

HANDGRIP DYNAMOMETER INTERGRATED WITH PULSE OXIMETER

Submitted in partial fulfillment of the requirements for the award of
Master of Technology degree in Medical Instrumentation

By

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**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

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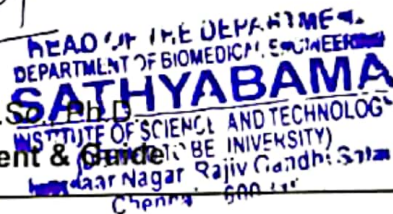
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BONAFIDE CERTIFICATE

This is to certify that this project report is the bonafide work of Sollensselvan.V.(Reg. No. 41440011) who carried out the project entitled "Handgrip Dynamometer Integrated with Pulse Oximeter" under our supervision from November 2022 to April 2023.

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Submitted for Viva-voce Examination held on 05-05-2023

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DECLARATION

I, Sollenselvan.V (Reg. No. 41440011) hereby declare that the project report entitled "Handgrip Dynamometer Integrated with Pulse Oximeter" done by me under the guidance. Dr. T. SUDHAKAR, M.Sc., Ph.D, Department of Biomedical Engineering is submitted in partial fulfillment of the requirements for the award of **Master of Technology** degree in **Medical Instrumentation**.

DATE: 5-5-23

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SIGNATURE OF THE CANDIDATE

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(Sollenselvan V)

ABSTRACT

The main aim of the project is to measure the maximum isometric strength of the hand and forearm muscles, primarily for testing the hand grip strength of Sports & fitness persons then simultaneously measure the pulse rate and oxygen saturation of the Sports & fitness persons' who taking continuous and heavy workout during rehabilitation. The best result from several trials for each hand will be recorded the digital display will not only show the maximum hand grip strength but also continuous pulse rate variations and spo2 level, which will be beneficial to teach undergraduate medical students about the effect of isometric exercise on heart rate and oxygen saturation.

Keywords: IoT-based health monitoring system, Isometric strength, ESP8266, Pulse oximeter sensor & Force sensitive resistor.

TABLE OF CONTENTS

CHAPTER NO.	TITLE	PAGE NO.
	ABSTRACT	i
	LIST OF ABBREVIATIONS	iv
	LIST OF FIGURES	v
	LIST OF TABLES	vi
1	INTRODUCTION	1
	1.1 OBJECTIVE OF THE PROJECT	2
	1.2 SHORT COMING OF EXISTING SYSTEM	2
	1.3 BACKGROUND	2
	1.4 PLAN OF IMPLEMENTATION	3
	1.5 ADVANTAGE OF THIS INSTRUMENTATION	5
2	LITERATURE REVIEW	6
3	AIM AND SCOPE	11
	3.1 AIM	11
	3.2 SCOPE	11
4	MATERIALS AND METHODS	12
	4.1 BLOCK DIAGRAM	12
	4.1.1 NODE MCU	13
	4.1.2 FORCE SENSITIVE RESISTOR	13
	4.1.3 PULSE OXIMETER	14
	4.1.4 OLED DISPLAY	15
	4.2 DESIGNING AND IMPLEMENTATION OF AN FORCE SENSOR	16
	4.3 DESIGNING AND IMPLEMENTATION OF THE PULSE OXIMETER	18

	4.3.1 FEATURES OF MAX30100 PULSE OXIMETER	18
	4.4 IMPLEMENTATION OF INTERFACE BETWEEN NODE MCU AND OLED DISPLAY	19
	4.5 ESTABLISHING THE CONNECTION BETWEEN NODE MCU AND THE CLOUD SERVER	21
	4.6 ALGORITHMS AND LIBRARIES USED	22
5	RESULTS AND DISCUSSION	24
	5.1 DISCUSSION	24
	5.1.1.PREPARE EQUIPMENT	24
	5.1.2.PRE-TEST MEASURES	25
	5.1.3.PREPARE ATHLETES	25
	5.1.4 GUIDELINES FOR TESTING	25
	5.1.4.1 NUTRITIONAL PREPARATION	25
	5.1.4.2 PHYSICAL PREPARATION	26
	5.2 DESCRIPTION OF THE PRESENT INVENTION	27
	5.2.1 CLAIMS	28
	5.2.2. MANUFACTURING	28
	5.3 RESULT	28
6	CONCLUSION AND FUTURE WORK	31
	6.1 CONCLUSION	31
	6.2 FUTURESCOPE OF THIS PROJECT	31
	REFERENCES	32

LIST OF ABBREVIATIONS

BPM	BEATS PER MINUTE
FSR	FORCE SENSITIVE RESISTOR
GND	GROUND
HR	HEART RATE
HS	HANDGRIP STRENGTH
HRV	HEART RATE VARIABILITY
IHG	ISOMETRIC HANDGRIP
IoT	INTERNET OF THINGS
I2C	INTER-INTEGRATED CIRCUIT
MCU	MICRO-CONTROLLER UNIT
OLED	ORGANIC LIGHT-EMITTING DIODE
RXD	RECEIVE DATA
SCL	SERIAL CLOCK
SDA	SERIAL DATA
SPO2	OXYGEN SATURATION
TXD	TRANSMITTED DATA
VCC	VOLTAGE COMMON COLLECTOR

LIST OF FIGURES

FIG NO	TITLE	PAGE NO
4.1	BLOCK DIAGRAM OF IOT HAND GRIP	12
4.2	NODE MCU	13
4.3	FORCE SENSITIVE RESISTOR	14
4.4	PULSE OXIMETER	15
4.5	OLED DISPLAY	16
4.6	NODE MCU WITH FORCE SENSOR	17
4.7	NODE MCU WITH PULSE OXIMETER	19
4.8	NODE MCU WITH OLED DISPLAY	20
4.9	NODE MCU WITH BLYNK APPLICATION	22
5.1	PROTOTYPE	28
5.2	OUTPUT DISPLAY ON THE OLED DISPLAY	29
5.3	IOT BLYNK APPLICATION	30

LIST OF TABLES

TABLE	TITLE	PAGE NO
4.1	FORCE VALUE WITH DIFFERENT RESISTOR	18

CHAPTER 1

INTRODUCTION

Edme Regnier created the hand grip dynamometer in 1807 using the design of another dynamometer at the time. The maximal isometric strength of the hand and forearm muscles may be measured with the use of a hand grip dynamometer. Traditional hand grip dynamometers come in analogue and digital formats. Both assess the user's force in order to calculate their pressure capacity and, in turn, their muscular strength. To assess blood oxygen saturation and pulse rate, Takuo Aoyagi created the pulse oximeter in 1974. The article's goal is to analyse how an injured athlete, fitness enthusiast, or sportsperson is recuperating by using main tests like heart rate, spo2 level, and muscular strength on the injured area and daily case study records. Cardiac patients who are receiving rehabilitation can easily obtain their recovery period.

In an effort to assess hand strength, heart rate, and oxygen saturation, we strive to introduce a novel apparatus. The major goal of this invention is to make it easier for athletes to regularly assess their isometric muscular strength in order to pass a fitness test. Strength, balance, and teaching abilities necessary for ADLS are developed through collaboration between physical therapists and occupational therapists. The goal of therapy is to improve the patient's muscle strength, joint mobility, and balance. The goal of this treatment session is to assist patients become better at doing daily tasks. Patients who use wheelchairs, walking sticks, etc. should be conscious of how their muscles have evolved and what they do. The normal activities of daily living, or ADLs, are improved with the use of treatments. Occupational therapists may use a variety of activities and tools to improve your strength.

The main goal of using a handgrip dynamometer is to track the amount of pressure exerted by the user throughout various workout sessions. In order to process and treat patients more quickly, premier hospitals need a quick and traditional way for detecting pressure. The advantage of having numerous parameters is only available to digital devices at this time. Consequently, it includes the add-on

idea for continuous heart rate and spo2 level measurement. Currently, the heart rate and oxygen saturation are measured independently utilising type-specific devices for measuring muscular strength in the rehabilitation sector using stand-alone dynamometers and other current models. There is no technology that can carry out these tests simultaneously.

1.1 OBJECTIVE OF THE PROJECT

In this work, a revolutionary integrated digital hand grip dynamometer is designed, built, and data on the strength of the hand grip are analysed. In contrast to similar products on the market, the dynamometer may immediately save information in a computer. Ergonomics are prioritised in the dynamometer's design. Data acquisition device from National Instruments serves as the signal receiver for signals sent to the computer. demonstrating that factors and strength had a moderate to significant correlation. Numerous locations on the body can be used to gauge the pulse. An artery can be crushed against a bone at these locations, just beneath the skin, causing us to feel each heartbeat.

