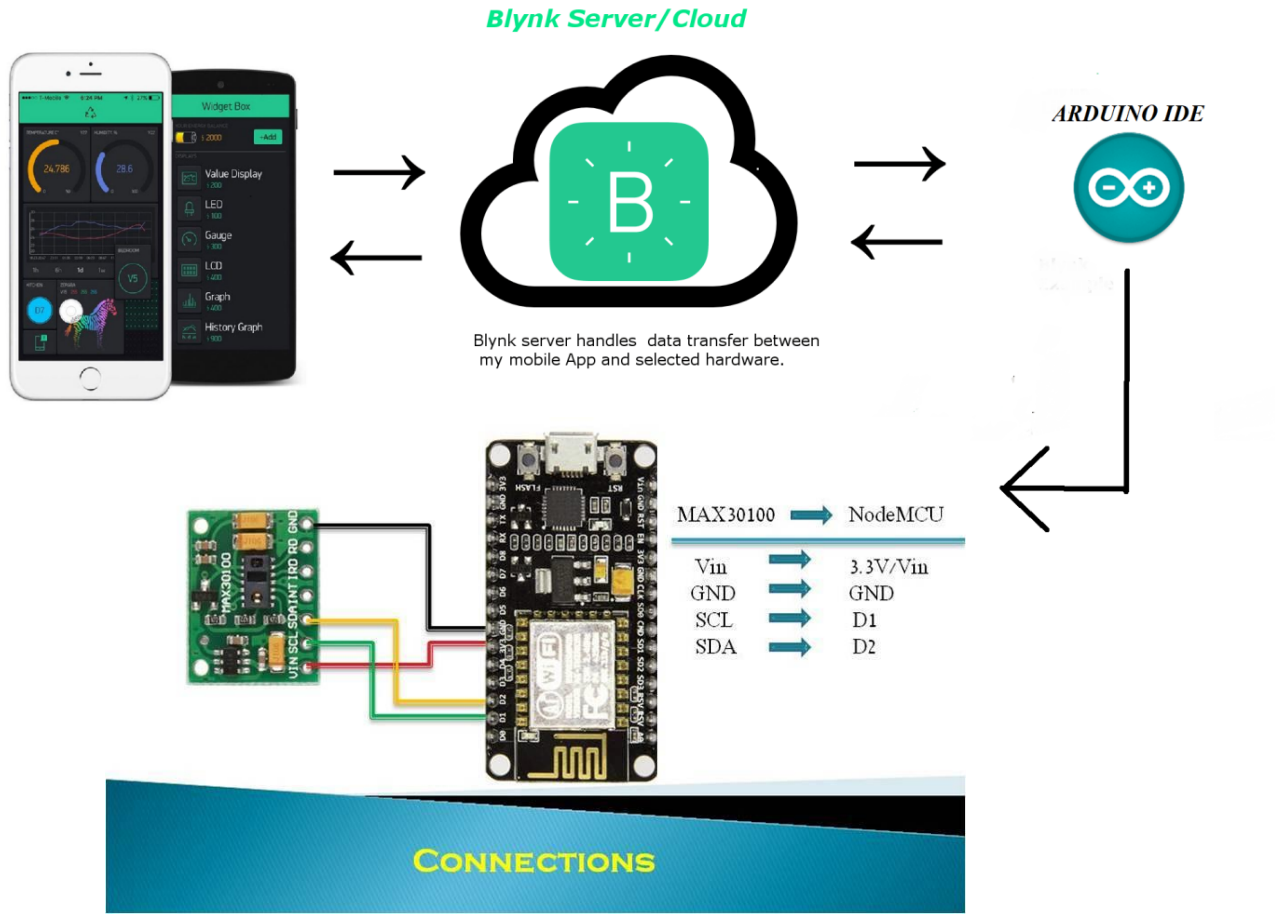

Fig:3.1 – Block Diagram

3.4 REQUIRED HARDWARE / SOFTWARE

1).NODEMCU (WIFI MODULE):

NodeMCU is a low-cost open source IoT platform. NodeMCU is a Lua based firmware and development board specially targeted for IoT based Applications. It initially included firmware which runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware which was based on the ESP-12 module. Later, support for the ESP32 32-bit MCU was added.

