ALZOT: AN IOT BASED HEALTH CARE ASSISTANT FOR ALZHEIMER'S PATIENT

A Dissertation submitted in partial fulfillment of the requirements
for the award of degree of

BACHELOR OF TECHNOLOGY

IN

ELECTRONICS & COMMUNICATIONS ENGINEERING

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ACCREDITED by NBA & NAAC-UGC

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DEPT. OF ELECTRONICS & COMMUNICATION ENGG

CERTIFICATE

THIS IS TO CERTIFY THAT THE PROJECT ENTITLED

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IS THE BONAFIDE WORK OF

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SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF DEGREE OF BACHELOR OF TECHNOLOGY IN ELECTRONICS AND COMMUNICATION ENGINEERING DURING THE YEAR 2020-2021.

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INDEX

ABSTRACT

The necessity for healthcare assistants is growing at present situations in particular for the elderly people who are suffering from long-term chronic diseases such as Alzheimer's, Parkinson's, Paralysis and so on. In the early 90's, a number of studies began to highlight the problem of the increasing number of people with Alzheimer's disease. It is a neuro-degenerative disease that occur when the brain no longer functions normally, where in the early stage the symptoms may be minimal, but as the disease causes more damage to the brain, symptoms worsen. The most common symptom in the early stage is the shortterm memory loss (difficulty in remembering events). IoT devices with intelligent applications can be used for monitoring the health condition of such patients.

The aim of this project is to build a device that will provide an independency to the Alzheimer's patient and reduce the work for care-takers using IoT based Assistive technology. The proposed device – ALZOT provides various functionalities like tracking the live location of the patient through GPS technology, give push notifications to remind about medicines, exercise, bathing and food intake and reduce the work of caregiver(s). Parameters like temperature, pressure and altitude are monitored continuously and in case of emergency or when the patient falls down an alert message is sent to care takers mobile through the Bluetooth module.

Research suggests that exposure to light flickering at 40Hz may promote gamma-wave brain activity, which could potentially activate cells in the brain to eliminate beta-amyloid plaques that are common in Alzheimer's disease. Hence, we are including a flickering light in this device that can be used to activate cells and might help the patient to recognize objects, remember events and navigate to places. Since it takes a lot of people to provide care to an Alzheimer's patient but with the help of ALZOT, which can be attached to a patient's body, we can have even offline monitoring of the patient keeping in check the functionality of the device and response of the patient to it. The proposed device no only helps to monitor the health condition of the patient, but also aids to bring improvement in their day to activities.

LIST OF FIGURES

LIST OF TABLES

ACRONYMS

S. No	Abbreviation	Full Form
1	MEMS	Micro Electro Mechanical System
2	GPS	Global Positioning System
3	IoT	Internet of Things
4	WoT	Web of Things
5	GSM	Global System for Mobile Communications
6	MQTT	MQ Telemetry Transport
7	HTTP	Hypertext Transfer Protocol
8	ADKT	Alzheimer's Disease Knowledge Test
9	UAB - ADKT	University of Alabama at Birmingham Alzheimer's Disease Knowledge Test
10	DQ	Dementia Quiz
11	KAML-C	Knowledge of Aging and Memory Loss and Care
12	ADKS	Alzheimer's Disease Knowledge Scale
13	TSMC	Taiwan Semiconductor Manufacturing Company
14	DAC	Digital to Analog Converter
15	ADC	Analog to Digital Converter
16	QFN	Quad Flat No
17	BLE	Bluetooth Low Energy
18	EDR	Enhanced Data Rate
18	SAR	Successive Approximation Register
19	GPIO	General Purpose Input Output
20	SPI	Serial Peripheral Interface
21	UART	Universal Asynchronous Receiver Transmitter
22	CAN	Controller Area Network
23	IIC	Inter Integrated Circuit
24	SDIO	Secure Digital Input Output
25	CE-ATA	Consumer Electronics-Advanced Technology Attachment
26	MMC	Multimedia Card

27	EMMC	Embedded Multimedia Card
28	DMA	Direct Memory Card
29	PWM	Pulse Width Modulation
30	WPA	WiFi Protected Access
32	WPA2	WiFi Protected Access II
33	WAPI	WLAN Authentication and Privacy Infrastructure
34	AES	Advanced Encryption Standard
35	SHA2	Secure Hash Algorithm 2
36	RSA	Rivest-Shamir-Adelman
37	ECC	Elliptical Curve Cryptography
38	RNG	Random Memory Generation
39	SDK	Software Development Kit
40	AWS	Amazon Web Service
41	IDE	Integrated Development Environment
42	RTOS	Real Time Operating System
43	REPI	Read Eval Print Loop
44	PCB	Printed Circuit Board
45	LCD	Liquid Crystal Display
46	LED	Light Emitting Diode
47	TFT	Thin Flim Transistor
48	SBAS	Satellite-based Augmented System
49	WAAS	Wide Area Augmented System
50	EGNOS	European Geostationary Navigation Overlay Service
51	MSAS	MTSAT Satellite Augmented System
52	MTSAT	Multifunctional Transport Satellites
53	GAGAN	GPS- Aided GEO Augmented Navigation
54	CMG	Control Moment Gyroscope
55	DMP	Digital Motion Processor
56	USB	Universal Serial Bus
57	FIFO	First In First Out

58	EEPROM	Electrically Erasable Programmable Read Only Memory
59	IIS	Inter IC Sound Bus
60	DMIPS	Dhrystone Million Instructions Per Second
61	LDR	Light Dependent Resistor
62	SRAM	Static Random Access Memory
63	ROM	Read Only Memory
64	ULP	Ultra Low Power
65	RTC	Real Time Clock

1. INTRODUCTION

IoT technology has a huge impact on human life in all aspects like medicine, health, industry, transportation, education, and agriculture from the last decade. This technology uses sensors or actuators to understand the state of the surrounding environment. Most of them connected via these communication technologies such as WiFi and Global System for Mobile (GSM) to communicate with control centers and send data collected from the environment and to help for making decisions at remote control centers. Smart homes are currently being developed with great acceptance by people around the world.

1.1 ABOUT PROJECT IN BRIEF

In this project, the focus is on patients of Alzheimer's disease, which is the most common neurological disorder in the last decade. It is a type of dementia that occurs for most elderly people. In this type of illness, a person becomes oblivious as he/she is not able to perform his/her daily tasks independently and needs to have a person in the family always care for their behaviors and health. Therefore, for families with Alzheimer's patients, the cost of hiring a nurse or continuing care of this patient is high. However, it is expected that we will be able to remotely monitor the behaviors and health status of these patients using the facilities that the Internet of Things can provide, as to decrease the extra expenses and timely response to these patients. The IoT can play a vital role in this current COVID-19 pandemic situation. Different types of smartwatches, sensors, and actuators are installed at the home of these patients. These IoT devices are used to collect the data regarding their temperature, medicine intake timings, and movement. The different types of sensors and actuators have been used for their secure data transfer that the existing protocols have been used. These protocols have been used under the umbrella of Web of Things (WoT) like MQTT, WebSocket, and HTTP. The data collected from these IoT devices have been secured during communication and as it is stored at the cloud servers. Several methods have been performed for monitoring the health conditions of patients. One of them is neural networks and Bayesian [2] for monitoring the skin in real-time with the help of IoT.

1.2 OVERVIEW OF ALZHEIMER'S DISEASE

Alzheimer's disease is a type of brain disease. It is also a degenerative disease which means it worsens over time. Alzheimer's disease is thought to become hidden for 20 years or more, and the patient cannot detect minor changes in the patient's behavior. Over the years, people have noticed symptoms such as memory loss and speech problems. The cause of these symptoms is that nerve cells are damaged or destroyed in areas of the brain that are involved in thinking, learning, and memory (cognitive function). In the advanced stages of the disease, one loses the ability to perform daily activities and is said to be suffering from dementia or Alzheimer's disease. The brain of a healthy adult has about 100 billion neurons, each with long and branching branches. These branches enable individual neurons to communicate with other neurons. Such connections are called synapses. The brain has about 100 trillion synapses. They allow signals to move quickly in the neural circuits of the brain, which is related to emotional and emotional messages, memories, thoughts, movements, and skills. Beta-amyloid protein fragment accumulation (also known as beta-amyloid plaque) outside the neurons and accumulation of abnormal tau protein (called tau tangles) in the neurons are two of the changes caused by Alzheimer's disease. Beta-amyloid plaques may interfere with the neuronal communication of neurons in synapses, leading to cell death, while the tau tangles block the transport of nutrients and other essential molecules into the neurons. By increasing the amount of beta-amyloid, we reach a stage where tau is abnormally distributed throughout the brain.

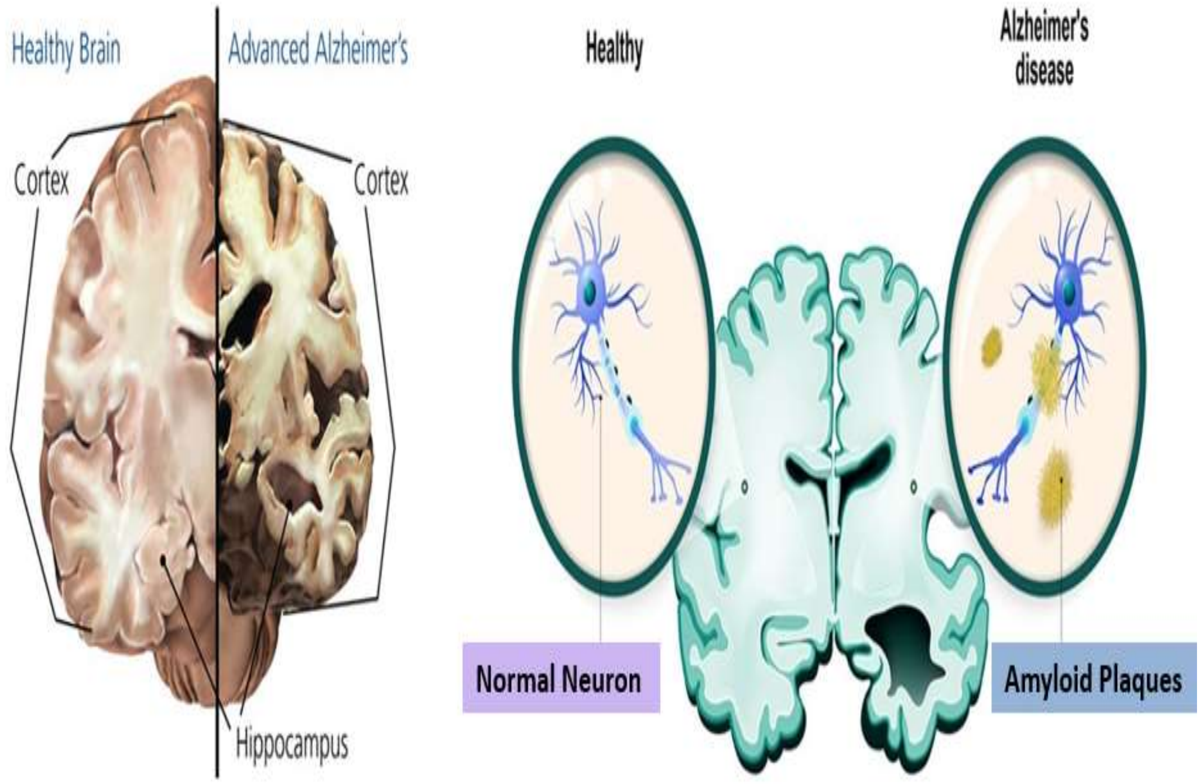


Fig 1.1 Comparison of Healthy Person Brain Neurons with Alzheimer Patient Brain Neurons

1.2.1 Symptoms of Alzheimer's Disease

The main symptoms of Alzheimer's disease include the following:

- Loss of memory that disrupts human daily life
- Occurring problems in planning or solving problems
- Difficulties in doing chores at home and work
- Confusion on choosing a time or place
- Difficulties in understanding visual images and spatial relations
- Difficulties in using new words in conversation or writing
- Missing objects and being unable to retrieve those objects
- Decreasing decision-making power in work or social activities

1.3 OBJECTIVES

- Monitor the state of the Alzheimer' disease patient if he was stable or not.
- Receives notifications if the patient falls on the ground.
- Locate the patient and show his position on google map.
- Monitor the patient's heart rate.
- Exposure to light flickering at 40Hz that may promote gamma-wave brain activity.

1.4 IoT TECHNOLOGY

The Internet of Things (IoT) provides how intelligent objects can be interconnected in computing environments everywhere. Internet infrastructure as a global platform plays an important role in the formation of the Internet of Things and enabling it to communicate between physical objects. Innovations in the IoT are accomplished by incorporating sensors into the objects that make them intelligent and allowing physical infrastructures to be integrated around the world and able to connect using communication technologies.

The term "Internet of Things" refers to an Internet-based architecture that facilitates the exchange of services, information, and data between billions of predominantly intelligent objects. The idea of the Internet of Things was first proposed by Kevin Ashton in 1998 and has been the focus of many universities and industries in the short term. The overall architecture of the Internet of Things is illustrated in fig 1.2.