1.2 SHORT COMINGS OF EXISTING SYSTEM

The primary application of a hand grip dynamometer is to measure the strength of patients, athletes, cricket players, etc. Due to the spring gauge, analogue instruments are overly heavy and have poor accuracy. Digital hand grips are precise, simple to use, and real-time observable. We have included a pulse oximeter in this gadget to continuously and in real time measure the pulse rate and spo2 level.

1.3 BACKGROUND

- Conventional handgrip dynamometer are of both analog and digital.
- Both measures the force exerted by the user for determining the pressure capacity of the user thereby calculating the muscle strength.
- The digital one's have the advantage of possessing multiple parameters but currently no device has such advantage.

- Hence the add-on concept for continuous recording of pulse rate and spo2 level is included in it.

1.4 PLAN OF IMPLEMENTATION

The project is implemented in various stages mentioned below

Stage 1 Designing the mainframe

Stage 2 Designing and implementation of the force sensor

Stage 3: Designing and implementation of the pulse oximeter

Stage 4: Implementation of interface between Node-MCU and OLED Display

Stage 5: Establishing the connection between Node-MCU and the cloud server

Stage 1

As the mainframe's design is being done at this point, it is the most crucial aspect of the system. The mainframe plays a critical role in improving the accuracy with which the patient's pressure, heart rate, and spo2 level are measured.

The mainframe is made to carry all the components compactly without placing a significant burden on the patient's hands, which is present in the current market-available devices and lowers measurement accuracy and causes pain to the patient.

The frame is constructed such that it can support both the Node-MCU and the oled display on that side. The pressure handle, on which the force sensor is mounted for the isometric strength measurement, makes up the central section. Separately placed in a band and left in a mobile state is the pulse oximeter sensor..

Stage 2

Connecting one end of a resistive sensor to power and the other to a pull-down resistor to ground is the simplest way to measure it. The analogue input of a microcontroller is then linked to the point between the fixed pull-down resistor and

the variable FSR resistor. Processing for this may be carried out just as readily with a 5V source as it can with a 3.3V one. The analogue voltage reading in this setup runs from 0V (ground) to around 5V (or almost the same as the power supply voltage). According to how it operates, the total resistance of the FSR and pull-down resistor drops from around 100 kohm to 10 kohm as the FSR's resistance rises. That implies that both are being affected by the current.

Stage 3

The instrument known as a pulse oximeter is often worn on a fingertip. It calculates the pulse rate and blood's oxygen saturation using laser beams. The quantity of oxygen transported by the blood is revealed by oxygen saturation. Without taking a blood sample, the pulse oximeter can determine the quantity of oxygen in the blood.

A pulse oximeter typically displays two or three values. The oxygen saturation level, which is the most crucial figure, is typically abbreviated SpO2 and shown as a percentage. The abbreviation for the pulse rate, which is akin to heart rate, is PR, and there may occasionally be a third digit indicating signal strength. Most healthy people have oxygen saturation levels between 95% and 100%, although patients with lung issues can have lower numbers. Higher altitude residents often have somewhat lower oxygen saturation levels. The simplest basic pulse oximeter is made up of a single photodiode (PD) in a reflecting or transmissive arrangement, two LED (one red 660 nm LED and one infrared (IR) 940 nm LED), Red will be pulsed by the pulse oximeter.

Stage 4

The steps listed below must be completed in order to connect an OLED display to Node MCU: Choose an OLED display that is compatible with Node MCU. A number of commercially available OLED screens are supported by the Node MCU platform. An alternative is a display with a suitable interface and resolution. Connect the OLED display to the Node MCU. Connect the data, ground, and power lines of the OLED display to the corresponding Node MCU board pins. VCC, GND, SDA, and

SCL are the four connecting pins that OLED screens commonly have. Install the required libraries. The Adafruit_SSD1306 library, an OLED display library for Node MCU, has to be installed. The Node MCU firmware may be used to install these libraries.

Stage 5:

To connect Node MCU to a cloud server, adhere to the steps listed below: choosing a server platform for the cloud The multiple cloud server platforms available include AWS IoT, Google Cloud IoT, Microsoft Azure IoT, and IBM Watson IoT, to name just a few. Select a platform based on your needs. Establish a profile: Create an account on the platform for the cloud server of your choice and modify it to suit your needs.

Create a Wi-Fi network connection configuration for the Node MCU to set up. You may use the integrated Wi-Fi module in Node MCU to access the internet. You will also need to install and configure the required libraries for your cloud server platform. Connect to the cloud-based server: Use the cloud server platform's APIs and libraries to connect.

1.5 ADVANTAGES OF THIS INSTRUMENTATION

The following are the list of advantages

- Hardware reduction in terms of elimination of bulky instrumentation
- Cost effective and cheap measurement system
- Easy to measure the pulse rate, spo2 level & strength in same time
- Accuracy can be increases
- Presence of Pulse oximeter recording sensors which will continuously record the pulse rate and spo2 level.

CHAPTER 2

LITERATURE SURVEY

- 1) AmritaPal.*etal.*,(2022)Obstructive sleep apnea increases sympathetic vasoconstrictor drive and reduces baroreflex sensitivity, the degree to which blood pressure changes modify cardiac output. Whether night time continuous positive airway pressure corrects BRS in the awake state in remains unclear. We assessed spontaneous BRS using non-invasive continuous BP and ECG recordings at rest and during handgrip and Valsalva challenges, maneuvers that increase vasoconstrictor drive with progressively higher BP, in untreated OSA CPAP-treated OSA and healthy participants.
- 2) Anas Rashid *et al.*,(2022) The present study aimed to compare sympathetic hemodynamic effects in masticatory and limb muscles in response to different stressors. Twelve healthy participants were subjected to a randomized series of stressors, including cold pressor test mental arithmetic test, apnea, isometric handgrip (IHG) and post-handgrip muscle ischemia, while in the supine position. Spatially-resolved near-infrared spectroscopy was used to measure relative changes in blood volume and oxygenation of the resting masseter and biceps muscles. Cardiac output, heart rate, and arterial blood pressure were also monitored.
- 3) Andrea Herrera-Santelices *et al.*, (2021) Bariatric surgery is an effective approach to weight loss and long-term comorbidity resolution. Although recommended in several guidelines, supervised exercise has not been systematically prescribed after bariatric surgery. The aim of this study is to determine the effects of two types of exercise, moderate-intensity continuous training and high-intensity interval training, on body composition, cardiopulmonary function, and perceived quality of life in bariatric surgery patients.
- 4) BurakGürer *et al.*, (2020) The current study aims to determine the acute effects of rock and ice climbing on a particular strength, circulation, and tactile feeling

features that could affect climbing performance when considered together, such as handgrip strength (HS), oxygen saturation (SpO₂), heart rate (HR), and tactile discrimination using two-point discrimination. To this end, 13 rock climbers and 16 ice climbers, who had at least ten years of experience, participated in the study. HS, SpO₂, HR, and TPD measurements were implemented before and after climbing. HS was measured with a dynamometer, SpO₂ and HR were measured with a pulse oximeter, and the TPD measurement was performed with a two-point discriminator.

- 5) Champaneri Viral I., Kathrotia Rajesh (2016) To study the effects of exercise, how important it is to choose a posture? We aimed to characterize the possible impact of different body positions on cardiovascular parameters during and after sustained isometric handgrip (IHG) Cross sectional study was carried out in 33 young adult males (mean age: 19.21±1.083 years). We recorded Blood Pressure, Heart rate (HR) and SpO₂ at rest, 1st minute of exercise, at 3rd minute of exercise or prior to failure and at 2 minutes after IHG exercise at 30% of Maximum voluntary contraction in sitting, supine and standing positions. Mean arterial pressure, Pulse pressure and Rate Pressure Product were calculated from BP and HR data. Results: SBP, DBP, MAP, HR and RPP increased significantly during 1st and 3rd min of exercise and returned to resting level at 2 min after exercise in all three postures. During resting period and at 2 min after IHG exercise SBP and PP were significantly higher in supine compared with sitting and standing position, while DBP, HR and RPP were significantly increased in standing position. DBP, PP, MAP and HR changed significantly in supine, sitting
- 6) Dr. Rajesh D. Chandrawanshi (2020.) On the basis of research study it is concluded that Science and Technology is useful to analysis the lacuna of body movements, to rectify the medical internal and external problems of body parts, performance base data analysis, correct judgment with help of latest equipments at the time of sports skills performance and to manufacture latest scientific equipments of various games and sports
- 7) Ebru Calik-Kutukcu1 et al., (2015.) Arm strength training may improve

functional performance for patients with chronic obstructive pulmonary disease. This trial investigated the effects of arm strength training on arm exercise capacity, activities of daily living and occupational performance in patients with COPD. These was a randomized controlled trial in an outpatient clinic. Forty-two stable patients with COPD were randomly assigned into treatment and control groups. The treatment group underwent an 8-week (23 sessions) arm strength training programme. Both groups completed daily breathing exercises at home. Tests included hand grip strength, arm ergometer test, the Glittre-ADL and ADL Simulation tests and measures included the Milliken ADL Scale (MAS) and the Canadian Occupational Performance Measure (COPM).