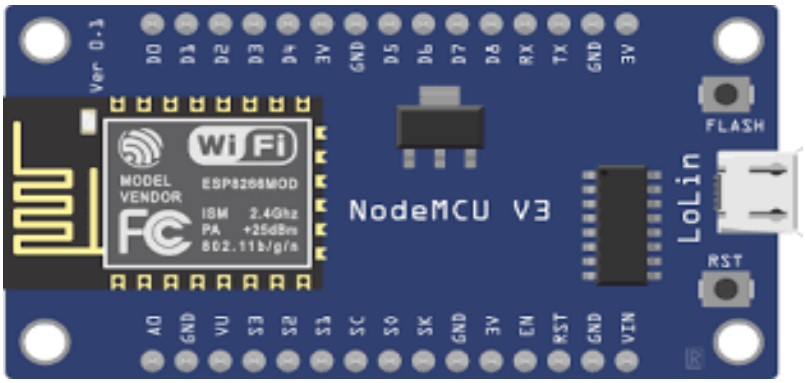

Fig:3.2 – Node Mcu

2).ARDUINO SOFTWARE (IDE):

The Arduino Integrated Development Environment or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino and Genuino hardware to upload programs and communicate with them.

Fig:3.3 – Arduino Software

3. BLYNK:

Blynk is a Platform with iOS and Android apps to control Arduino, Raspberry Pi over the Internet. It's a digital dashboard where you can build a graphic interface for your project by simply dragging and dropping widgets. Blynk was designed for the Internet of Things. It can control hardware remotely, it can display sensor data, it can store data, vizualize it and do many other cool things. Blynk Server - responsible for all the communications between the smartphone and hardware . It is useful to view the output by using the smart phone.

Fig:3.4 - Blynk

3.5 SENSOR USED

1.MAX30100 PULSE OXIMETER:

The MAX30100 is an integrated pulse oximetry to measure blood saturation level and heart rate can also be measured by using this. It combines two LEDs, a photodetector, optimized optics, and low-noise analog signal processing to detect pulse oximetry and heart-rate signals. The MAX30100 operates from 1.8V and 3.3V power supplies and can be powered down through software with negligible standby current, permitting the power supply to remain connected at all times.

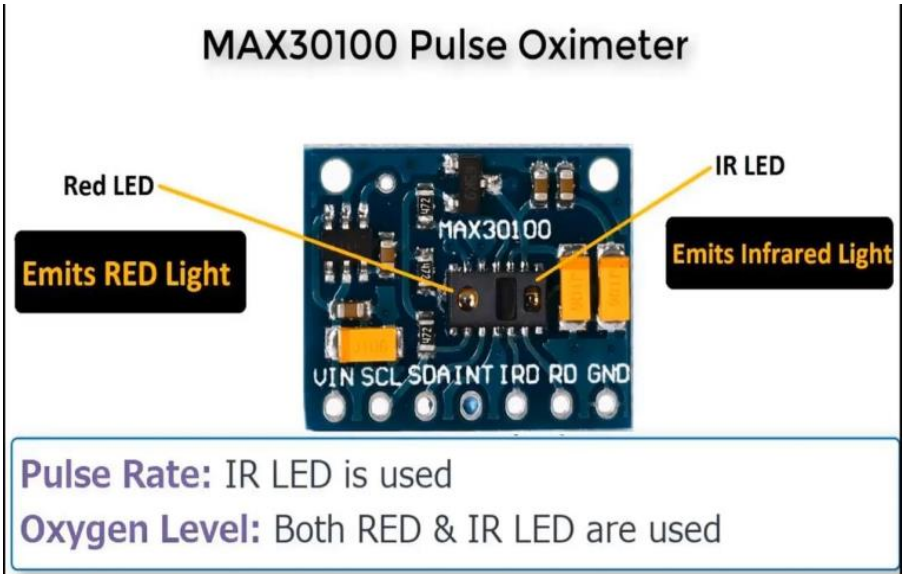

Fig:3.5 – MAX30100 Pulse Oximeter

3.6 EXPLANATION

A pulse oximeter is a medical instrument that indirectly measures the saturation oxygen level of a patients' blood, i.e what proportion of the oxygen-carrying molecules in the blood (called hemoglobin) are actually carrying oxygen. This is known as oxygen saturation or SpO2. In our paper we proposed to develop a pulse oximeter to measure the saturation point oxygen level and the same would be stored in the cloud .The pulse oximeter is designed using infrared and visible (red) light detection from light that passes through a patient's finger from an emitter. The absorption will tell when blood is moving through the finger and how much of this is oxygen-rich. The output of this analog circuit will be fed into an Node microcontroller, which computes the pulse and oxygen level from these numbers. The values are uploaded to a cloud computing web host called Blynk from where it can be viewed.This project works on the main principles of IoT and sending acquired data over Cloud. All the wearable sensors used to measure the body parameters of the patient are centrally connected to a NodeMCU (ESP8266) which collects the data and sends the same over cloud and displays the respective outputs remotely on an applicationThis sensor works on the protocol of I2C communication which enables the SCL and SDA pin of the sensor to communicate with the microcontroller. This sensor particularly has two mode- infrared and red LEDs. So whenever we are trying to inhale the oxygen which subsequently increasesthe oxygenated blood into our body results in the absorption of the more infrared signal than that of red lights so in common terminology the SPO2 increases. And vice versa when we exhale, the deoxygenated blood is more than that of oxygenated blood which particularly absorbs more of the red lights and pass the infrared lights . And in course of time the interval in between the two basic functioning which are oxygenated and deoxygenated blood results in calculating of the heart rate in BPM .