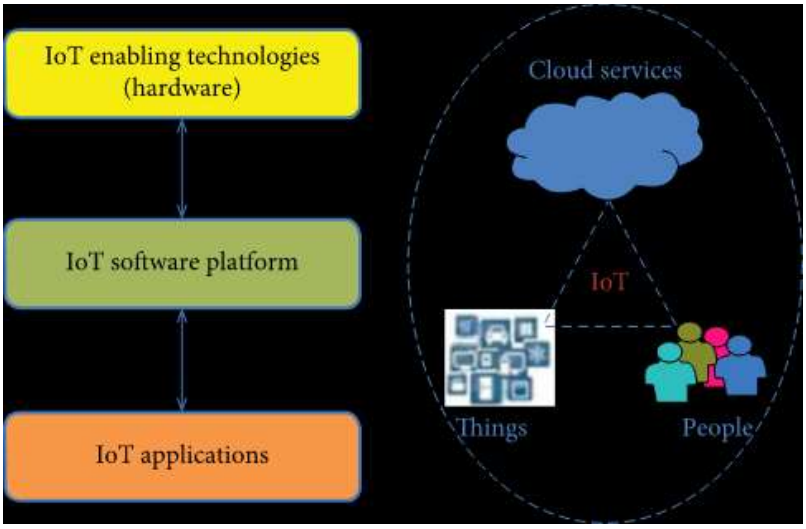


Fig 1.2 The overall architecture of the Internet of Things

From Fig 1.2, we can see that hardware and software solutions work together to create an Internet of Things object. The Internet of Things must be able to communicate between billions or trillions of nonhomogenous devices over the Internet, so there is a critical need to create a layered architecture for flexible Internet of Things.

IoT technology has been developed in the last decade. By using different sensors, we can understand the environment and communicate with different objects in remote environments with the help of one of the communication technologies (such as WiFi and GSM). In the case of Alzheimer's patients, by installing sensors in various locations of the smart home, we can fully monitor the movements and activities of these patients indoors. We can also monitor the movement of these patients anywhere outside the home by installing sensors on the clothing or body of patients.

By analyzing the data collected by these sensors, which are sent to embedded control centers through one of the communication technologies (such as WiFi), we will be able to extract useful information and this information can be used by physicians and health professional to be effective in making appropriate decisions in the care or treatment of these patients.

1.5 LITERATURE REVIEW

Dieckmann and colleagues investigated the tool that is used for Alzheimer's disease knowledge test (ADKT). The metrics used for these tests ADKT by these researchers showed that five important metrics[3] for measuring the outcomes of caring of Alzheimer's patients have been proposed by different researchers: ADKT, UAB-ADKT for health professionals, DQ [5], KAML-C, and ADKS.

Karlin and Dalley [1] conducted a study on the relationship between people's concerns about dementia and Alzheimer's disease, the likelihood of doing tests and screenings, and applying methods to detect changes in cognitive status or patient performance, to detect the disease early. They made a descriptive study using data from Porter Novelli' SummerStyles 2013 online survey. They used chi squares with case-level weighting used for analyzing data of the 6,105 people over the age of 18 who were surveyed; 4033 (66% of all of these people who are selected) responded to the surveys.

Brian researched the detection of Alzheimer's disease [9]. The results of this study showed that the biggest challenge in this area is the lack of knowledge needed for the early diagnosis of this disease, not the mistake of diagnosis.

Srimathi conducted studies on cloud computing, fog computing, big data analytics, IoT, and mobile-based applications and emerging technologies in the field of personalized medical care systems [2]. The researchers looked at the challenges of better designing a healthcare system for the early detection of diseases and explored possible solutions for delivering health-related care electronically and safely. This study emphasizes the need for developing high quality and precision electronic healthcare systems.

Smyth and colleagues [3] proposed a new idea to modify the existing access control system to detect medical conditions associated with the brain and receive a timely response from physicians in the time of medical emergencies. The idea is to improve the quality of medical services available to people around the world. In the follow-up to the study, the researchers developed a simple device that could help physicians to find brain abnormalities as quickly as possible in humans. The device can also be highly effective in the care of these patients remotely using IoT technology.

2. SYSTEM DESCRIPTION

The design of the project is considered the most important phase of the development process of each project, therefore this phase requires a considerable time for the general life cycle of the project. If we consider the project as a system containing several parts, the proposed system can be divided into two main units, the hardware, and the software units. In this chapter, the highlevel design followed by the detailed about the design of the project is being the center of attention for detailed discussion as shown in fig 2.1.Both hardware and software requirement designs are being discussed here intensively, describing their components and their circuit diagrams. As well as specifying the detailed functions of the project's units and interfaces implemented between them.

Fig 2.1 Overall System's Illustration

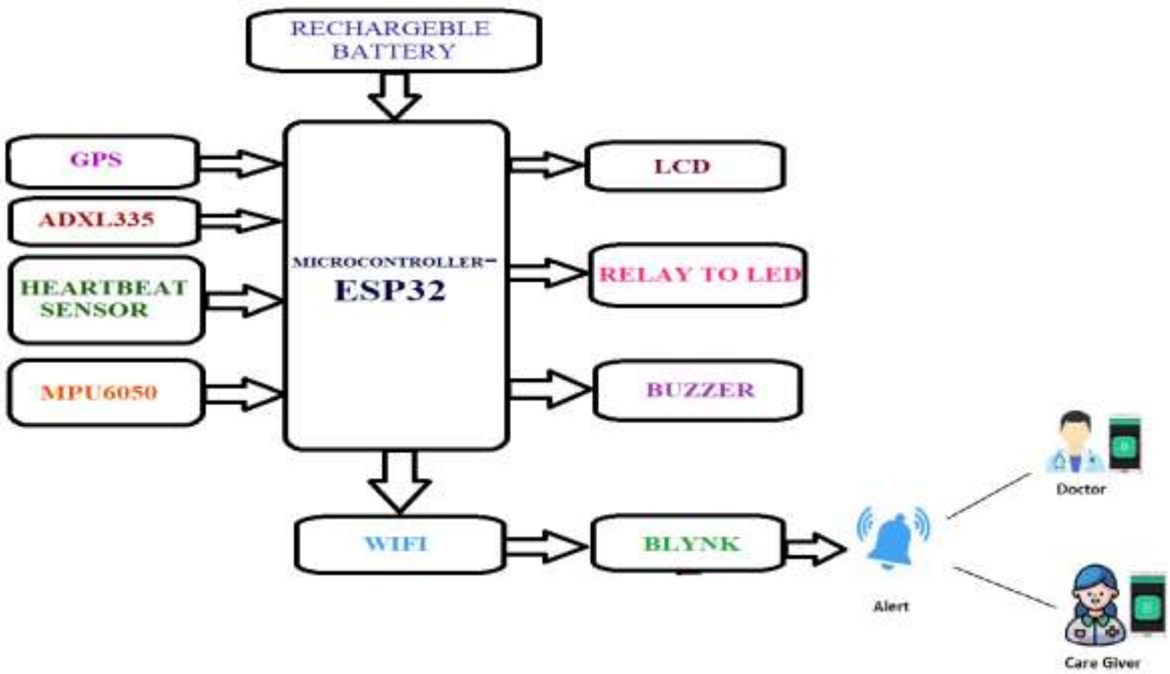


Figure 2.2 Block Diagram

2.1 HARDWARE REQUIREMENTS

The Hardware components used in our project are as follows:

2.1.1 ESP32 Development Board

ESP32 is a series of low-cost, low power system on a chip microcontrollers with integrated WiFi and dual-mode bluetooth. The ESP32 series employs a Tensilica Xtensa LX6 microprocessor in both dual-core and single-core variations and includes in-built antenna switches, RF balun, power amplifier, low-noise receive amplifier, filters, and power-management modules. ESP32 is created and developed by Espressif Systems, a Shanghai-based Chinese company, and is manufactured by TSMC using their 40 nm process. It is a successor to the ESP8266 microcontroller.

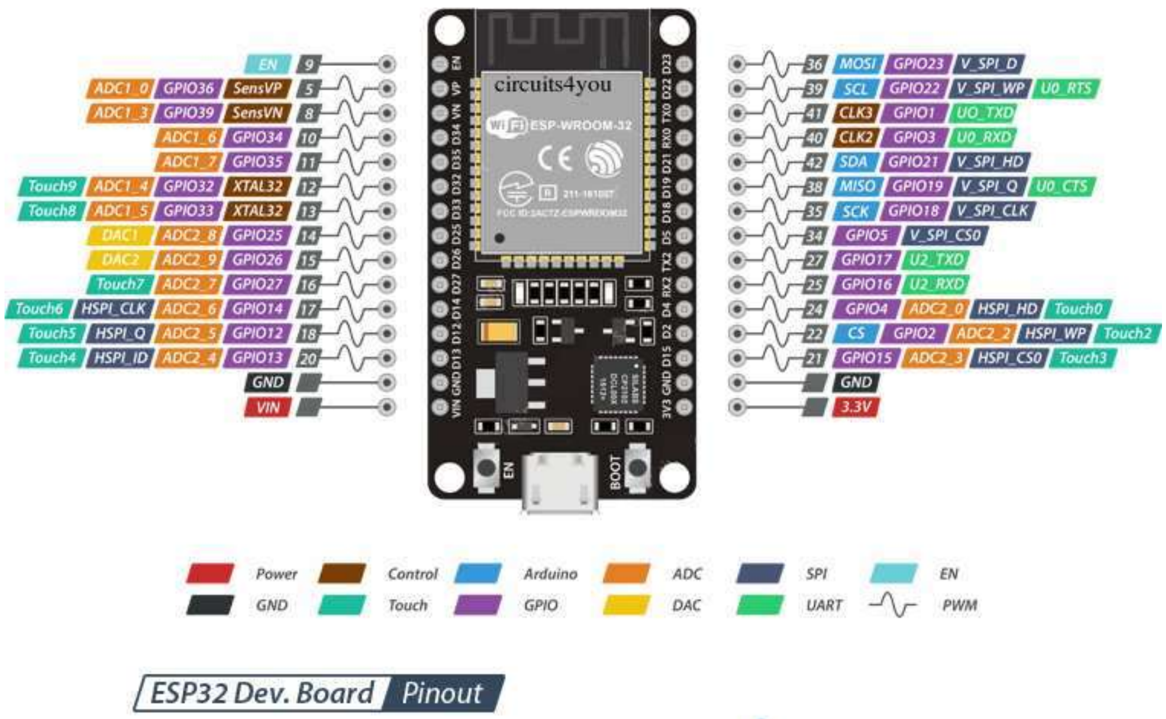


Fig 2.3 ESP32 Board Pinout Description

ESP32 has two 8-bit DAC **(**digital to analog converter**)** channels, connected to GPIO25 (Channel 1) and GPIO26 (Channel 2)**.** The DAC driver allows these channels to be set to arbitrary voltages. ESP32 is housed in QuadFlat No leads (QFN) packages of varying sizes with 49 pads. Specifically, 48 connection pads along the sides and one large thermal pad (connected to ground) on the bottom. The ESP32 board pinout decription in shown in fig 2.3.

The ESP32 system on a chip integrated circuit is packaged in both 6×6 mm and 5×5 mm sized QFN packages. The ESP32-PICO-D4 system in package module combines an ESP32 silicon chip, crystal oscillator, flash memory chip, filter capacitors, and RF matching links into a single 7×7 mm sized QFN package as shown in the fig 2.4.

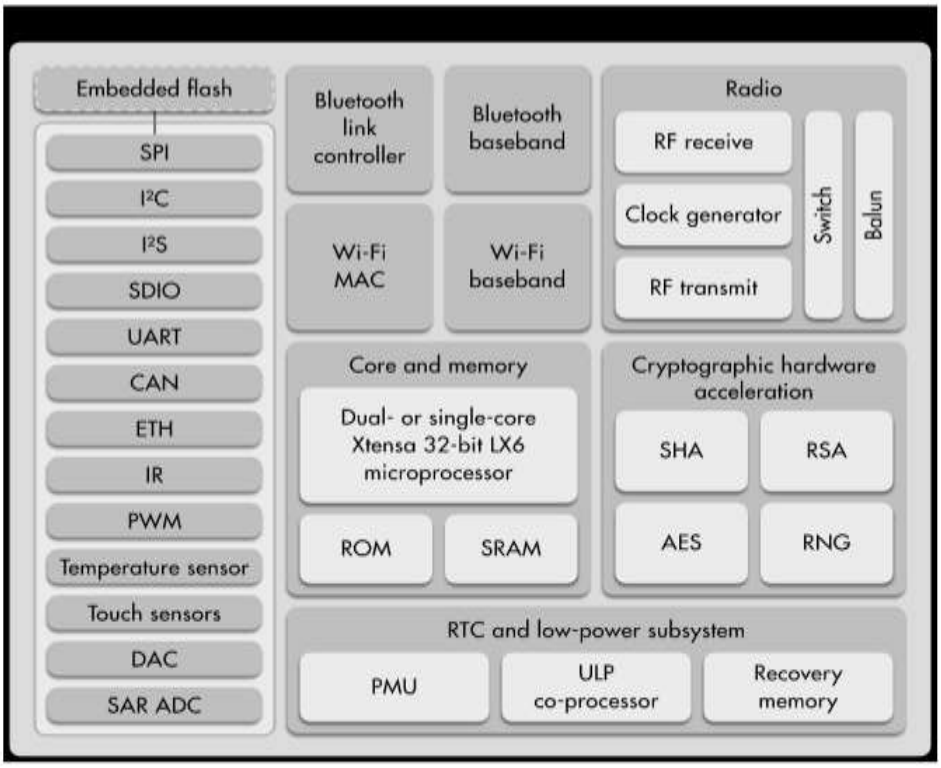


Fig 2.4 ESP32 Functional Block Diagram

Features

Features of the ESP32 include the following:

- Processors:
  - CPU: Xtensa dual-core (or single-core) 32-bit LX6 microprocessor, operating at 160 or 240 MHz and performing at up to 600 DMIPS
  - Ultra low power (ULP) co-processor
- Memory: 520 KiB SRAM, 448 KiB ROM
- Wireless connectivity:
  - Wi-Fi: 802.11 b/g/n
  - Bluetooth: v4.2 BR/EDR and BLE (shares the radio with Wi-Fi)
- Peripheral interfaces:
  - 34 × programmable GPIOs
  - 12-bit SAR ADC up to 18 channels