- 8) Ilse Vanhorebeek et al., (2022) Many critically ill children face long-term developmental impairments. The PEPaNIC trial attributed part of the problems at the level of neurocognitive and emotional/behavioral development to early use of parenteral nutrition (early-PN) in the PICU, as compared with withholding it for 1 week (late-PN). Insight in long-term daily life physical functional capacity after critical illness is limited. Also, whether timing of initiating PN affects long-term physical function of these children remained unknown.
- 9) Michael J. Macartney et al., (2020.) Heart rate variability (HRV) is often measured during clinical and experimental cardiovascular reflex tests, as a reflection of cardiac autonomic modulation, despite limited characterization of the rapid responses that occur. Therefore, we evaluated the responsiveness of HRV indices in 20 healthy young adults (age, 27 ± 6 y; mass, 76.9 ± 16.8 kg; height, 1.79 ± 0.12 m) during four separate established CRT.
- 10) SHALINI SHARMA¹ et al., (2012) COPD, overactivation of ergoreceptors may be a link between peripheral changes, sympathetic over activation and increased hemodynamic and ventilatory responses to exercise. The current study was undertaken to test the hypothesis that, ergoreflex in COPD patients is hyperactive and contributes to breathlessness and exercise limitation. The aim of study was to demonstrate its hyperactivity in COPD. To record other efferent effects. Twenty stable COPD male patients aged 50 ± 2.5 years and

twenty healthy male subjects aged 48 ± 3.5 years were studied under experimental and control groups. The ergoreflex contribution to cardio respiratory parameters was assessed by post-handgrip regional circulatory occlusion method (PH-RCO) and computed as the difference in heart rate and respiratory rate response between PH-RCO and control run without PHRCO. Results were analyzed for significance between two groups by repeated measures ANOVA.

11) TREVOR SHORT *et al.*, (2022) Phase angle has emerged as a prognostic indicator of survival and quality of life in cancer patients. Identifying measures of physical fitness that correlate with can provide guidance towards optimizing cancer rehabilitation programs. To examine the relationship between and physical fitness in breast cancer survivors. Sixty-three breast cancer survivors (60 ± 9 years, PhA 4.59 ± 0.52 , mean $\pm$ SD) completed assessments for muscular strength, muscular endurance, cardiorespiratory endurance, flexibility, and body composition. and body composition were measured using bioimpedance analysis (Inbody 770) at 50 KHz. The correlations between phase angle and measures of fitness were evaluated using Pearson coefficients. Simple and multiple linear regression was used to test if measures of muscular strength, muscular endurance, and cardiorespiratory endurance significantly predict PhA.

12) Vanessa Teixeira do Amaral *et al.*, (2022) Our aim was to test the hypothesis that tele-supervised home-based exercise training (exercise) is an effective strategy for improving cardiovascular, respiratory, and functional capacity parameters in individuals that were hospitalized due to coronavirus disease 2019 (COVID-19). Thirty-two individuals (52 ± 10 years; 17F) randomly assigned to exercise ($N = 12$) and control groups ($N = 20$), had their anthropometric (weight, body mass index), hemodynamic (brachial and central blood pressure), vascular (arterial stiffness), ventilatory (pulmonary function and respiratory muscle strength), and functional parameters (handgrip strength, five-time sit to stand, timed up and go test and six-minute walking test [6MWT]) assessed at baseline (30 to 45 days of hospital discharged) and after 12 weeks of follow-up. Both groups similarly increased ($P < 0.001$) forced vital

capacity (absolute and % of predicted), forced expiratory volume in the first second (absolute and % of predicted), and handgrip strength during follow-up. However, only exercise group reduced carotid-femoral pulse wave velocity (-2.0 ± 0.6 m/s, $P = 0.048$), and increased ($P < 0.05$) resting oxygen saturation (1.9 ± 0.6 %), mean inspiratory pressure (24.7 ± 7.1 cmH₂O), mean expiratory pressure (20.3 ± 5.8 cmH₂O) and % of predicted mean expiratory pressure (14 ± 22 %) during follow-up.

- 13)** Viral I Champaneri , Rajesh G Kathrotia (2019.) Isometric exercise is less extensively studied and compared to isotonic exercises, variable circulatory responses were observed by previous researchers to isometric exercise. The present study aimed to analyze the changes in cardio circulatory parameters during and after isometric exercise in young adult males. : A total of 31 normotensive young healthy males (Mean age: 19.065 ± 0.92 years) were randomly selected in a cross-sectional study. Isometric handgrip (IHG) exercise at 30% of maximum voluntary contraction was maintained by participants for 3 min or till fatigue. Hemodynamic factors such as blood pressure, heart rate, and peripheral oxygen saturation were recorded noninvasively at rest, 1st min of exercise, at 3rd min or till failure, and 2 min after completion of exercise. Mean arterial pressure, pulse pressure, and rate pressure product were calculated subsequently. Anthropometric variables were correlated with MVC

CHAPTER 3

AIM AND SCOPE OF THE HAND GRIP DYNAMOMETER

3.1 AIM

The Node MCU board is connected to the Pulse Oximeter, Force Sensor, and OLED display on the breadboard in order to power all of the instruments. Node-MCU is connected to the Blynk application to transport data to a PC or mobile device.

3.2. SCOPE

- A Force Sensitive Resistor and a pulse sensor are used in the experiment to measure force and heart rate, respectively.
- Its main components are the Force Sensitive Resistor, Pulse Oximeter, and Node MCU. The test subject holds the dynamometer in the hand with the arm straight and the elbow at the side of the body.
- The handle of the dynamometer can be altered if necessary so that the base sits on the heel of the palm and the grip rests on the middle four fingers.
- When ready, the participant contracts isometrically for the whole two seconds while holding the dynamometer. Your body may only move at this certain time. After several trials, the best performance of each hand will be recorded.
- Using the ESP8266, a serial hand grip dynamometer with integrated pulse rate is created.
- For serial communication between the power and the instruments in this, an ESP8266 is employed.
- Esp8266 is a microcontroller used for information transmission and reception.
- The strength, pulse rate, and spo2 level of the sensor are easily ascertainable.
- The instrument also becomes more accurate. It is shown on a nearby OLED Display.

CHAPTER 4

MATERIALS AND METHODS

4.1 BLOCK DIAGRAM

Handgrip strength is a key factor in patient studies, athletes, and sportspeople. The main goal of using a handgrip dynamometer is to track the amount of pressure exerted by the user throughout various workout sessions. In order to process and treat patients more quickly, premier hospitals need a quick and traditional way for detecting pressure. Traditional handgrip dynamometers come in both analogue and digital varieties.