4. RESULTS AND DICUSSION

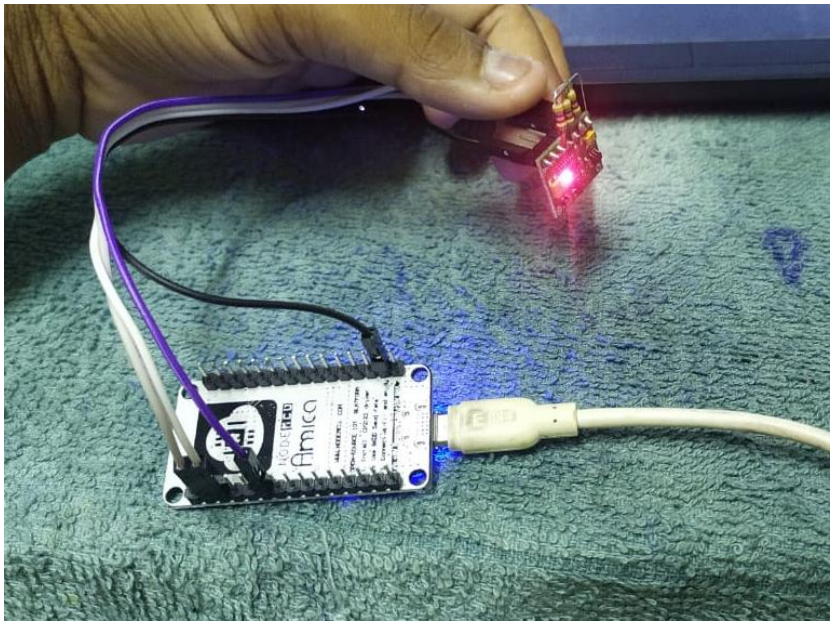

Fig:4.1 – Node Mcu with Pulse Oximeter

FITNESS_MONITORING_SYSTEM

```
#include <Adafruit_BusIO_Register.h>
#include <Adafruit_I2CDevice.h>
#include <Adafruit_I2CRegister.h>
#include <Adafruit_SPIDevice.h>
#include <Adafruit_GFX.h>
#include <Adafruit_SPITFT.h>
#include <Adafruit_SPITFT_Macros.h>
#include <gfxfont.h>
#include <Wire.h>
#include "MAX30100_PulseOximeter.h"
#define BLYNK_PRINT Serial
#include <Blynk.h>
#include <ESP8266WiFi.h>
#include <BlynkSimpleEsp8266.h>
#include "Wire.h"
#define REPORTING_PERIOD_MS 1000
char auth[] = "itL16H_aqEdDgkh8JOpeh7Iu1ilviHUC";
char ssid[] = "Vishal";
char pass[] = "12345678";
```