- 2 × 8-bit DACs
- 10 × touch sensors (capacitive sensing GPIOs)
- 4 × SPI
- 2 × I²S interfaces
- 2 × I²C interfaces
- 3 × UART
- SD/SDIO/CE-ATA/MMC/EMMC host controller
- SDIO/SPI slave controller
- Ethernet MAC interface with dedicated DMA and IEEE 1588 Precision Time Protocol support
- CAN bus 2.0
- Infrared remote controller (TX/RX, up to 8 channels)
- Motor PWM
- LED PWM (up to 16 channels)
- Hall effect sensor
- Ultra low power analog pre-amplifier

- Security:
  - IEEE 802.11 standard security features all supported, including WFA, WPA/WPA2 and WAPI
  - Secure boot
  - Flash encryption
  - 1024-bit OTP, up to 768-bit for customers
  - Cryptographic hardware acceleration: AES, SHA-2, RSA, elliptic curve cryptography (ECC), random number generator (RNG)
- Power management:
  - Internal low-dropout regulator
  - Individual power domain for RTC
  - 5 µA deep sleep current
  - Wake up from GPIO interrupt, timer, ADC measurements, capacitive touch sensor interrupt

Programming languages, frameworks, platforms, and the environments used for the ESP32 programming:

- Arduino IDE with the ESP32 Arduino Core
- Espressif IoT Development Framework-Official Espressif development framework for ESP32.
- Espruino-JavaScript SDK and firmware closely emulating Node js.
- Lua RTOS for ESP32
- Mongoose OS-An operating system for connected products on microcontrollers; programmable with Javscript. A recommended platform by Espressif Systems, AWS IoT, and Google Cloud IoT
- mruby for the ESP32
- PlatformIO Ecosystem and IDE
- Pymakr IDE-IDE designed for use with Pycom devices; handles firmware upgrades and includes MicroPython REPL console.
- Simba Embedded Programming Platform
- Whitecat Ecosystem Blockly Based Web IDE
- MicroPython
- Zerynth-Python for IoT and microcontrollers, including the ESP32.

2.1.2 Accelerometer (ADXL335)

The MMA7260QT low cost capacitive micromachined accelerometer features signal conditioning, a 1-pole low pass filter, temperature compensation and g-Select which allows for the selection among 4 sensitivities[6]. Zero-g offset full scale span and filter cut-off are factory set and require no external devices. Includes a Sleep Mode that makes it ideal for handheld battery powered electronics.

Features

- Selectable Sensitivity (1.5g/2g/4g/6g)
- Low Current Consumption: 500 μA
- Sleep Mode: 3 μA

- Low Voltage Operation: 2.2 V – 3.6 V
- 6mm x 6mm x 1.45mm QFN
- High Sensitivity (800 mV/g @ 1.5g)
- Fast Turn On Time
- Integral Signal Conditioning with Low Pass Filter
- Robust Design, High Shocks Survivability
- Pb-Free Terminations
- Environmentally Preferred Package
- Low Cost

Functional Block Diagram of Accelerometer

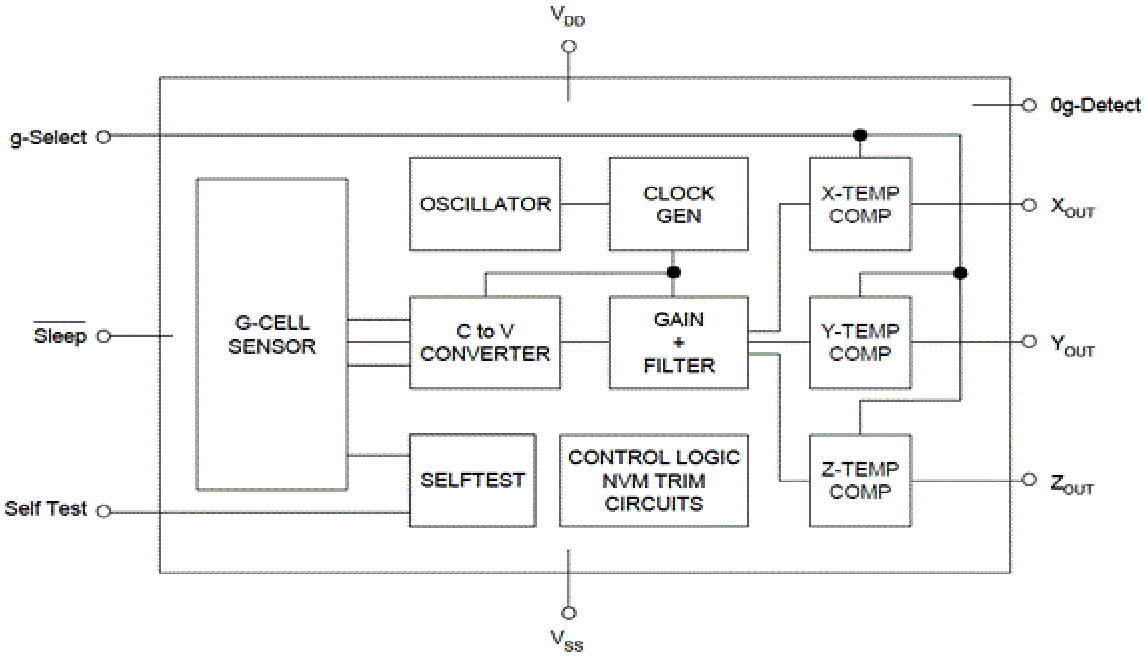


Fig 2.5 Simplified Accelerometer Functional Block Diagram

Table 2.1 Maximum Ratings of Accelerometer ADXL335

Rating	**Symbol**	**Value**	**Unit**
Maximum Acceleration (all axis)	gmax	±5000	g
Supply Voltage	VDD	–0.3 to +3.6	V
Drop Test	Ddrop	1.8	m
Storage Temperature Range	Tstg	–40 to +125	°C

Table 2.2 Operating Characteristics

Unless otherwise noted: –40°C ≤ T_A ≤ 105°C, 2.2 V ≤ V_{DD} ≤ 3.6 V, Acceleration = 0g, Loaded output.

Characteristic	Symbol	Min	Typ	Max	Unit
Operating Range Supply Voltage Supply Current Supply Current at Sleep Mode Operating Temperature Range Acceleration Range, X-Axis, Y-Axis, Z-Axis g-Select1 & 2: 00 g-Select1 & 2: 10 g-Select1 & 2: 01	VDD IDD IDD T_A gFS gFS gFS gFS	2.2 - 40 — — —	3.3 500 3.0 ±1.5 ±2.0 ±4.0 ±6.0	3.6 800 10 +105 — — — —	V µA µA °C g g g g
Output Signal Zero-g (T_A = 25°C, V_{DD} = 3.3 V) Zero g X-axis Y-axis Z-axis Sensitivity (T_A = 25°C, V_{DD} = 3.3 V) 1.5g 2g 4g 6g Sensitivity X-axis Y-axis Z-axis Bandwidth Response X	VOFF VOFF, TA S1.5g S2g S4g S6g S, T_A f-3dB f-3dB	1.485 ±2 6 ±5.8 ±1.0 740 555 277.5 185 ±0.02 ±0.01 ±0.01 — —	1.65 ±0.6 ±5.8 ±0.8 800 600 300 200 ±0.02 ±0.01 ±0.00 350 150	1.815 ±3 8 ±5 9 ±0.8 860 645 322.5 215 ±0.02 ±0.01 ±0.01 — —	V mg/°C mV/g mV/g mV/g mV/g % /°C Hz Hz
Noise RMS (0.1 Hz – 1 kHz) Power Spectral Density RMS (0.1 Hz – 1 kHz)	nRMS nPSD —	— — —	4.7 350	— —	mVrms l^g/Hz

Control Timing Power-Up Response Time Enable Response Time Sensing Element Resonant Frequency XY Z Internal Sampling Frequency	tRESPONSE tENABLE fGCELL fGCELL fCLK	— — — — —	1.0 0.5 6.0 3.4 11	2.0 2.0 — — —	ms ms kHz kHz kHz
Output Stage Performance Full-Scale Output Range (I_{OUT} = 30	VFSO	V_{SS}+0.2 5	—	V_{DD}–0.25	V
Nonlinearity, X_{OUT}, Y_{OUT}, Z_{OUT}	NLOUT	–1.0	—	+1.0	%FSO
Cross-Axis Sensitivity	VXY, XZ, YZ	—	—	5.0	%
Ratiometric Error	error	—	—	—	%

- For a loaded output, the measurements are observed after an RC filter consisting of a 1.0 kΩ resistor and a 0.1 µF capacitor on V_{DD}-GND.
- These limits define the range of operation for which the part will meet specification.
- Within the supply range of 2.2 and 3.6 V, the device operates as a fully calibrated linear accelerometer. Beyond these supply limits the device may operate as a linear device but is not guaranteed to be in calibration.
- This value is measured with g-Select in 1.5g mode.
- The device can measure both + and – acceleration. With no input acceleration the output is at midsupply. For positive acceleration the output will increase above $V_{DD}/2$. For negative acceleration, the output will decrease below $V_{DD}/2$.
- These values represent the 10th percentile, not the minimum.
- These values represent the 90th percentile, not the maximum.
- The response time between 10% of full scale V_{DD} input voltage and 90% of the final operating output voltage.
- The response time between 10% of full scale Sleep Mode input voltage and 90% of the final operating output voltage.
- A measure of the device's ability to reject an acceleration applied 90 from the true axis of sensitivity.
- Zero-g offset ratiometric error can be typically >20% at V_{DD} = 2.2 V. Sensitivity ratiometric error can be typically >3% at V_{DD} = 2.2. Consult factory for additional information.

Principle of Operation

The Freescale acceleromter is a surface-micromachined integrated-circuit accelerometer. The device consists of two surface micromachined capacitive sensing cells (g-cell) and a signal conditioning ASIC contained in a single integrated circuit package[12]. The sensing elements are sealed hermetically at the wafer level using a bulk micromachined cap wafer.

The g-cell is a mechanical structure formed from semiconductor materials (polysilicon) using semiconductor processes (masking and etching). It can be modeled as a set of beams attached to a movable central mass that move between fixed beams. The movable beams can be deflected from their rest position by subjecting the system to an acceleration (Figure 3). As the beams attached to the central mass move, the distance from them to the fixed beams on one side will increase by the same amount that the distance to the fixed beams on the other side decreases. The change in distance is a measure of acceleration.

The g-cell beams form two back-to-back capacitors as shown in fig 2.6. As the center beam moves with acceleration, the distance between the beams changes and each capacitor's value will change, (C = AE/D). Where A is the area of the beam, **E** is the dielectric constant, and D is the distance between the beams.

The ASIC uses switched capacitor techniques to measure the g-cell capacitors and extract the acceleration data from the difference between the two capacitors[12]. The ASIC also signal conditions and filters (switched capacitor) the signal, providing a high level output voltage that is ratiometric and proportional to acceleration.

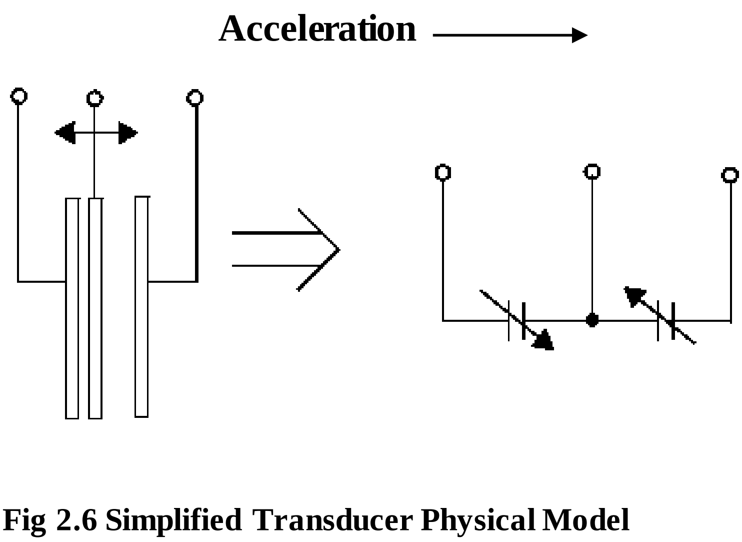


Fig 2.6 Simplified Transducer Physical Model

Special Features

1) g-Select

The g-Select feature allows for the selection among 4 sensitivities present in the device. Depending on the logic input placed on pins 1 and 2, the device internal gain will be changed allowing it to function with a 1.5g, 2g, 4g, or 6g sensitivity as shown in table 2.3. This feature is ideal when a product has applications requiring different sensitivities for optimum performance. The sensitivity can be changed at anytime during the operation of the product. The g-Select1 and g-Select2 pins can be left unconnected for applications requiring only a 1.5g sensitivity as the device has an internal pull-down to keep it at that sensitivity (800mV/g).

Table 2.3 g-Select Pin Descriptions

g-Select2	g-Select1	g-Range	Sensitivity
0	0	1.5g	800 mV/g
0	1	2g	600 mV/g
1	0	4g	300 mV/g
1	1	6g	200 mV/g

2) Sleep Mode

The 3 axis accelerometer provides a Sleep Mode that is ideal for battery operated products. When Sleep Mode is active, the device outputs are turned off, providing significant reduction of operating current. A low input signal on pin 12 (Sleep Mode) will place the device in this mode and reduce the current to 3 μA typ. For lower power consumption, it is recommended to set g-Select1 and g-Select2 to 1.5g mode. By placing a high input signal on pin 12, the device will resume to normal mode of operation.

3) Filtering

The 3 axis accelerometer ADXL335 contains onboard single-pole switched capacitor filters. Because the filter is realized using switched capacitor techniques, there is no requirement for external passive components (resistors and capacitors) to set the cut-off frequency.