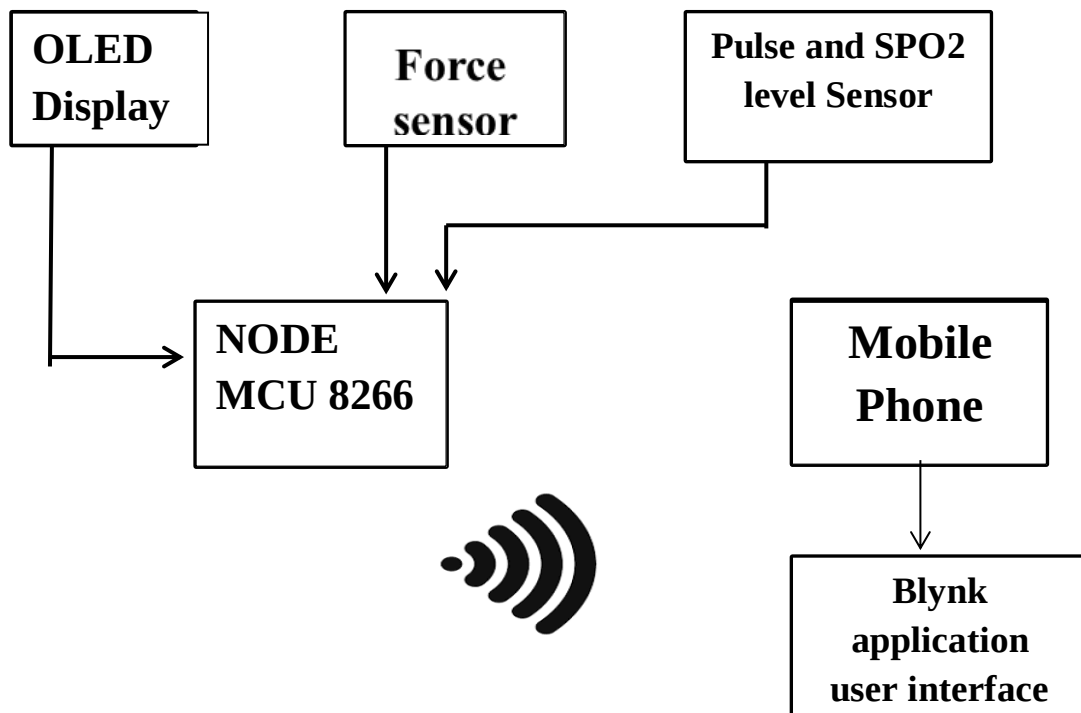


Figure 4.1 Block diagram of IOT hand grip

Both monitor the amount of force the user applies in order to calculate their pressure tolerance and, in turn, their muscular strength. Although no gadget presently has this advantage, digital ones have the benefit of having various parameters. Consequently, it has the add-on idea for continuous heart rate recording.

4.1.1 NODE MCU

An open source LUA-based firmware called NodeMCU was created for the ESP8266 WiFi chip. Node-MCU firmware includes an ESP8266 Development board/kit in order to explore ESP8266 chip capability. An open source IoT platform is NodeMCU. This ESP8266 NodeMcu includes hardware based on ESP-8266 modules (shown in figure 3.2 below) and firmware that can operate on ESP8266 Wi-Fi SoC chips.

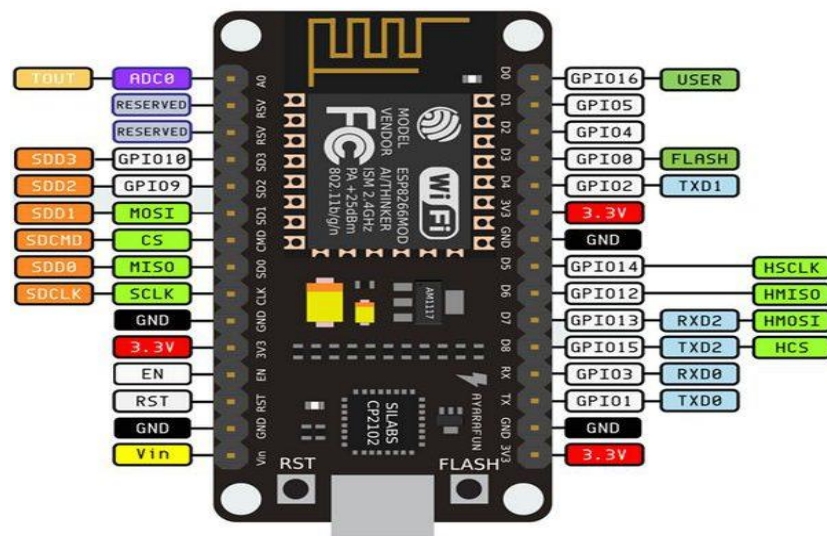


Fig 4.2 Node MCU

The gear that can be accessed by WiFi and Bluetooth called WiFi + Bluetooth hardware. Hardware based on the ESP-8266 module and firmware that works on Espressif Systems' ESP8266 are also included. The firmware is typically referred to as "NodeMCU" rather than the development kits. The Lua programming language is employed by the firmware. It has a Lua project foundation.

The ESP8266 WiFi-enabled chip is part of the NodeMCU Kit and Board. A low-cost Wi-Fi chip using the TCP/IP protocol was created by Systems. You may refer to ESP8266 WIFI MODULE for additional details about this device.

4.1.2 Force sensitive resistor

Force sensors are basically devices used to convert an applied force to a quantity that can be measured. Force sensors are available in different forms and

are of different types. Force sensor use load cells to weigh objects and prevent machinery from overloading. At the core of force sensor load cells, transducers that convert force into measurable electrical outputs(shown in the figure 4.2 below).



Fig 4.3 Force sensitive resistor

Load cells are an example of a force sensor. Load cells come in a variety of kinds, including pneumatic load cells, capacitive load cells, strain gauge load cells, hydraulic load cells, etc. Understand every aspect of force-sensing resistor technology. Sensors are physical objects that are capable of detecting events and changes in different factors, including the environment, temperature, humidity, and others. The sensors can produce the right output based on the (events or) changes that are sensed.

Force sensors function by responding to the applied load and weight before converting them into a measurable output. The pneumatic load cell, which serves as a force balancing mechanism, is one example. Since pneumatic load cells do not produce electricity, they are not considered Force transducers.

- **Detecting human interaction.** Sense whether a touch is accidental or intentional by a reading force (or other signal processing)
- **Using force for UI feedback.** Detect user's touch force to make a more intuitive interface
- **Enhancing tool safety.** Differentiate a grip from a touch as a safety lock
- **Finding centroid of force.** Use multiple sensors to determine centroid of force

- **Detecting presence, position, or motion** Sense a person/patient in a bed, chair, or medical device
- **Detecting liquid blockage.** Detect tube or pump occlusion or blockage by measuring back pressure

4.1.3 Pulse Oximeter

The sensor module known as the MAX30100 has both a pulse oximeter and a heart rate sensor. It is often employed in wearable electronics to measure oxygen saturation and pulse rate.

The MAX30100's pulse oximeter function measures the quantity of light that is absorbed by shining red and infrared light through a body part, such as a finger. As opposed to oxygenated blood, which transmits more red light while absorbing more infrared light, deoxygenated blood absorbs more infrared light. By analysing the ratio of absorbed light at the two wavelengths (as illustrated in figure 4.3 below), the MAX30100 can estimate oxygen saturation.



Fig 4.4 Pulse Oximeter

The MAX30100's heart rate sensor tracks fluctuations in blood volume caused by heartbeats. It can therefore calculate the pulse rate. In general, wearable technology uses the MAX30100 sensor to measure heart rate and oxygen saturation. The readings from pulse oximeters should be evaluated carefully, it should be emphasised, since they can be impacted by things like poor circulation, skin pigmentation, and motion artefacts.

4.1.4 OLED Display

A 1.3 inch OLED display with I2C interface is a small display module that uses OLED technology to produce a high-quality, high-contrast image. A 1.3-inch

screen and an I2C interface, which permits two-wire bus connection with other electrical devices, are also features of this gadget.

Each pixel on the display is able to independently emit light thanks to OLED technology, creating a high-quality image with vibrant colours, deep blacks, and excellent contrast. This makes it appropriate for a range of applications, including wearable technologies, embedded systems, and portable electronics.

The display uses the common I2C interface, which enables several devices to interact with one another via a single, two-wire bus. As can be seen in figure 3.5 below, this makes it easier to link the display to other electrical devices such sensors, single-board computers, and microcontrollers.

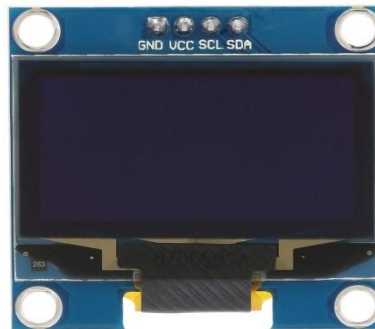


Fig 4.5 OLED Display

The 1.3 inch OLED display's I2C interface, compact size, and superior image quality make it easy to incorporate into tiny electrical projects. Its low power consumption also makes it the ideal choice for battery-powered devices. Additionally, the I2C interface makes it simple to control and programming the display, which speeds up prototyping and development.

4.2 DESIGNING AND IMPLEMENTATION OF AN FORCE SENSOR

Connecting one end of a resistive sensor to power and the other to a pull-down resistor to ground is the simplest way to measure it. The analogue input of a microcontroller like an Arduino is linked to the point between the fixed pull-down resistor and the variable FSR resistor.

Processing for this may be carried out just as readily with a 5V source as it can with a 3.3V one. The analog voltage reading in this setup runs from 0V

(ground) to around 5V (or almost the same as the power supply voltage). According to how it operates, the total resistance of the FSR and pull-down resistor drops from around 100 kohm to 10 kohm as the FSR's resistance rises. That indicates that both are experiencing current flow .