Fig:4.2-Source Code

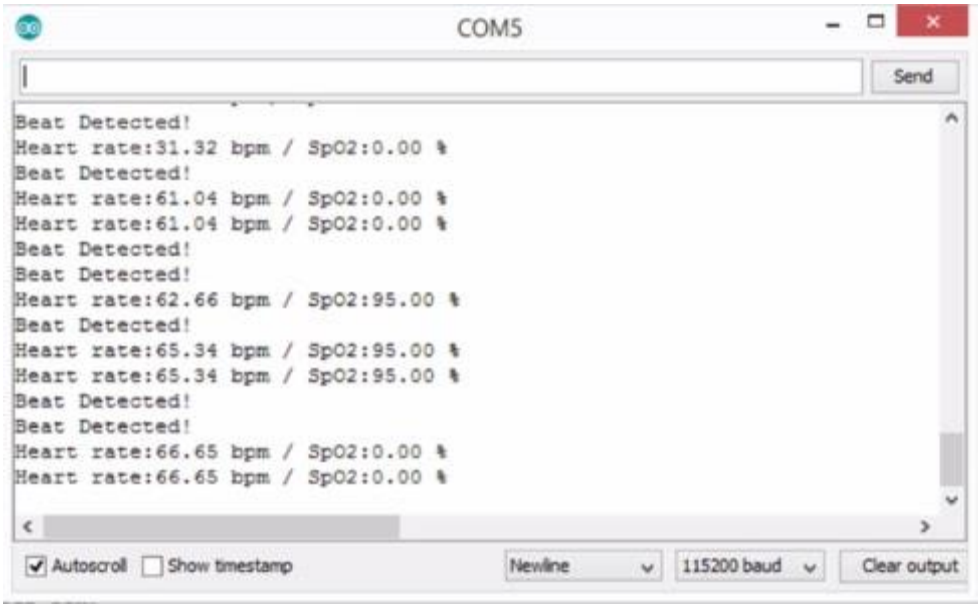

Fig:4.3-Output in Serial Monitor

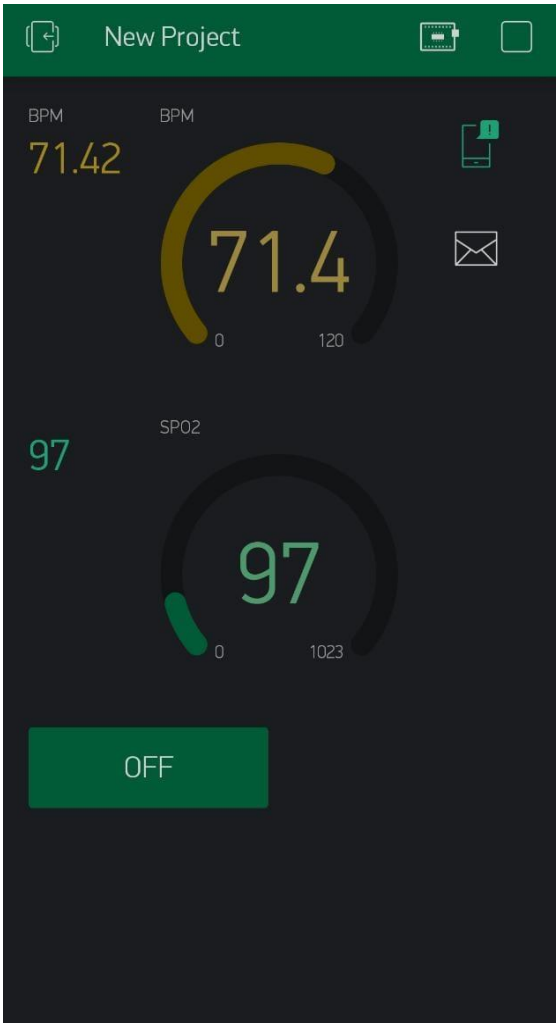

Fig:4.4 – Output in Blynk Application

5. CONCLUSION

In this project, we designed and developed an “Arduino based Fitness monitoring system”. This paper proposes a merit of health care application for easy and effortless life plus demonstrated using a low power wearable IOT system. We have described the major parameters of the designed system and briefed their implementation data. Plus we have constructed to develop the various performances of the designed system regardless of low cost. This system is implemented using a wearable sensor. The improved version of this project will work on the security and encryption of the data accumulated from the patient by using a android Blynk app. Thus, we have shown the results of both and hardware and simulation part of “Arduino based Fitness monitoring system”. We have discussed about the monitoring of heat rate which can be calculated within a fraction of seconds. ARDUINO software for programming purpose and output will be shown in hardware part. This hardware is easy to handle and quite simple in its connections.With the help of the remote monitoring system provided by our prototype, health monitoring can be done by the doctors or health care providers at anytime from any location in a cost effective manner. Doctors can see data remotely and analyze the health parameters of patients. The persons living in remote locations who have no access to a doctor can be helped through a greater extent through this system, as this system sends all the values and signals on the website and the doctors which are far away can get an accurate idea of heart condition of a person. Furthermore this system can be used in ambulance which saves a lot of time and can save a life of a person because every second counts.

5.1 FUTURE TECHNOLOGY

Using this concept, the future work is we can remotely control/move the things around the physically abled persons. Whenever there is a rise in the heart rate, we can connect this module to the emergency alert to the nearby hospital ambulance. This can be later upgraded to other module like microcontroller, vlsi and advanced types of integrated boards. The purpose of various parameter: system "wearability", task of android device, employed sensor, classification of the recognizing algorithms. • Measuring devices for instance blood pressure attached with glucose will be the advanced version to control the health of a patient.

5.2 ADVANTAGE

Its size is less and portable and easily can be use.Maintenance is very simple.Online prescription will be given by seeing the heart rate.Operating supply voltage is very less.Non-invasive. It can be used to evaluate trends (evaluation of oxygenation during exercise, sleep, during procedures).Fast Data Output Capability.The LEDs in MAX30100 are pulsed with a low duty cycle for power savings.

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