4) Ratiometricity

Ratiometricity simply means the output offset voltage and sensitivity will scale linearly with applied supply voltage. That is, as supply voltage is increased, the sensitivity and offset increase linearly; as supply voltage decreases, offset and sensitivity decrease linearly. This is a key feature when interfacing to a microcontroller or an A/D converter because it provides system level cancellation of supply induced errors in the analog to digital conversion process. Offset ratiometric error can be typically >20% at V_{DD} = 2.2 V.

Basic Connections

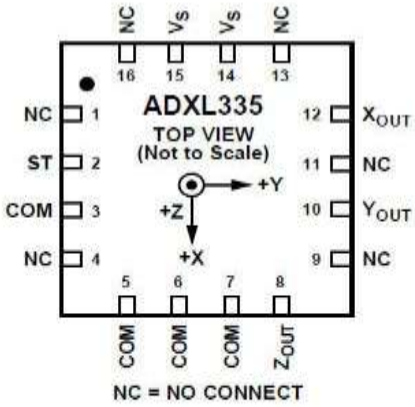


Fig 2.7 Pin Out Description of ADXL335

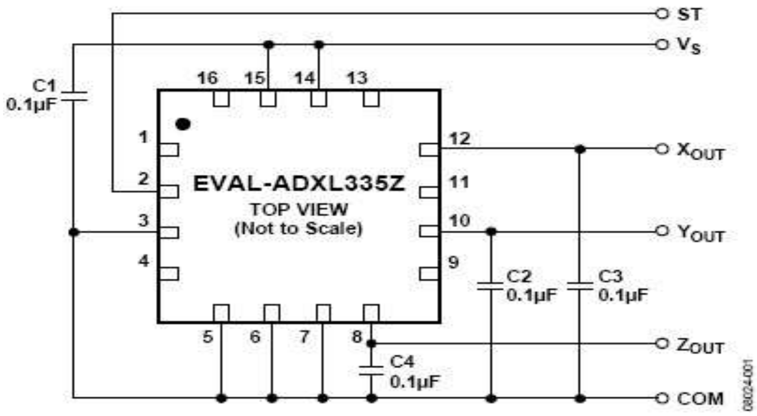


Fig 2.8 PCB Layout of Accelerometer

Table 2.4 Pin Descriptions of ADXL335

Pin No.	Pin Name	Description
1	g-Select1	Logic input pin to select g level.
2	g-Select2	Logic input pin to select g level.
3	VDD	Power Supply Input
4	VSS	Power Supply Ground
5 - 7	N/C	No internal connection. Leave unconnected.
8 - 11	N/C	Unused for factory trim. Leave unconnected.
12	Sleep Mode	Logic input pin to enable product.
13	ZOUT	Z direction output voltage.
14	YOUT	Y direction output voltage.
15	XOUT	X direction output voltage.
16	N/C	No internal connection. Leave unconnected.

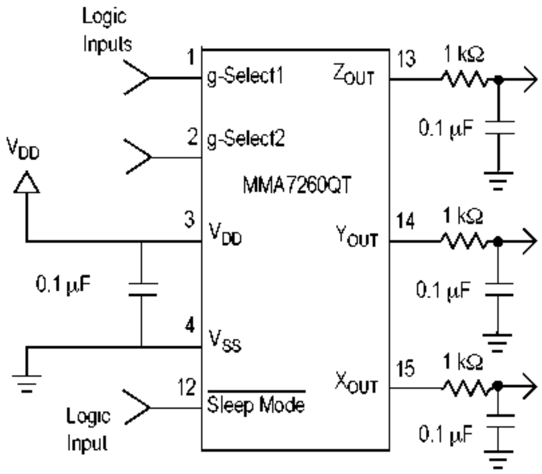


Figure 2.9 Accelerometer with Recommended Connection Diagram

Specifications:

- Verify V_{DD} line has the ability to reach 2.2 V in $\leq$ 0.1ms as measured on the device at the V_{DD} pin. Rise times greater than this most likely will prevent start up operation.
- Physical coupling distance of the accelerometer to the microcontroller should be minimal.
- The flag underneath the package is internally connected to ground. It is not recommended for the flag to be soldered down.
- Place a ground plane beneath the accelerometer to reduce noise, the ground plane should be attached to all of the open ended terminals shown in Figure 6.
- Use an RC filter with 1.0 kΩ and 0.1 µF on the outputs of the accelerometer to minimize clock noise (from the switched capacitor filter circuit).
- PCB layout of power and ground should not couple power supply noise.
- Accelerometer and microcontroller should not be a high current path.
- A/D sampling rate and any external power supply switching frequency should be selected such that they do not interfere with the internal accelerometer sampling frequency (11 kHz for the sampling frequency). This will prevent aliasing errors.
- PCB layout should not run traces or vias under the QFN part. This could lead to ground shorting to the accelerometer flag.

2.1.3 Heart Beat Sensor

Heartbeat Sensor is an electronic device that is used to measure the heart rate i.e. speed of the heartbeat. Monitoring body temperature, heart rate and blood pressure are the basic things that we do in order to keep us healthy.

Heart Rate can be monitored in two ways: one way is to manually check the pulse either at wrists or neck and the other way is to use a Heartbeat Sensor.But the more easy way to monitor the heart rate is to use a Heartbeat Sensor. It comes in different shapes and sizes and allows an instant way to measure the heartbeat.Heartbeat Sensors are available in Wrist Watches (Smart Watches), Smart Phones, chest straps, etc. The heartbeat is measured in beats per minute or bpm, which indicates the number of times the heart is contracting or expanding in a minute

Principle of heart beat sensor

The principle behind the working of the Heartbeat Sensor is Photoplethysmograph. According to this principle, the changes in the volume of blood in an organ is measured by the changes in the intensity of the light passing through that organ.

Usually, the source of light in a heartbeat sensor would be an IR LED and the detector would be any Photo Detector like a Photo Diode, an LDR (Light Dependent Resistor) or a Photo Transistor.With these two i.e. a light source and a detector, we can arrange them in two ways: A Transmissive Sensor and a Reflective Sensor.

In a Transmissive Sensor, the light source and the detector are place facing each other and the finger of the person must be placed in between the transmitter and receiver. Reflective Sensor, on the other hand, has the light source and the detector adjacent to each other and the finger of the person must be placed in front of the sensor.

Working of heart beat Sensor

A simple Heartbeat Sensor consists of a sensor and a control circuit. The sensor part of the Heartbeat Sensor consists of an IR LED and a Photo Diode placed in a clip.The Control Circuit consists of an Op-Amp IC and few other components that help in connecting the signal to a Microcontroller. The working of the Heartbeat Sensor can be understood better if we take a look at its circuit diagram. Usually, the source of light in a heartbeat sensor would be an IR LED and the detector would be any Photo Detector like a Photo Diode, an LDR (Light Dependent Resistor) or a Photo Transistor.With these two i.e. a light source and a detector, we can arrange them in two ways: A Transmissive Sensor and a Reflective Sensor.

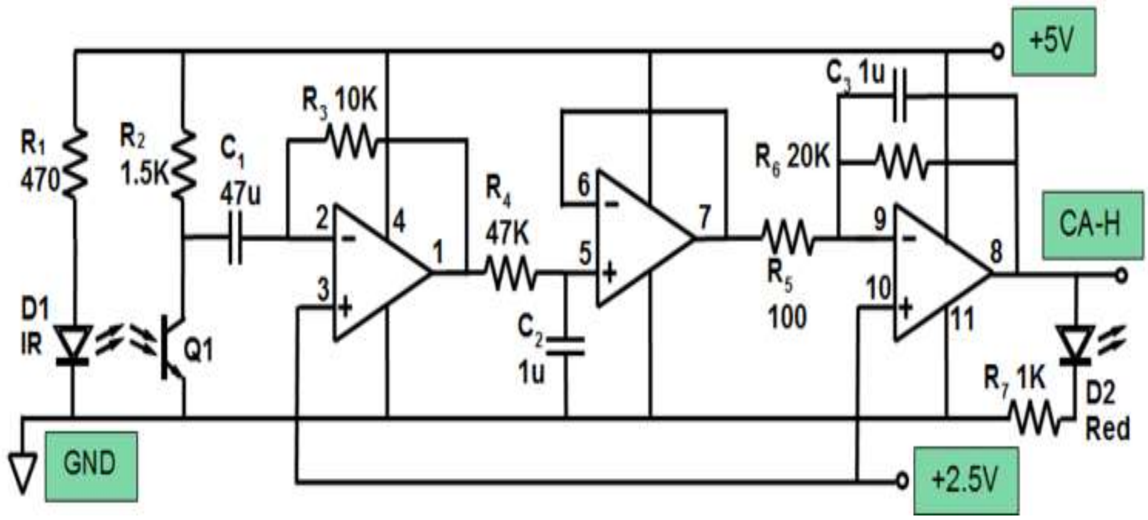


Fig 2.10 Heart Rate Sensor Circuit Diagram

Above fig 2.10 shows the finger type heartbeat sensor, which works by detecting the pulses. Every heartbeat will alter the amount of blood in the finger and the light from the IR LED passing through the finger and thus detected by the Photo Diode will also vary.

The output of the photo diode is given to the non-inverting input of the first op-amp through a capacitor, which blocks the DC Components of the signal. The first op-amp cats as a non-inverting amplifier with an amplification factor of 1001.

The output of the first op-amp is given as one of the inputs to the second op-amp, which acts as a comparator. The output of the second op-amp triggers a transistor, from which, the signal is given to a Microcontroller like Arduino.

The Op-amp used in this circuit is LM358. It has two op-amps on the same chip. Also, the transistor used is a BC547. An LED, which is connected to transistor, will blink when the pulse is detected.

2.1.4 Rechargable Battery

A rechargeable battery is a type of electrical battery which can be charged, discharged into a load, and recharged many times, as opposed to a disposable or primary battery, which is supplied fully charged and discarded after use. It is composed of one or more electrochemical cells.

During charging, the positive active material is oxidized, producing electrons, and the negative material is reduced thus consuming the electrons. These electrons constitute the current flow in the external circuit. The electrolyte may serve as a simple buffer for internal ion flow between the electrodes, as in lithium-ion and nickel-cadmium cells, or it may be an active participant in the electrochemical reaction, as in lead–acidcells.

The energy used to charge rechargeable batteries usually comes from a battery charger using AC mains electricity, although some are equipped to use a vehicle's 12-volt DC power outlet as shown in fig 2.11. The voltage of the source must be higher than that of the battery to force current to flow into it, but not too much higher or the battery may be damaged.Chargers take from a few minutes to several hours to charge a battery. Slow "dumb" chargers without voltage or temperature-sensing capabilities will charge at a low rate, typically taking 14 hours or more to reach a full charge. Rapid chargers can typically charge cells in two to five hours, depending on the model, with the fastest taking as little as fifteen minutes. Fast chargers must have multiple ways of detecting when a cell reaches full charge (change in terminal voltage, temperature, etc.) to stop charging before harmful overcharging or overheating occurs. The fastest chargers often incorporate cooling fans to keep the cells from overheating. Battery packs intended for rapid charging may include a temperature sensor that the charger uses to protect the pack; the sensor will have one or more additional electrical contacts.

Different battery chemistries require different charging schemes. For example, some battery types can be safely recharged from a constant voltage source. Other types need to be charged with a regulated current source that tapers as the battery reaches fully charged voltage. Charging a battery incorrectly can damage a battery; in extreme cases, batteries can overheat, catch fire, or explosively vent their contents.

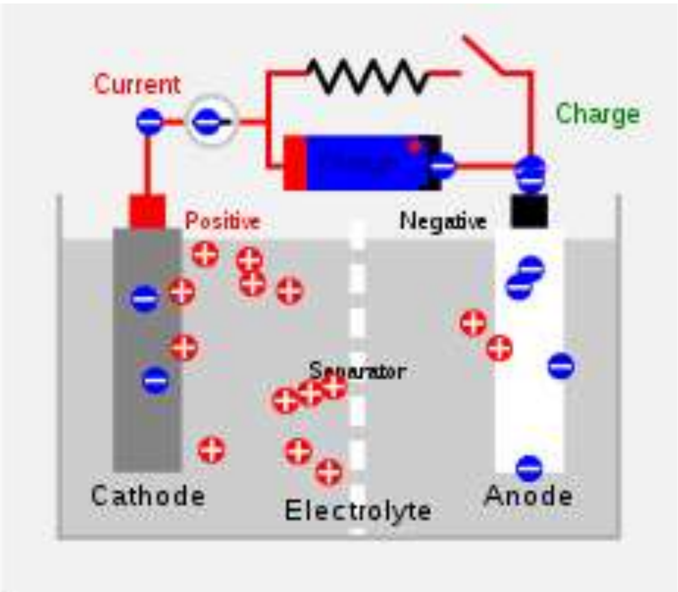


Fig 2.11 Diagram of the charging of a secondary cell or battery.

Battery charging and discharging rates are often discussed by referencing a "C" rate of current as shown in the Fig 3.10. The C rate is that which would theoretically fully charge or discharge the battery in one hour. For example, trickle charging might be performed at C/20 (or a "20 hour" rate), while typical charging and discharging may occur at C/2 (two hours for full capacity). The available capacity of electrochemical cells varies depending on the discharge rate. Some energy is lost in the internal resistance of cell components (plates, electrolyte, interconnections), and the rate of discharge is limited by the speed at which chemicals in the cell can move about. For lead-acid cells, the relationship between time and discharge rate is described by Peukert's law; a lead-acid cell that can no longer sustain a usable terminal voltage at a high current may still have usable capacity, if discharged at a much lower rate. Data sheets for rechargeable cells often list the discharge capacity on 8-hour or 20-hour or other stated time; cells for uninterruptible power supply systems may be rated at 15 minute discharge.