A substance that varies in resistance in response to pressure or force is referred to as a force-sensing resistor. When compared to other sensor types, this force detecting resistor is extremely sensitive, and there is little delay between each measurement and the transfer of the data to the Arduino and, ultimately, the microcontroller. Although force sensing resistors are tiny, they can detect strong forces. (as seen in picture 4.5 below).

Processing for this may be carried out just as readily with a 5V source as it can with a 3.3V one. The analog voltage reading in this setup runs from 0V (ground) to around 5V (or almost the same as the power supply voltage).

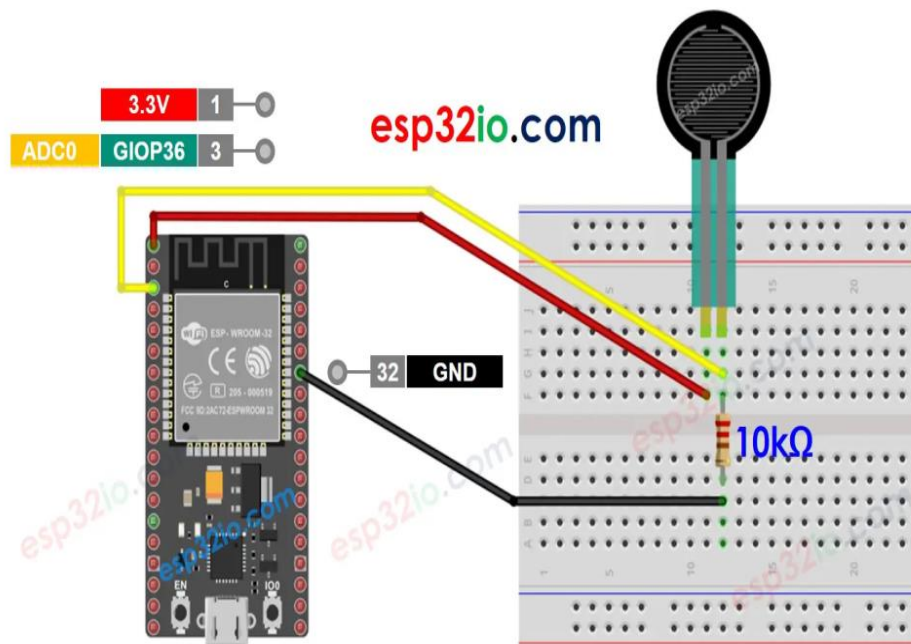


Fig 4.6 Node MCU with force sensor

A conductive polymer makes up force-sensing resistors, which alter resistance in a predictable way in response to the application of force to their surface. Typically, they are provided in the form of a polymer sheet or an ink that may be screen printed on. Particles suspended in a matrix, both electrically

conducting and non-conducting, make up the sensing film. The sub-micrometer-sized particles are designed to boost surface durability, improve mechanical qualities, and lessen temperature dependency. Particles on the sensing film's surface that come into contact with the conducting electrodes change the film's resistance when a force is applied to the surface.

This table indicates the approximate analog voltage based on the sensor force/resistance w/a 5V supply and 10K pull-down resistor.

As with all resistive based sensors, force-sensing resistors require a relatively simple interface and can operate satisfactorily in moderately hostile environments.

Table4.1 Force value with different resistor

Force (lbs.)	Force (N)	FSR Resistance	(FSR + R) ohm	Current thru FSR+R	Voltage across R
None	None	Infinite	Infinite!	0 mA	0V
0.04 lbs.	0.2 N	30 K ohm	40 Kohm	0.13 mA	1.3 V
0.22 lbs.	1 N	6 Kohm	16 Kohm	0.31 mA	3.1 V
2.2 lbs.	10 N	1 Kohm	11 Kohm	0.45 mA	4.5 V
22 lbs.	100 N	250 ohm	10.25 Kohm	0.49 mA	4.9 V

The benefits of FSRs over conventional force sensors are their small size (usually less than 0.5 mm thick), low cost, and strong shock resistance. Their poor accuracy is a drawback; measurement results might vary by 10% or more. It is more important to consider light than to continuously adjust the value when obtaining a perment value. The load cell should be employed.

4.3 DESIGNING AND IMPLEMENTATION OF THE PULSE OXIMETER

The sensor is a combined pulse oximetry and heart rate sensor. To detect pulse and pulse-rate signals, it incorporates two LEDs, a photodetector, improved optics, and low-noise analogue signal processing. It runs on 1.8V and 3.3V power

sources and can be software turned down with little any standby current, allowing the power supply to always be connected.

4.3.1 Features of MAX30100 Pulse Oximeter

1. Consumes very low power (operates from 1.8V and 3.3V)
2. Ultra-Low Shutdown
3. Fast Data Output Capability

We will now connect the MAX30100 Pulse Oximeter to the I2C 1.3" OLED Display and NodeMCU ESP8266. The connections and circuit schematic are shown below. The gadget may be put together precisely as illustrated in figure 4.6 below.

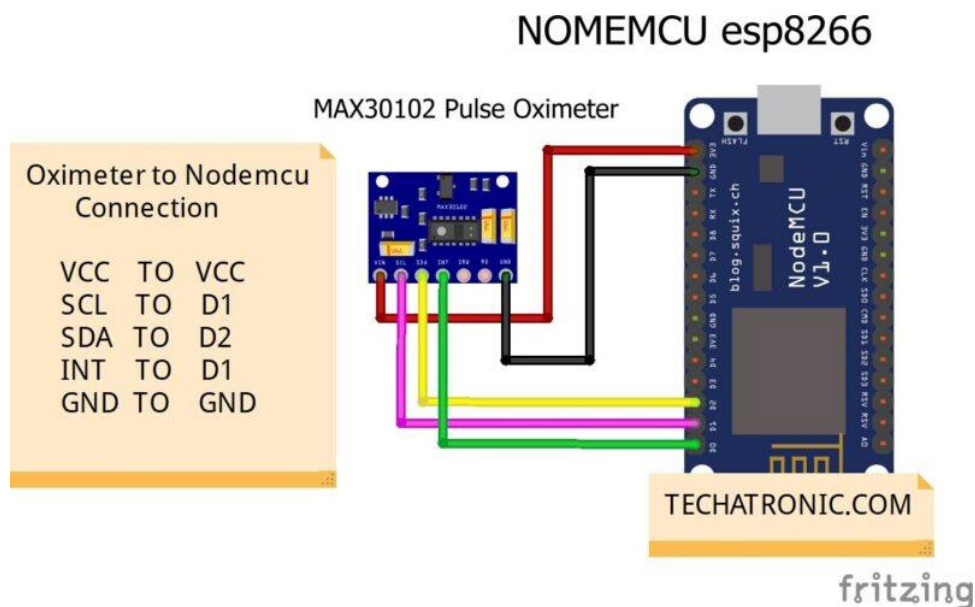


Fig 4.7 Node MCU with pulse oximeter

I2C pins are shared by the OLED Display and the MAX30100. So, connect their SDA and SCL pins to the NodeMCU ESP8266 Board's D2 and D1, respectively. OLED Display and NodeMCU need a 3.3V power source. So, join their VCC terminal to the NodeMCU's 3.3V supply.

4.4 IMPLEMENTATION OF INTERFACE BETWEEN NODE MCU AND OLED DISPLAY

OLED displays come in a variety of sizes (12864, 12832, etc.) and colours (white, blue, and dual-color OLEDs, for example). Others have an SPI interface, while other OLED panels have an I2C interface. a 0.96-inch 12864 I2C OLED

screen. Regardless of the size or colour of your module, the information on this page is still helpful.

A potent single-chip CMOS OLED driver controller called SSD1306, located at the centre of the module, manages all RAM buffering with very little assistance from your ESP8266. Additionally, the 3.3V microcontrollers like the ESP8266 may be interfaced with using the SSD1306 controller because its working voltage varies from 1.65V to 3.3V. Display the output on an OLED display using a certain matrix. This matrix can assist to show the Heart BPM, FORCE, and spo2 within a specific range. The marixes utilised in the programme are (0, 0), (0, 25), (0, 45), and (0, 55).

Because an OLED display produces its own light, it does not need a backlight, unlike a character LCD display. The display's great contrast, incredibly broad viewing angle, and capacity for displaying deep black depths are all explained by this.

The Figure 4.7 below shows how to connect everything.