The terminal voltage of the battery is not constant during charging and discharging. Some types have relatively constant voltage during discharge over much of their capacity. Non-rechargeable alkaline and zinc–carbon cells output 1.5V when new, but this voltage drops with use.Battery manufacturers technical notes often refer to voltage per cell (VPC) for the individual cells that make up the battery. For example, to charge a 12 V lead-acid battery (containing 6 cells of 2 V each) at 2.3 VPC requires a voltage of 13.8 V across the battery's terminals.

2.1.5 Relay

A relay is an electrically operated switch. Many relays use an electromagnet to operate a switching mechanism, but other operating principles are also used. Relays find applications where it is necessary to control a circuit by a low-power signal, or where several circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits, repeating the signal coming in from one circuit and re-transmitting it to another. Relays found extensive use in telephone exchanges and early computers to perform logical operations. A type of relay that can handle the high power required to directly drive an electric motor is called a contactor. Solid-state relays control power circuits with no moving parts, instead using a semiconductor device triggered by light to perform switching. Relays with calibrated operating characteristics and sometimes multiple operating coils are used to protect electrical circuits from overload or faults; in modern electric power systems these functions are performd by digital instruments still called "protection relays".

Basic Design and Operation

A simple electromagnetic relay, such as the one taken from a car in the first picture, is an adaptation of an electromagnet. It consists of a coil of wire surrounding a soft iron core, an iron yoke, which provides a low reluctance path for magnetic flux, a movable iron armature, and a set, or sets, of contacts; two in the relay pictured. The armature is hinged to the yoke and mechanically linked to a moving contact or contacts. It is held in place by a spring so that when the relay is de-energized there is an air gap in the magnetic circuit. In this condition, one of the two sets of contacts in the relay pictured is closed, and the other set is open. Other relays may have more or fewer sets of contacts depending on their function. The relay in the picture also has a wire connecting the armature to the yoke. This ensures continuity of the circuit between the moving contacts on the armature, and the circuit track on the printed circuit board (PCB) via the yoke, which is soldered to the PCB.

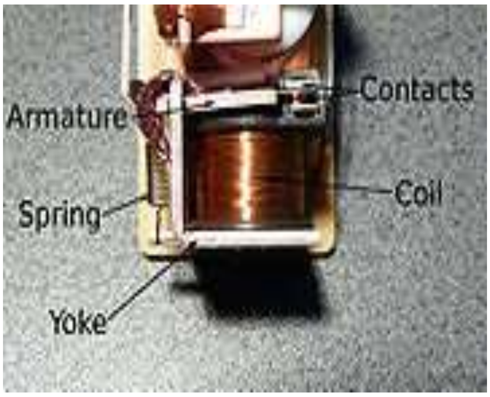


Fig 2.12 Simple electromechanical relay

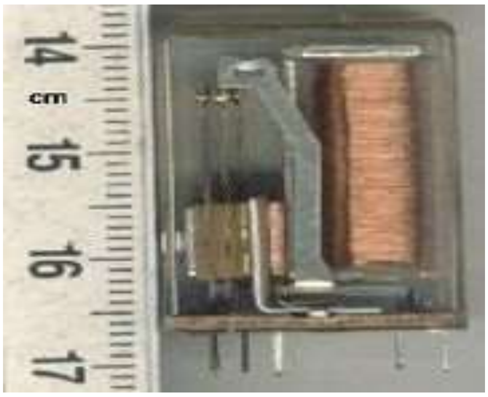


Fig 2.13 Small relay as used in electronics

When an electric current is passed through the coil, the resulting magnetic field attracts the armature and the consequent movement of the movable contact or contacts either makes or breaks a connection with a fixed contact. If the set of contacts was closed when the relay was De-energized, then the movement opens the contacts and breaks the connection, and vice versa if the contacts were open. When the current to the coil is switched off, the armature is returned by a force, approximately half as strong as the magnetic force, to its relaxed position. Usually this force is provided by a spring, but gravity is also used commonly in industrial motor starters. Most relays are manufactured to operate quickly. In a low voltage application, this is to reduce noise. In a high voltage or high current application, this is to reduce arcing.

If the coil is energized with DC, a diode is frequently installed across the coil, to dissipate the energy from the collapsing magnetic field at deactivation, which would otherwise generate a voltage spike dangerous to circuit components. Some automotive relays already include a diode inside the relay case. Alternatively a contact protection network, consisting of a capacitor and resistor in series, may absorb the surge. If the coil is designed to be energized with AC, a small copper ring can be crimped to the end of the solenoid. This "shading ring" creates a small out-of-phase current, which increases the minimum pull on the armature during the AC cycle. By analogy with the functions of the original electromagnetic device, a solid-state relay is made with a thyristor or other solid-state switching device. To achieve electrical isolation an opt coupler can be used which is a light-emitting diode (LED) coupled with a photo transistor.

2.1.6 Liquid Crystal Display (LCD)

LCD (Liquid Crystal Display) is a type of flat panel display which uses liquid crystals in its primary form of operation . LEDs have a large and varying set of use cases for consumers and businesses, as they can be commonly found in smartphones, televisions, computer monitors and instrument panels.

LCDs were a big leap in terms of the technology they replaced, which include light-emitting diode (LED) and gas-plasma displays. LCDs allowed displays to be much thinner than cathode ray tube (CRT) technology[5]. LCDs consume much less power than LED and gas-display displays because they work on the principle of blocking light rather than emitting it. Where an LED emits light, the liquid crystals in an LCD produces an image using a backlight.As LCDs have replaced older display technologies, LCDs have begun being replaced by new display technologies such as OLEDs.

Fig 2.14 2X16 LCD

Working of LCD

A display is made up of millions of pixels. The quality of a display commonly refers to the number of pixels; for example, a 4K display is made up of 3840 x2160 or 4096x2160 pixels. A pixel is made up of three subpixels; a red, blue and green-commonly called RGB. When the subpixels in a pixel change color combinations, a different color can be produced. With all the pixels on a display working together, the display can make millions of different colors. When the pixels are rapidly switched on and off, a picture is created.

The way a pixel is controlled is different in each type of display; CRT, LED, LCD and newer types of displays all control pixels differently. In short, LCDs are lit by a backlight, and pixels are switched on and off electronically while using liquid crystals to rotate polarized light. A polarizing glass filter is placed in front and behind all the pixels, the front filter is placed at 90 degrees. In between both filters are the liquid crystals, which can be electronically switched on and off.

LCDs are made with either a passive matrix or an active matrix display grid. The active matrix LCD is also known as a thin film transistor (TFT) display. The passive matrix LCD has a grid of conductors with pixels located at each intersection in the grid. A current is sent across two conductors on the grid to control the light for any pixel. An active matrix has a transistor located at each pixel intersection, requiring less current to control the luminance of a pixel. For this reason, the current in an active matrix display can be switched on and off more frequently, improving the screen refresh time. Some passive matrix LCD's have dual scanning, meaning that they scan the grid twice with current in the same time that it took for one scan in the original technology. However, active matrix is still a superior technology out of the two.

2.1.7 GPS Module (NEO-6M)

The NEO-6M is a GPS(Global Positioning System) module and is used for navigation. The module is simply checks its location on earth and provides output data which is longitude and latitude of its position. It is from a family of stand-alone GPS receivers featuring the high performance u-blox 6 positioning engine. These felxible and cost effective receivers offer numerous connectivity options in a miniature(16 x 12.2 x 2.4 mm) package as shown in fig 2.15. The compact architecture power and memory options make NEO-6M modules ideal for battery operated mobile devices with very strict cost and space constraints. Its Innovative design gives NEO-6M excellent naviagtion performance even in the most challenging environments.

Fig 2.15 GPS Module NEO-6M

GPS Module Pin Configuration

The module has four output pins and we will describe the function each pin of them below. The powering of module and communication interface is done through these four pins as shown in fig 2.16.

Table 2.5 Pin Description of GPS

Pin Name	Description
VCC	Positive power pin
TX	UART transmit pin
RX	UART receive pin
GND	Ground

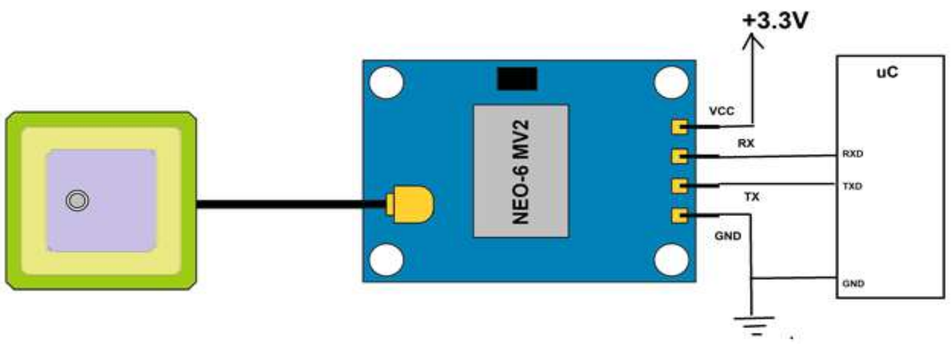


Fig 2.16 GPS Module Connection to External circuit

Features and Electrical Properties

- Standalone GPS receiver.
- Anti-jamming technology.
- UART Interface at the output pins (Can use SPI ,I2C and USB by soldering pins to the chip core).

- Under 1 second time-to-first-fix for hot and aided starts.
- Receiver type: 50 Channels - GPS L1 frequency - SBAS (WAAS, EGNOS, MSAS, GAGAN).
- Time-To-First-fix: For Cold Start 32s, For Warm Start 23s, For Hot Start <1s.
- Maximum navigation update rate: 5Hz.
- Default baud rate: 9600bps.
- EEPROM with battery backup.
- Sensitivity: -160dBm.
- Supply voltage: 3.6V.
- Maximum DC current at any output: 10Ma
- Operation limits: Gravity-4g, Altitude-50000m, Velocity-500m/s
- Operating temperature range: -40ºC TO 85°C

2.1.8 Buzzer

A buzzer or beeper is an audio signaling device, which may be mechanical, electromechanical, or electronic. Typical uses of buzzers and beepers include alarms, timers and confirmation of user input such as a mouse click or keystroke.

Fig 2.17 Buzzer

Features

- The PB series are high-performance buzzers with a unimorph piezoelectric ceramic element and an integral self-excitation oscillator circuit.
- They exhibit extremely low power consumption in comparison to electromagnetic units.
- They are constructed without switching contacts to ensure long life and no electrical noise
- Compact, yet produces high acoustic output with minimal voltage.

Voltage and Buzzer Sound Controls

When resistance is connected in series (as shown in fig 2.18 (a) and (b)), abnormal oscillation may occur when adjusting the sound volume. In this case, insert a capacitor in parallel to the voltage oscillation board (as shown in fig 2.18 (c)). By doing so, abnormal oscillation can be prevented by grounding one side. However, the voltage VB added to the voltage oscillation board must be within the maximum input voltage range, and as capacitance of 3.3μF or greater should be connected.

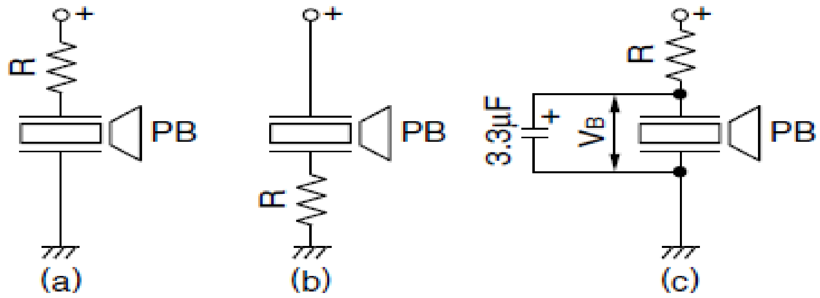


Fig 2.18 (a),(b) Resistance in series (c) Capacitor in parallel

2.1.9 Gyroscope (MPU6050)

A gyroscope is a device used for measuring or maintaining orientation and angular velocity. It is a spinning wheel or disc in which the axis of rotation (spin axis) is free to assume any orientation by it. When rotating, the orientation of this axis is unaffected by tilting or rotation of the mounting, according to the conservation of angular momentum[6]. It is an instrument, consisting of a wheel mounted into two or three gimbals providing pivoted supports, for allowing the wheel to rotate about a single axis as shown in fig 2.19. A set of three gimbals, one mounted on the other with orthogonal pivot axes, may be used to allow a wheel mounted on the innermost gimbals to have an orientation remaining independent of the orientation, in space, of its support.

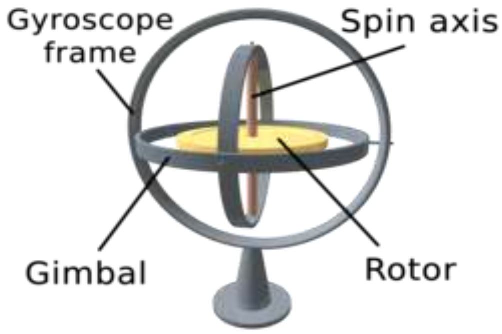


Fig 2.19 Gyroscope

In the case of a gyroscope with two gimbals, the outer gimbals, which is the gyroscope frame, is mounted so as to pivot about an axis in its own plane determined by the support. These outer gimbals possess one degree of rotational freedom and its axis possesses none. The second gimbals, inner gimbals, is mounted in the gyroscop e frame (outer gimbals) so as to pivot about an axis in its own plane that is always perpendicular to the pivotal axis of the gyroscope frame (outer gimbals). These inner gimbals have two degrees of rotational freedom.

The axle of the spinning wheel defines the spin axis. The rotor is constrained to spin about an axis, which is always perpendicular to the axis of the inner gimbals. So the rotor possesses three degrees of rotational freedom and its axis possesses two. The wheel responds to a force applied to the input axis by a reaction force to the output axis.

The behavior of a gyroscope can be most easily appreciated by consideration of the front wheel of a bicycle. If the wheel is leaned away from the vertical so that the top of the wheel moves to the left, the forward rim of the wheel also turns to the left. In other words, rotation on one axis of the turning wheel produces rotation of the third axis.

A gyroscope flywheel will roll or resist about the output axis depending upon whether the output gimbals are of a free or fixed configuration. Examples of some free-output-gimbals devices would be the attitude reference gyroscopes used to sense or measure the pitch, roll and yaw attitude angles in a spacecraft or aircraft.

The centre of gravity of the rotor can be in a fixed position. The rotor simultaneously spins about one axis and is capable of oscillating about the two other axes, and it is free to turn in any direction about the fixed point (except for its inherent resistance caused by rotor spin). Some gyroscopes have mechanical equivalents substituted for one or more of the elements[12]. For example, the spinning rotor may be suspended in a fluid, instead of being mounted in gimbals. A Control Moment Gyroscope (CMG) is an example of a fixed-output-gimbals device that is used on spacecraft to hold or maintain a desired attitude angle or pointing direction using the gyroscopic resistance force.

In some special cases, the outer gimbals (or its equivalent) may be omitted so that the rotor has only two degrees of freedom. In other cases, the centre of gravity of the rotor may be offset from the axis of oscillation, and thus the centre of gravity of the rotor and the centre of suspension of the rotor may not coincide.

MPU6050

The MPU6050 is a Micro Electro-Mechanical Systems (MEMS) which consists of a 3-axis Accelerometer and 3-axis Gyroscope inside it. This helps us to measure acceleration, velocity, orientation, displacement and many other motion related parameter of a system or object. This module also has a (DMP) Digital Motion Processor inside it which is powerful enough to perform complex calculation and thus free up the work for Microcontroller.

The module also have two auxiliary pins which can be used to interface external IIC modules like a magnetometer, however it is optional. Since the IIC address of the module is configurable more than one gyroscope MPU6050 sensor can be interfaced to Microcontroller using the AD0 pin. This module also has well documented and revised libraries available hence it's very easy to use with famous platforms like Arduino. So if you are looking for a sensor to control motion for your RC Car, Drone, and Self balancing Robot, Humanoid, Biped or something like that then this sensor might be the right choice for you.

Measuring Rotation

The MPU6050 can measure angular rotation using its on-chip gyroscope with four programmable full scale ranges of ±250°/s, ±500°/s, ±1000°/s and ±2000°/s.

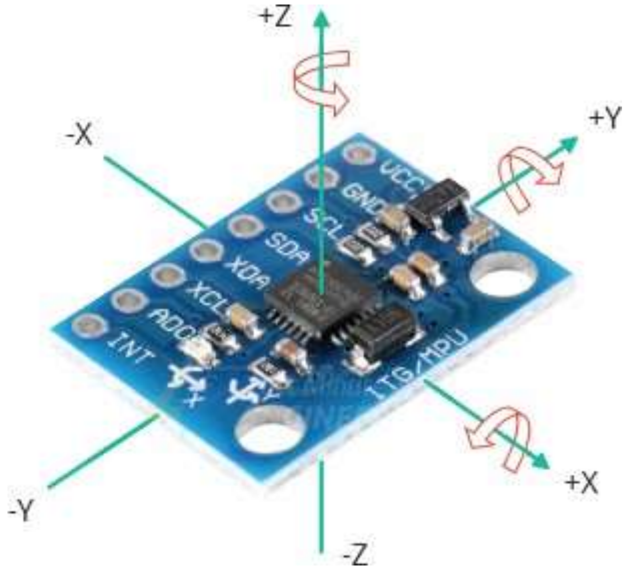


Fig 2.20 Angular Rotation of MPU6050

The Gyroscope MPU6050 has another three 16-bit analog-to-digital converters that simultaneously samples 3 axes of rotation (around X, Y and Z axis). The sampling rate can be adjusted from 3.9 to 8000 samples per second.

MPU6050 Pin Configuration

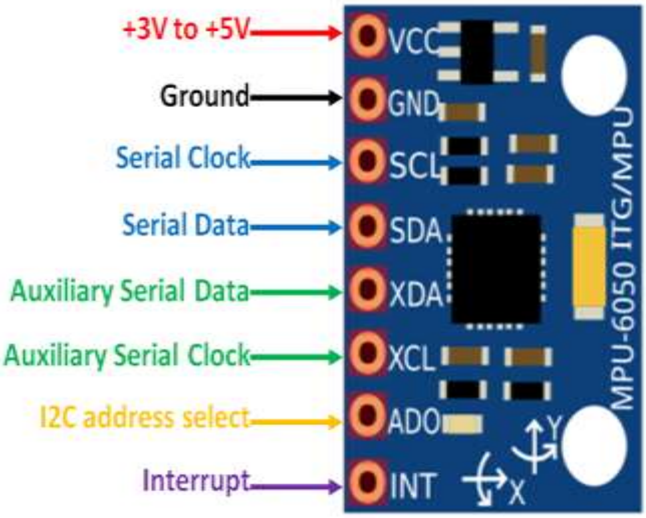


Fig 2.21 Pin Diagram of MPU6050

Table 2.6 MPU6050 Pin Description

Pin Number	Pin Name	Description
1	Vcc	Provides power for the module, can be +3V to +5V. Typically +5V is used
2	Ground	Connected to Ground of system
3	Serial Clock (SCL)	Used for providing clock pulse for I2C Communication
4	Serial Data (SDA)	Used for transferring Data through I2C communication
5	Auxiliary Serial Data (XDA)	Can be used to interface other I2C modules with MPU6050. It is optional
6	Auxiliary Serial Clock (XCL)	Can be used to interface other I2C modules with MPU6050. It is optional
7	AD0	If more than one MPU6050 is used a single MCU, then this pin can be used to vary the address
8	Interrupt (INT)	Interrupt pin to indicate that data is available for MCU to read.

MPU6050 Features

- MEMS 3-aixs accelerometer and 3-axis gyroscope values combined
- Power Supply: 3-5V
- Communication : I2C protocol
- Built-in 16-bit ADC provides high accuracy
- Built-in DMP provides high computational power
- Can be used to interface with other IIC devices like magnetometer
- Configurable IIC Address
- In-built Temperature sensor

How to use MPU6050

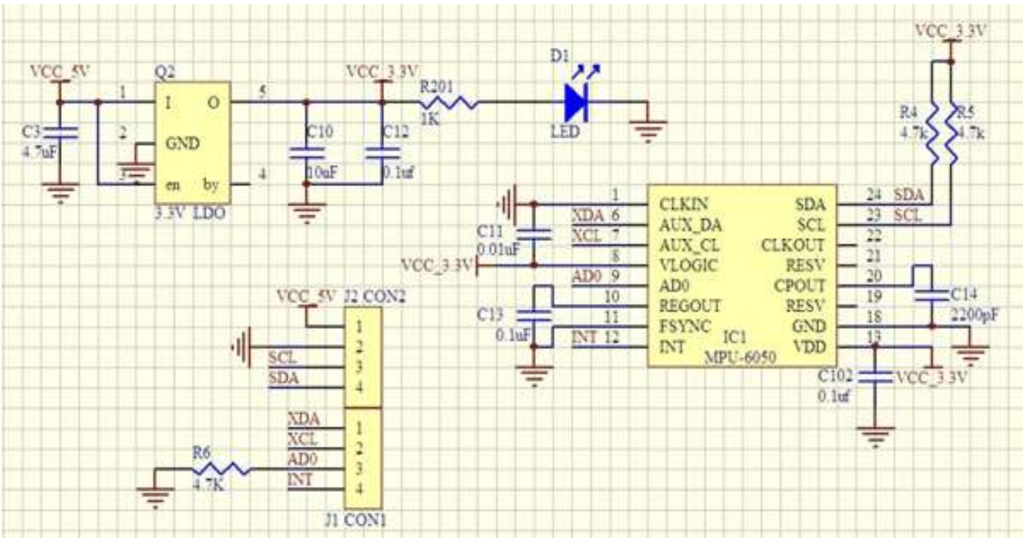


Fig 2.22 Circuit Diagram of MPU6050

The hardware of the module is very simple, it actually comprises of the MPU6050 as the main components as shown in above fig 2.22. Since the module works on 3.3V, a voltage regulator is also used. The IIC lines are pulled high using a 4.7k resistor and the interrupt pin is pulled down using another 4.7k resistor.

The MPU6050 module allows us to read data from it through the IIC bus. Any change in motion will be reflected on the mechanical system which will in turn vary the voltage. Then the IC has a 16-bit ADC which it uses to accurately read these changes in voltage and stores it in the FIFO buffer and makes the INT (interrupt) pin to go high. This means that the data is ready to be read, so we use a MCU to read the data from this FIFO buffer through IIC communication. As easy as it might sound, you may face some problem while actually trying to make sense of the data. However there are lots of platforms like Arduino using which you can start using this module in no time by utilizing the readily available libraries explained below.

How Gyroscope Works

While accelerometers measure linear acceleration, MEMS gyroscopes measure angular rotation. To do this they measure the force generated by what is known as The Coriolis Effect.

Coriolis Effect

Coriolis Effect tells us that when a mass (m) moves in a particular direction with a velocity (v) and an external angular rate (Ω) is applied (Red arrow); the Coriolis Effect generates a force (Yellow arrow) that causes a perpendicular displacement of the mass. The value of this displacement is directly related to the angular rate applied.

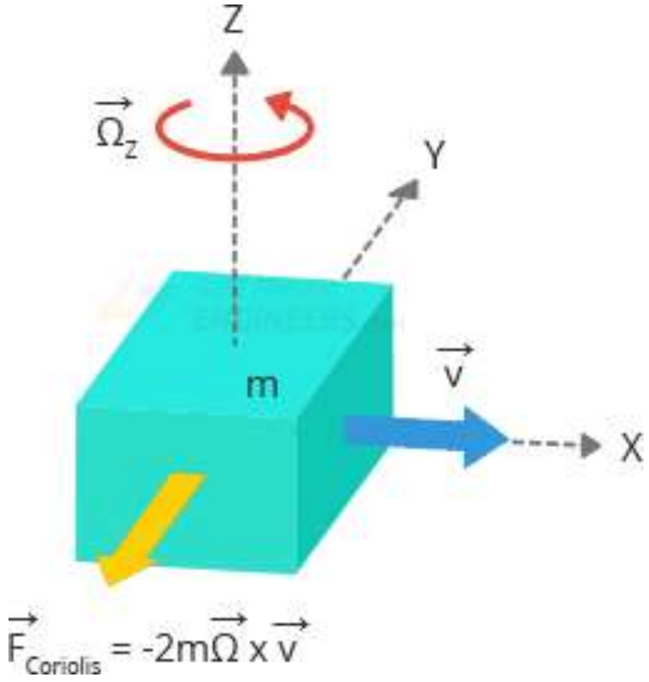


Fig 2.23 Coriolis Effect

Now suppose that there are two masses that are kept in constant oscillating motion so that they move continuously in opposite directions. When angular rate is applied, the Coriolis Effect on each mass is also in opposite directions, which results in a change in the capacitance between them; this change is sensed.

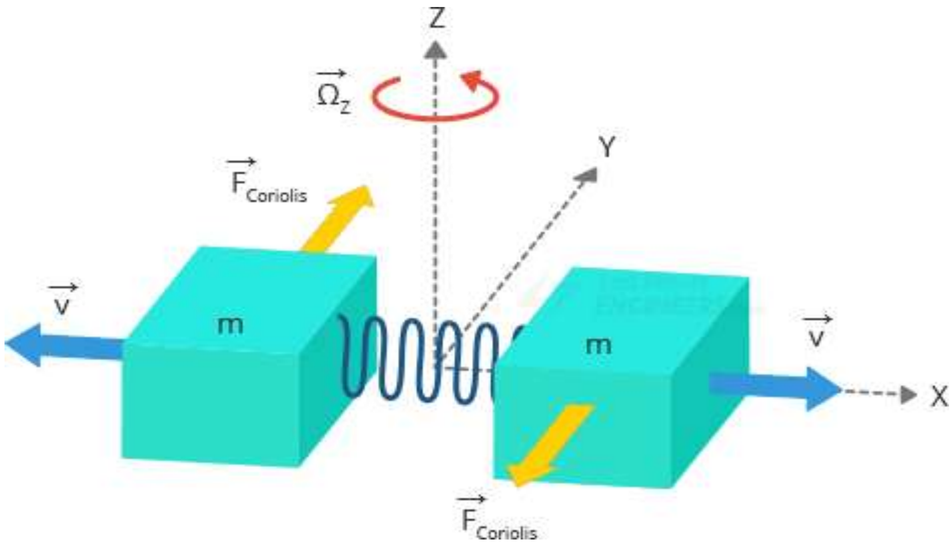


Fig 2.24 Coriolis Effect for two masses

Working of MEMS in Gyroscope

The MEMS sensor is composed of a proof mass (containing 4 parts M1, M2, M3 and M4) which is kept in a continuously oscillating movement so that is reacts to the Coriolis Effect. They move inward and outward simultaneously in the horizontal plane.