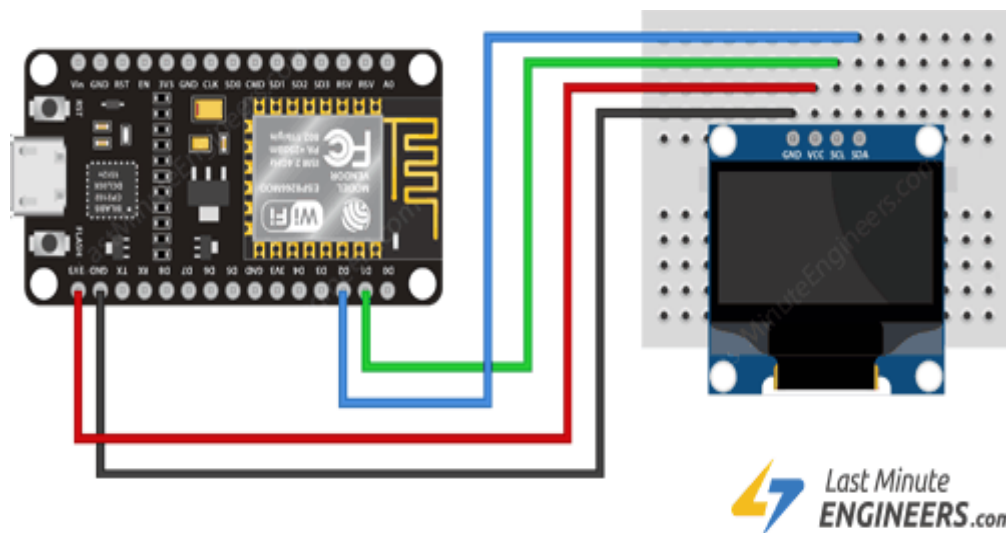


Fig 4.8 Node MCU with OLED Display

Power use is considerably reduced when there is no backlight. Although this fluctuates depending on how much of the panel is illuminated, an average OLED display needs roughly 20mA. These OLED screens can display extremely detailed visuals and are very readable due to their high contrast.

The connections are simple. Start by connecting the GND pin to ground and the VCC pin to the 3.3V output of the NodeMCU. Finally, connect the ESP8266's I2C pins D1 and D2 to the SCL and SDA pins, respectively.

The OLED display's SSD1306 controller features adaptable but difficult drivers. It needs a deep understanding of memory addressing to operate the SSD1306 controller. Thankfully, the Adafruit SSD1306 library was created to obscure the SSD1306 controller's complexity, enabling us to operate the display with straightforward commands. Go to Sketch > Include Library > Manage Libraries to install the library. Wait for the Library Manager to refresh the list of installed libraries and download the library index.

4.5 ESTABLISHING THE CONNECTION BETWEEN NODE MCU AND THE CLOUD SERVER

Blynk is an Internet-of-Things platform for iOS or Android smartphones that allows users to remotely operate devices like Arduino, Raspberry Pi, and NodeMCU. Using this programme, you may compile and provide the right address on the various widgets to construct a graphical interface or human machine interface (HMI).

For use with the Internet of Things, Blynk was created. It can store data, visualise it, show sensor data, remotely operate hardware, and perform many other fascinating things.

There are three major components in the platform:

- Blynk App: – It allows you to create amazing interfaces for your projects using various widgets which are provided.
- Blynk Server: – It is responsible for all the communications between the smartphone and hardware.

You can use the Blynk Cloud or run your private Blynk server locally. It's open-source, could easily handle thousands of devices and can even be launched on a Raspberry Pi.

- Blynk Libraries: – It enables communication, for all the popular hardware platforms, with the server and process all the incoming and outgoing

commands.

In the Blynk programme, pressing the Button initiates a process in which data is sent to the Blynk Cloud and then mysteriously finds its way to the installed devices. It is simple to create a smart home since NodeMCU is used as a client and put in every room of the house.

The Figure 4.8 below shows how to connect everything.

NodeMCU can operate as expected in its capacity to read sensors and carry out orders to trigger actuators. However, in order for the NodeMCU to operate within a certain range with a minimal power supply installed, it is important to monitor the I/O consumption load attached to the NodeMCU..

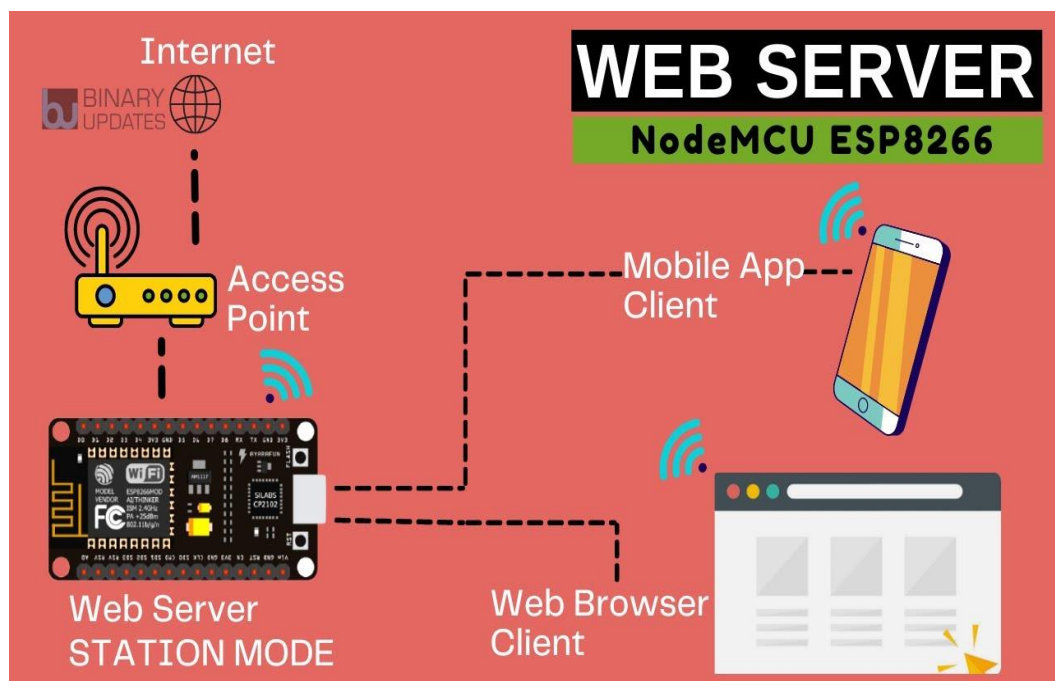


Fig 4.9 Node MCU with Blynk application

4.6 ALGORITHMS AND LIBRARIES USED

The programme creates an application that reads pulse and blood oxygen saturation levels and displays them on an OLED screen by combining a number of libraries and parts. It also has a function that shows a heart icon when a heartbeat is detected and a snowflake animation.

The program uses the following libraries:

- Wire.h
- MAX30100_PulseOximeter.h
- Blynk.h
- ESP8266WiFi.h
- BlynkSimpleEsp8266.h
- Adafruit_GFX.h
- Adafruit_SSD1306.h

Here is the algorithm for the program:

1. Import the required libraries and define global variables.
2. Set up the Wi-Fi connection and initialize the Blynk app with the authentication token.
3. Initialize the pulse oximeter and OLED display.
4. Display a message on the OLED screen indicating that the pulse oximeter is being initialized.
5. Check if the pulse oximeter initialization was successful.
6. If the pulse oximeter initialization was successful, display a message on the OLED screen indicating that the device is ready to use.
7. Set up a loop that reads pulse and blood oxygen saturation levels and sends them to the Blynk app every second.
8. Read the analog input from a force sensitive resistor (FSR) and check if it has exceeded a threshold value. If the FSR reading is above the threshold, display a heart icon on the OLED screen to indicate a beat has been detected.
9. Display a snowflake animation on the OLED screen.
10. Repeat steps 7-9.

CHAPTER 5

RESULT AND DISCUSSION

The strength and pulse value results and discussions may be saved and stored in the IOT application. A push force scale was utilised to supply the force sensor and the pulse rate (pulse sensor) for signal calibration. Latency can be added in the device for the purpose of accuracy. The load cell's voltage and load both changed linearly. Tolerance after amplification was 5%. Ergonomics are prioritized in the dynamometer's design. The load cell's circuit is powered by a 9 V battery, and its excitation voltage is 5 V. Data is transmitted from one device to another using Transmitted Data (TXD). Receive Data (RXD) receives the data. The Internet of things (IoT) is a network of interconnected computing devices, mechanical and digital machines, and human- and machine-to-computer contact is not necessary for data flow over the network.