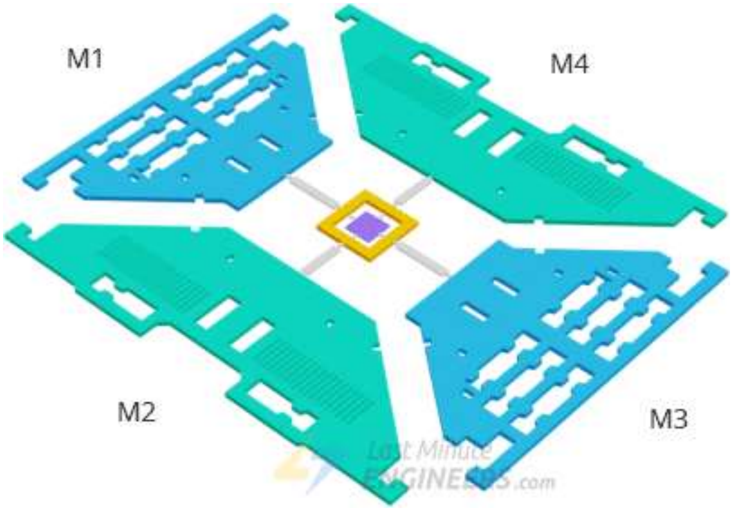


Fig 2.25 Inward and Outward Movement in Horizontal plane

When we start rotating the structure, the Coriolis force acting on the moving proof mass changes the direction of the vibration from horizontal to vertical. There are three modes depending on which axis the angular rotation is applied.

1) Roll Mode

When an angular rate is applied along the X-axis, due to the coriolis effect, then M1 and M3 will move up and down out of the plane. This causes the roll angle to change hence it is called Roll Mode.

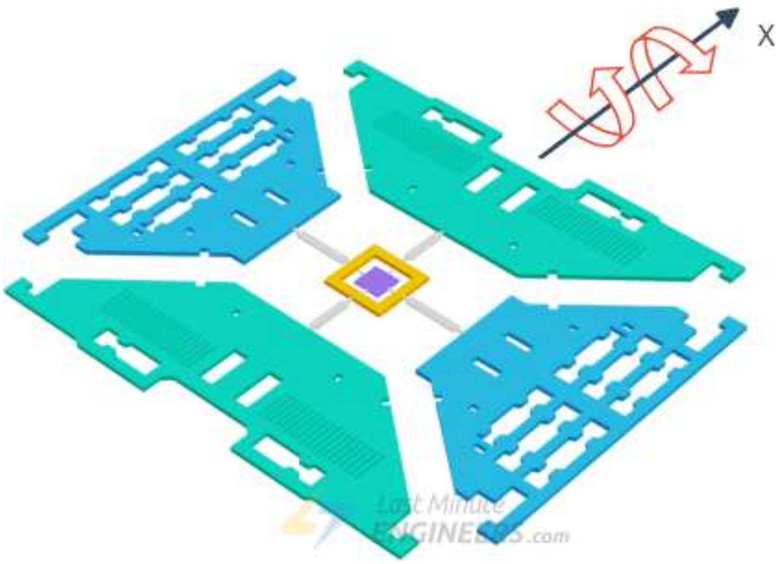


Fig 2.26 Roll Mode

2) Pitch Mode

When an angular rate is applied along the Y-axis, then M2 and M4 will move up and down. This causes the pitch angle to change hence it is called Pitch Mode.

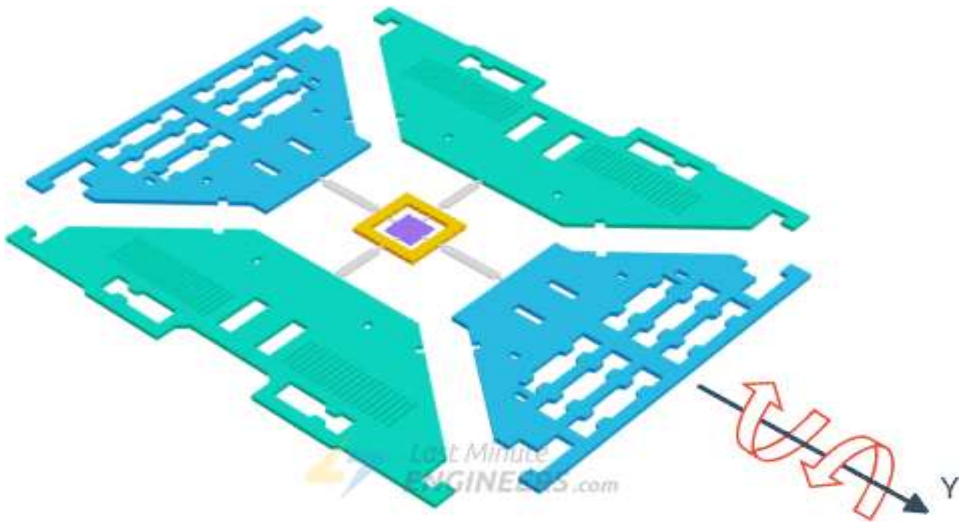


Fig 2.27 Pitch Mode

3) Yaw Mode

When an angular rate is applied along the Z-axis, M2 and M4 will move in the same horizontal plane in opposite directions. This causes the yaw angle to change hence it is called Yaw Mode.

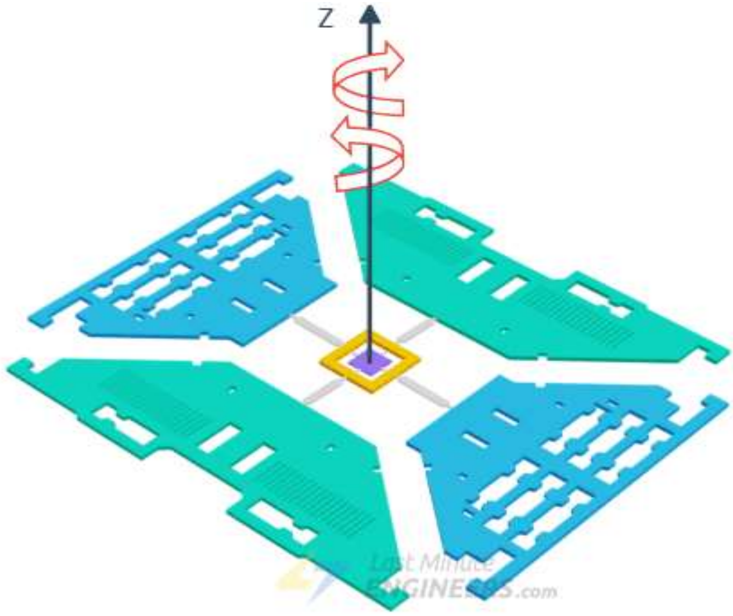


Fig 2.28 Yaw Mode

Whenever the Coriolis Effect is detected, the continuous movement of the driving mass will cause a capacitance change (ΔC) which is picked up by the sensing structure and then converted to a voltage signal.

2.2 SOFTWARE REQUIREMENTS

Arduino IDE

Arduino IDE where IDE stands for Integrated Development Environment - An official software introduced by Arduino.cc, that is mainly used for writing, compiling and uploading the code in the Arduino Device. Almost all Arduino modules are compatible with this software that is an open source and is readily available to install and start compiling the code on the go. In this post, I'll take you through the brief Introduction of the Software, how you can install it, and make it ready for your required Arduino module.

- Arduino IDE is open source software that is mainly used for writing and compiling the code into the Arduino Module.
- It is official Arduino software, making code compilation too easy that even a common person with no prior technical knowledge can get their feet wet with the learning process.
- It is easily available for operating systems like MAC, Windows, Linux and runs on the Java Platform that comes with inbuilt functions and commands that play a vital role for debugging, editing and compiling the code in the environment.

- A range of Arduino modules available including Arduino Uno, Arduino Mega, Arduino Leonardo, Arduino Micro and many more.
- Each of them contains a microcontroller on the board that is actually programmed and accepts the information in the form of code.
- The main code, also known as a sketch, created on the IDE platform will ultimately generate a Hex File which is then transferred and uploaded in the controller on the board.
- The IDE environment mainly contains two basic parts: Editor and Compiler where former is used for writing the required code and later is used for compiling and uploading the code into the given Arduino Module.
- This environment supports both C and C++ languages.

The IDE environment is mainly distributed into three sections

1. Menu Bar
2. Text Editor
3. Output Pane

As you download and open the IDE software, it will appear like the fig 2.29 below.

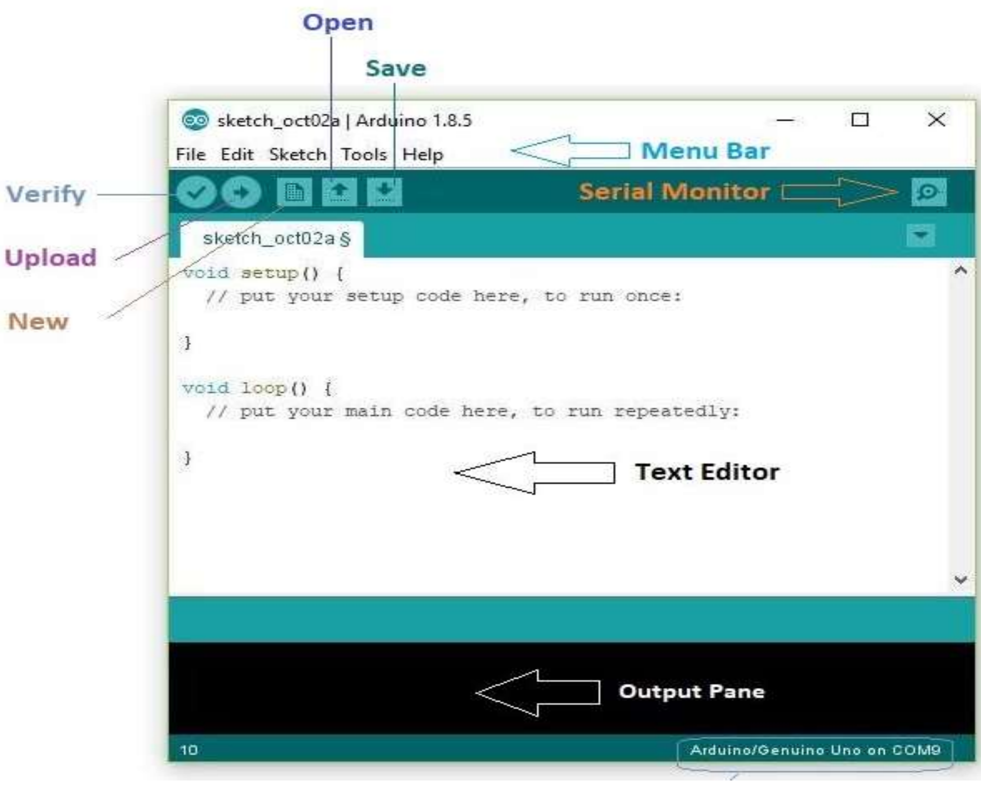


Fig 2.29 Introduction to Arduino IDE

File - You can open a new window for writing the code or open an existing one. Following table 2.7 shows the number of further subdivisions the file option is categorized into.

Table 2.7 Subdivisions of File Option

File	
New	This is used to open new text editor window to write your code
Open	Used for opening the existing written code
Open Recent	The option reserved for opening recently closed program
Sketchbook	It stores the list of codes you have written for your project
Examples	Default examples already stored in the IDE software
Close	Used for closing the main screen window of recent tab. If two tabs are open, it will ask you again as you aim to close the second tab
Save	It is used for saving the recent program
Save as	It will allow you to save the recent program in your desired folder
Page setup	Page setup is used for modifying the page with portrait and landscape options. Some default page options are already given from which you can select the page you intend to work on
Print	It is used for printing purpose and will send the command to the printer
Preferences	It is page with number of preferences you aim to setup for your text editor page
Quit	It will quit the whole software all at once

As you go to the preference section and check the compilation section, the Output Pane will show the code compilation as you click the upload button.

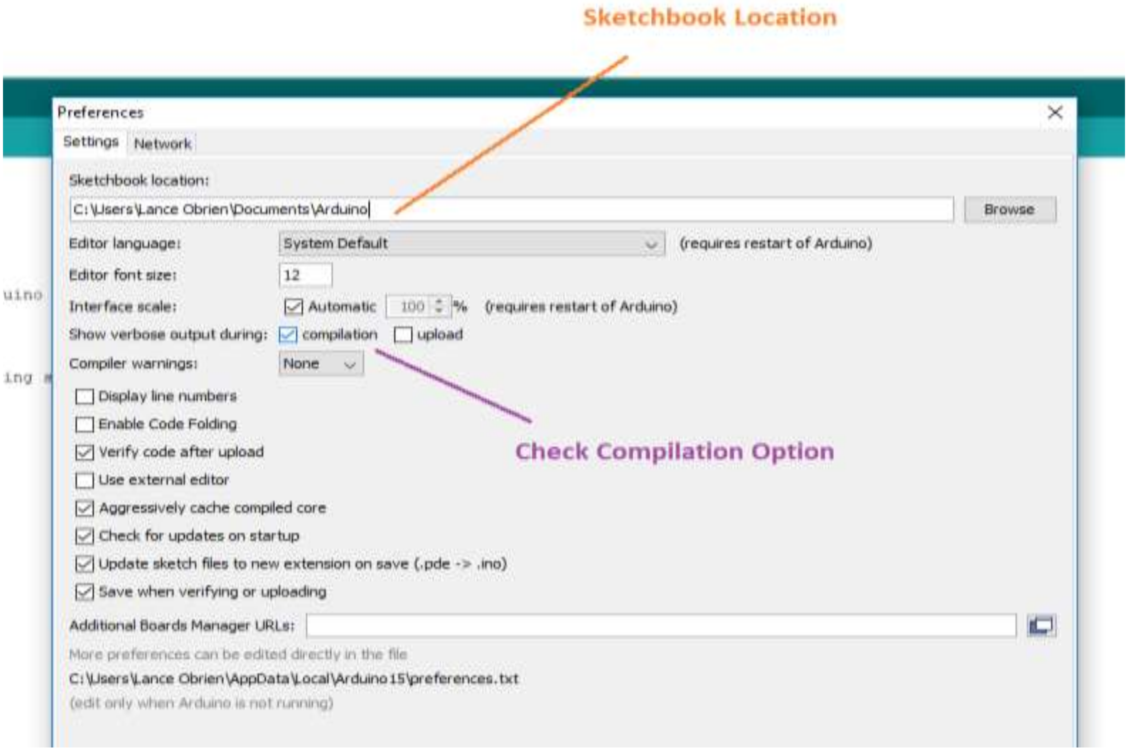


Fig 2.30 Compilation Section

And at the end of compilation, it will show you the hex file it has generated for the recent sketch that will send to the Arduino Board for the specific task you aim to achieve as shown in the fig 2.31.