5.1.DYNAMOMETER TEST PROCEDURES

There are several crucial procedures that must be followed before every testing session in order to guarantee its success, safety, and the accuracy of the data gathered. Many of the actions that need to be taken are listed here. In order to standardise the testing circumstances, including the test protocols and equipment, the same processes should be followed each time. This will increase the reliability of the test. There are several things the athlete may take to physically prepare oneself in the days before the testing session.

5.1.1.Prepare Equipment

- Verify that all necessary equipment is on hand and in working order.
- Recalibrate the apparatus as necessary.
- Make sure the equipment and testing location are free of risks. For example, change the seat height on a bike ergometer to suit the patient.
- Keep first aid supplies close by and have an emergency plan ready.
- Have first aid equipment nearby and an emergency procedure prepared.

5.1.2.Pre-Test Measures

- Run a health risk assessment and get informed permission. See more information on what should be in an informed consent form. Get them to complete a Physical Activity Readiness Questionnaire, which is a questionnaire that assesses a person's readiness for exercise, especially if they are elderly or unfit. Record test conditions, such as date, weather, surface, equipment used.
- Take note of the subject's name, age, height, weight, and gender.
- Obtain resting pulse oximeter measurements.

5.1.3.Prepare Athletes

- Take off constrictive jewellery, watches, bracelets, and earrings that dangle from your ears as these items may become entangled in machinery. Tell the subject how the exam will be conducted.
- Perform a customary warm-up routine. The type of warm-up that is performed will depend on the exam being taken.
- While most testing regimens contain tests in a set order such that the early tests serve as a warm-up for the later tests, other tests, such as some forms of the sit and reach test, expressly require you not to conduct a warm-up beforehand. Learn more about warm-up before testing.

5.1.4.Guidelines for Testing

For any fitness assessment, it is recommended that you ensure that your body is primed physically to perform to your potential. Maximum performance is more likely if these nutritional and physical guidelines are followed. If all participants follow the same procedures and are in the same physical state, then comparisons are more valid, and if the same procedures are followed for each testing session, then the results will be more reliable.

5.1.4.1.Nutritional Preparation

- Make sure you eat healthily the day before the exam.

- If at all feasible, eat a high-carb diet for the 24 hours before the testing sessions (such as pasta, potatoes, cereals, bread, fruit, etc.).
- Avoid eating a large meal two hours before finishing the exams, however it is highly recommended that you eat something in the four hours before the test.
- On the day of the test, caffeine-containing beverages (such coffee, cola, or tea) should be avoided.
- Tobacco and alcoholic beverages should be avoided for 24 hours before testing.
- Be careful to drink enough of water, especially in hot weather. Drink often in the days before the exam, especially in the twelve hours before the test.
- Top up body fluids by drinking water regularly throughout the testing session. Continue to consume adequate fluids following exercise to replace any fluids lost during testing.

5.1.4.2. Physical Preparation

- For the 24 hours before to the test, refrain from engaging in vigorous exercise. To ensure you are well rested for the test, avoid doing any exercise on test day.
- Dress appropriately for the weather (e.g., shorts, track trousers and a t-shirt, singlet or sports top) and put on non-slip sporting shoes with the laces tied.
- Take off constrictive jewellery, watches, bracelets, and dangling earrings that might tangle with machinery.
- If you have a sickness or injury that is likely to get worse as a result of participating in the testing, or if you are sick or not in excellent general health, do not take part in it.
- Before the test starts, make sure you warm up. See the warm-up instructions.

- Cool down appropriately. Do not sit or lie down immediately following maximal exercise. Following completion of testing continue moderate-to light aerobic activity (jog or walk) for 5 minutes followed by some light stretching of both the upper and lower body.

With the arm at a straight angle and the elbow at the side of the body, the subject holds the dynamometer in the hand that will be tested. If necessary, the dynamometer's handle can be modified such that the base rests on the first metacarpal (the heel of the palm) and the handle rests on the middle of the four fingers. When ready, the patient squeezes the dynamometer as hard as they can isometrically and holds that position for around two seconds. Other forms of movement are not permitted. The subject has to be pushed hard to put out their best effort.

validity: Given that the strength of the forearm muscles does not often correspond to the strength of other muscle groups, the test's efficacy as a gauge of overall strength has been questioned. There are various specific tests that may be carried out if you want to gauge the power of a certain muscle group.

reliability: To guarantee repeatable findings, the dynamometer might need to be calibrated often. To achieve dependability, consistent technique and enough rest are necessary.

advantages: This general strength test is straightforward, widely used, well-researched, and there are various standards accessible.

5.2.DESCRPTION OF THE PRESENT INVENTION:

Any sport in which the hands are utilised for catching, throwing, or lifting requires strong handgrips. An rise in blood pressure and heart rate that is characteristic of isometric exercise may be crucial for preserving muscle perfusion during prolonged contraction. A digital handgrip dynamometer with pulse oximeter sensors, with a maximum range of 1000 ohm (about 130 kg) and accuracy of 0.1% over full scale, is the subject of the current invention.

It will be a specially made hand grip dynamometer with a digital readout that can record the output on the screen as a digital recording and store the file for further examination. The pulse rate will be recorded using an integrated 2-channel

ADC and front-end software, which will analyse both the muscular strength and the continuous pulse rate fluctuations brought on by baroreceptor processes for instructing medical students in physiology and other fields.

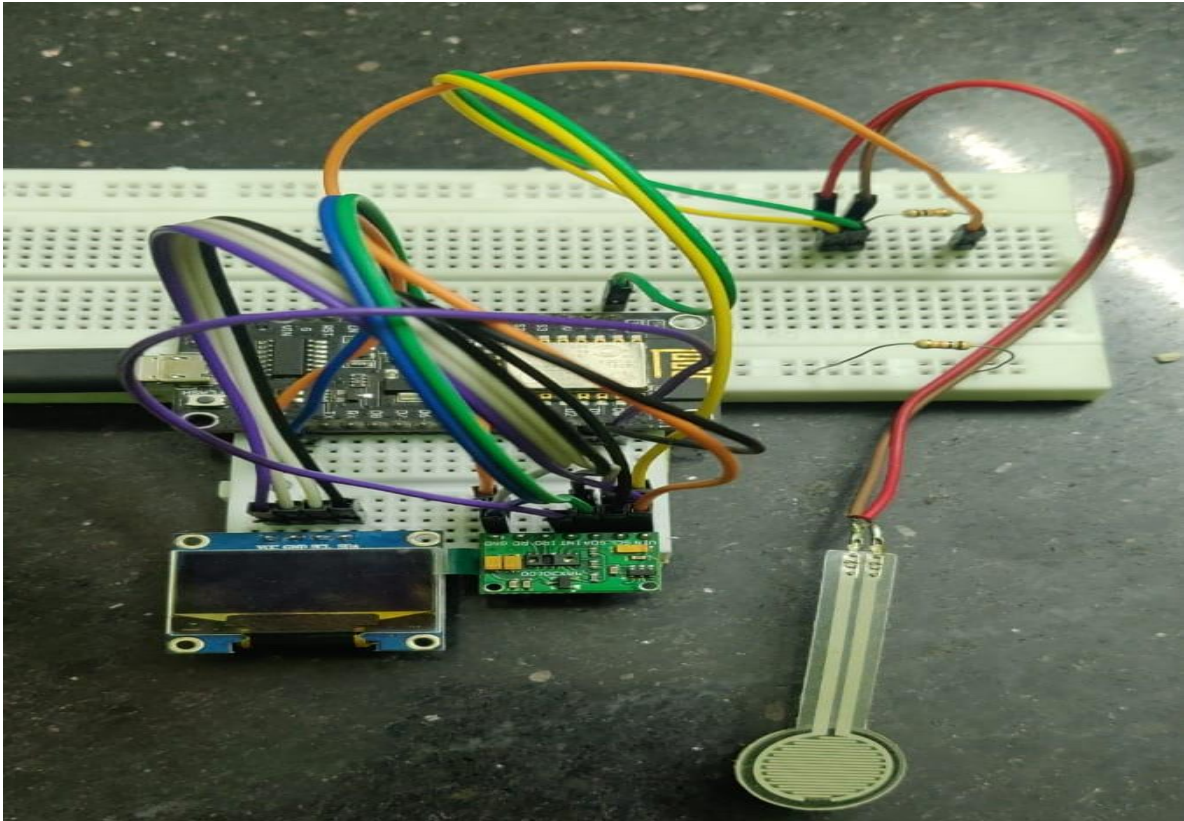


Fig 5.5: Prototype

5.2.1 Claims:

In addition to measuring hand grip strength, a digital hand grip dynamometer with a pulse rate recording sensor can continuously record pulse rate and spo2 levels, making it useful for teaching undergraduate medical students about the impact of isometric exercise on pulse rate and spo2 levels as well as for patient studies. NodeMCU is mostly used for sharing and ongoing information with mobile devices and computers. There are several applications used to share and save data. The information is kept in the Blynk programme.

5.2.2 Manufacturing

- Minimal weight and size
- Lightweight; • The presence of pulse oximeter recording sensors that will continually record the pulse rate and spo2 level may be utilised to teach undergraduate medical students about the impact of isometric exercise on pulse rate and spo2 level.

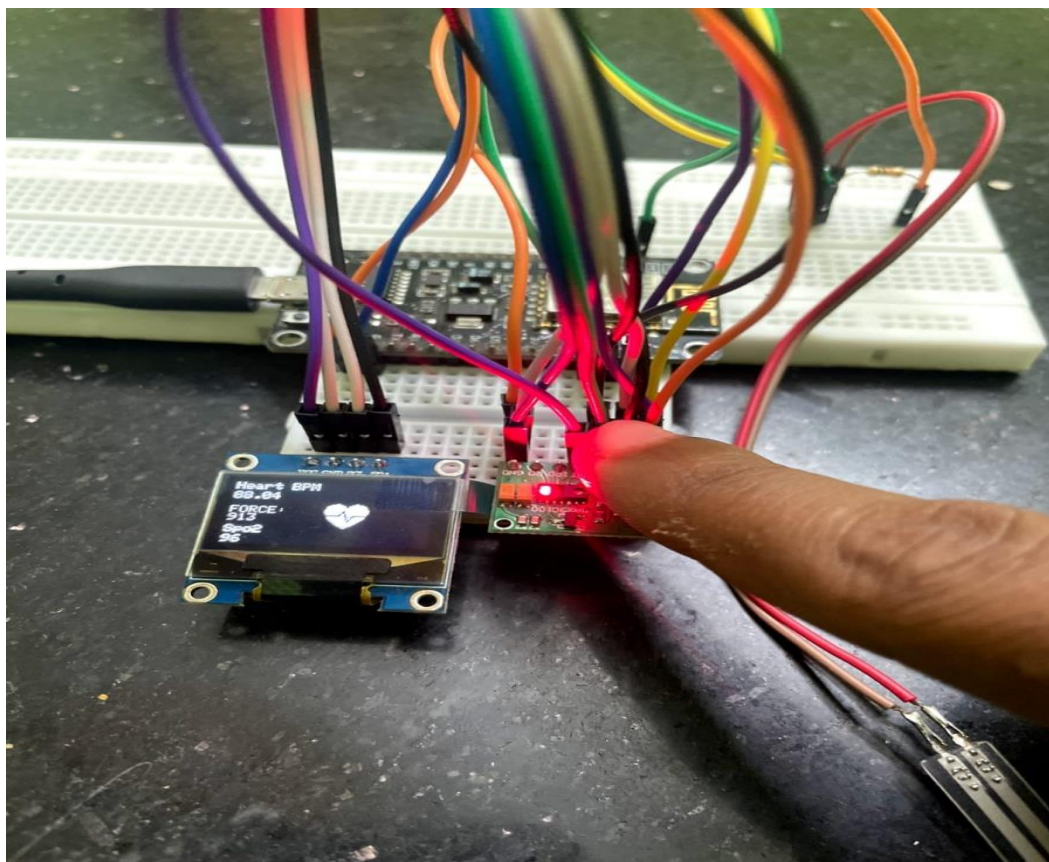
- Wide OLED display with sensors to show pulse rate, spo2 level, and grip force

5.3 Result

The sample value may be obtained through the Blynk programme and seen on any gadget, including a phone and a PC. The graph makes it simple to determine the pulse rate and may generate a steady output for unambiguous information. Strength may check the pulse rate and spo2 level with a consistent number and watch for a while. The Blynk programme may gather, store, and show data in IoT software on an OLED display.

The FSR has response phases: An initial “break force” or “turn on threshold” that dramatically swings the resistance from $>10\text{M}\Omega$ to roughly $10\text{k}\Omega$. After this threshold, the FSR resistance becomes inversely proportional to the applied force (following an inverse power-law characteristic). At the high-end of the force range (greater than 1000g), the FSR saturates and does not continue to drop resistance.

Fig 5.6: Output displa



OLED Display

This is the normal value of the individual normal person, they are:

- The normal value of the pulse rate is 70-90 (BPM).
- The normal value of the isometric strength of the right and left hand were, respectively, 600 and 900g in men, and 400 and 700g in women.
- The normal value of the spo2 level is 95% or higher.

This is the abnormal value of the individual normal person, they are:

- The abnormal value of the pulse rate is above or below 70-90 (BPM).
- The abnormal value of the isometric strength is below 400g .
- The abnormal value of the spo2 level is below 90%

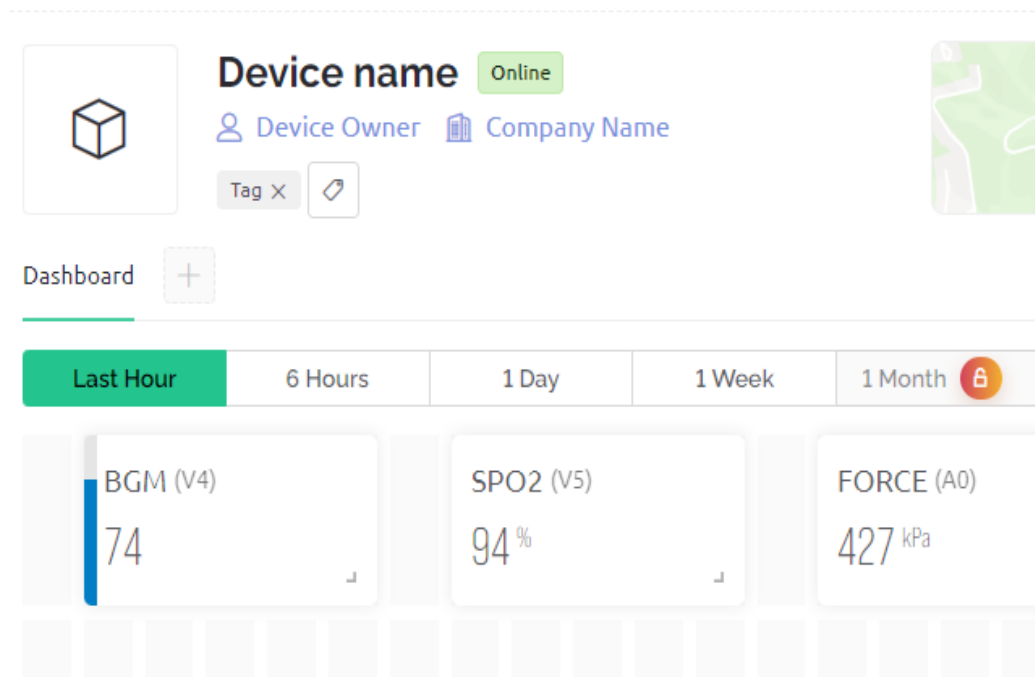


Fig 5.7: IoT Blynk application

- Cloud server is where the recorded and processed values are stored for any time reference and reference by the doctors and as well as the patients.
- Display the output of the pulse rate, spo2 level and force value separately.
- BLYNK is an open platform cloud server which is open and thus can be fully opened by anyone.
- It is a highly user friendly interface.

CHAPTER 6

CONCLUSION AND FUTURE WORK

6.1 CONCLUSION

The integrated digital dynamometer automatically records grip strength and pulse oximeter, the Wi-Fi module helps to share the information to the Blynk application for the further reference of the particular person continuously, the IOT hand grip is easy to compare with different person and receive the correct data. This instrument is mainly produced for the children to lift easily, they does not have any difficult to get the data.

The new design is lighter in weight, small size and easy to carry. Owing to the light weight the efficiency of recording is high compared to the existing models. Simultaneous measuring of pulse rate and spo2 level result in higher efficiency and accuracy in treatment which is simultaneously transmitted using IoT.

6.2 FUTURE SCOPE OF THIS PROJECT

This gadget may be used as a simultaneous strength, spo2 level, and heart rate monitor at the gym. While working out in the gym, the readings are immediately displayed in the instrument so that athletes and patients may quickly analyse them. The technique may provide a specific person with an average value over a predetermined number of trials. The benefit of the digital ones is the ability to add many parameters. It is inexpensive and widely accessible in our nation. A person's checkup can be conducted at home without needing to visit the hospital.

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