Fig 2.31 Generation of Hex file

Edit - Used for copying and pasting the code with further modification for font.

Sketch - For compiling and programming

Tools - Mainly used for testing projects. The Programmer section in this panel is used for burning a boot loader to the new microcontroller.

Help - In case you are feeling skeptical about software, complete help is available from getting started to troubleshooting.

The Six Buttons appearing under the Menu tab are connected with the running program.

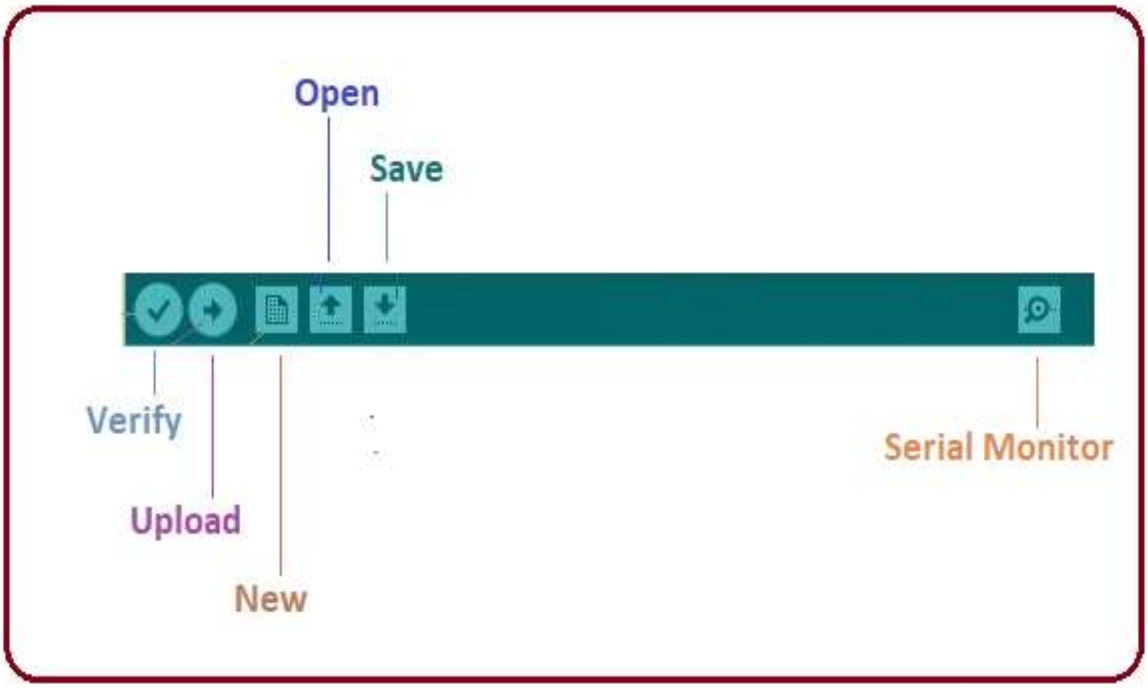


Fig 2.32 Running the Program

- The check mark appearing in the circular button is used to verify the code. Click this once you have written your code.
- The arrow key will upload and transfer the required code to the Arduino board.
- The dotted paper is used for creating a new file.
- The upward arrow is reserved for opening an existing Arduino project.
- The downward arrow is used to save the current running code.
- The button appearing on the top right corner is a Serial Monitor - A separate pop-up window that acts as an independent terminal and plays a vital role for sending and receiving the Serial Data.
- You can also go to the Tools panel and select Serial Monitor, or pressing Ctrl+Shift+M all at once will open it instantly. The Serial Monitor will actually help to debug the written Sketches where you can get a hold of how your program is operating.
- Your Arduino Module should be connected to your computer by USB cable in order to activate the Serial Monitor.

You need to select the baud rate of the Arduino Board you are using right now. For my Arduino Uno Baud Rate is 9600, as you write the following code and click the Serial Monitor, the output will show as the fig 2.33 below.

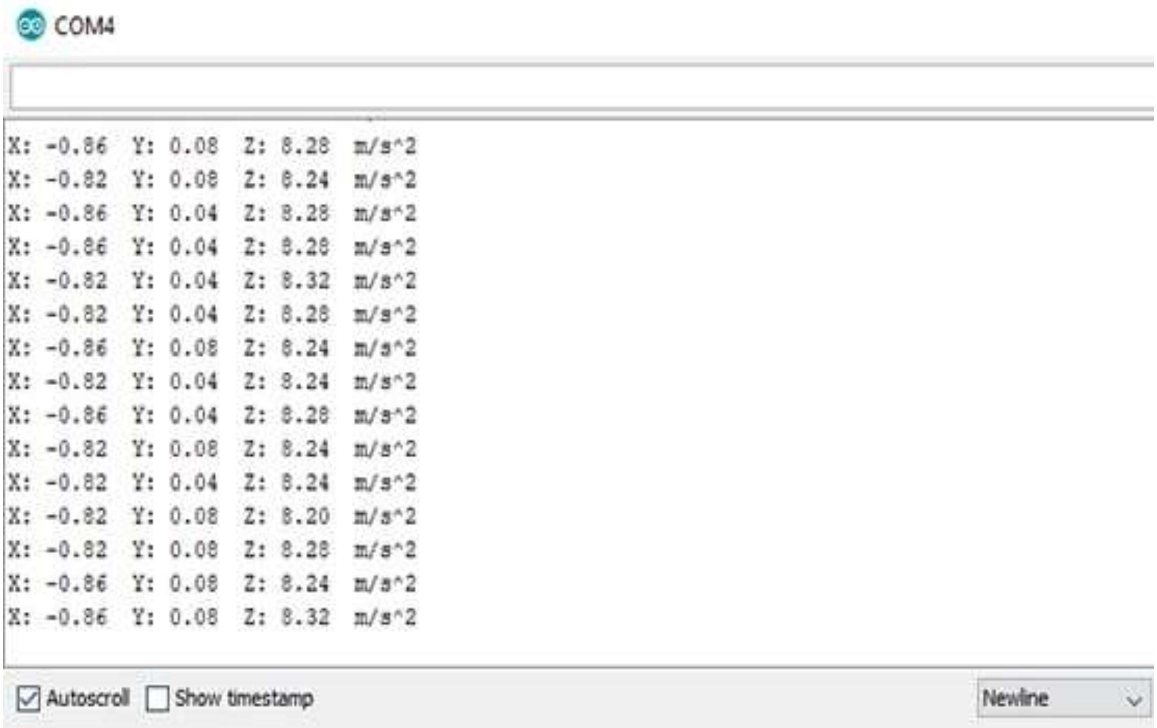


Fig 2.33 Serial Monitor Output

The main screen below the Menu bard is known as a simple text editor used for writing the required code.

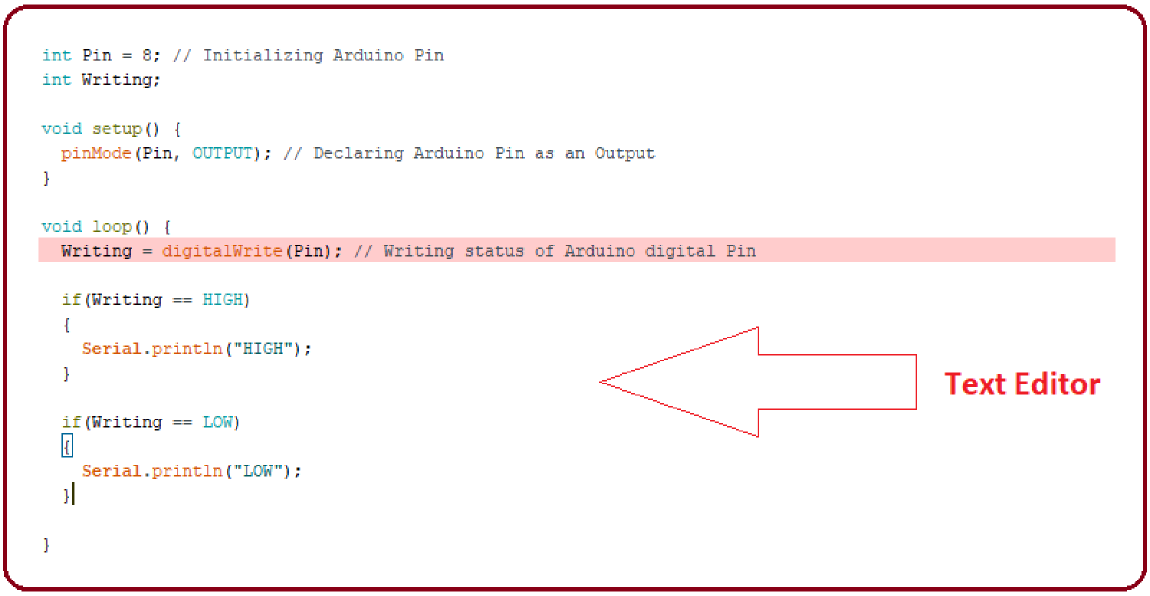


Fig 2.34 Simple Text Editor

The bottom of the main screen is described as an Output Pane that mainly highlights the compilation status of the running code: the memory used by the code, and errors occurred in the program. You need to fix those errors before you intend to upload the hex file into your Arduino Module.

Fig 2.35 Output Window

More or less, Arduino C language works similar to the regular C language used for any embedded system microcontroller, however, there are some dedicated libraries used for calling and executing specific functions on the board.

Libraries

Libraries are very useful for adding the extra functionality into the Arduino Module. There is a list of libraries you can add by clicking the Sketch button in the menu bar and going to Include Library.

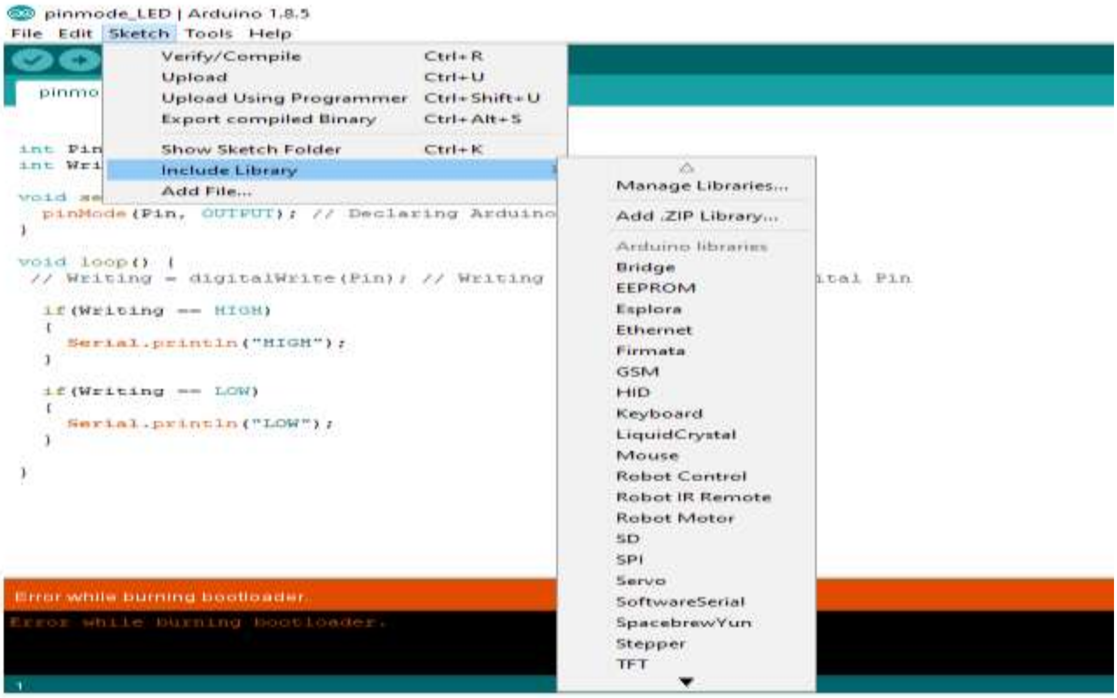


Fig 2.36 Including Libraries

As you click the Include Library and Add the respective library it will on the top of the sketch with a #include sign. Suppose, I Include the EEPROM library, it will appear on the text editor as #include <EEPROM.h>.Most of the libraries are preinstalled and come with the Arduino software. However, you can also download them from the external sources.

Making Pins Input or Output

The digitalRead and digitalWrite commands are used for addressing and making the Arduino pins as an input and output respectively.These commands are text sensitive i.e. you need to write them down the exact way they are given like digitalWrite starting with small "d" and write with capital "W". Writing it down with Digitalwrite or digitalwrite won't be calling or addressing any function.

How to Select the Board

In order to upload the sketch, you need to select the relevant board you are using and the ports for that operating system. As you click the Tools on the Menu, it will open like the fig 3.36 below. If the board is not installed go to preferences and copy the required board link and then search in the board manager and install the board in the arduino.

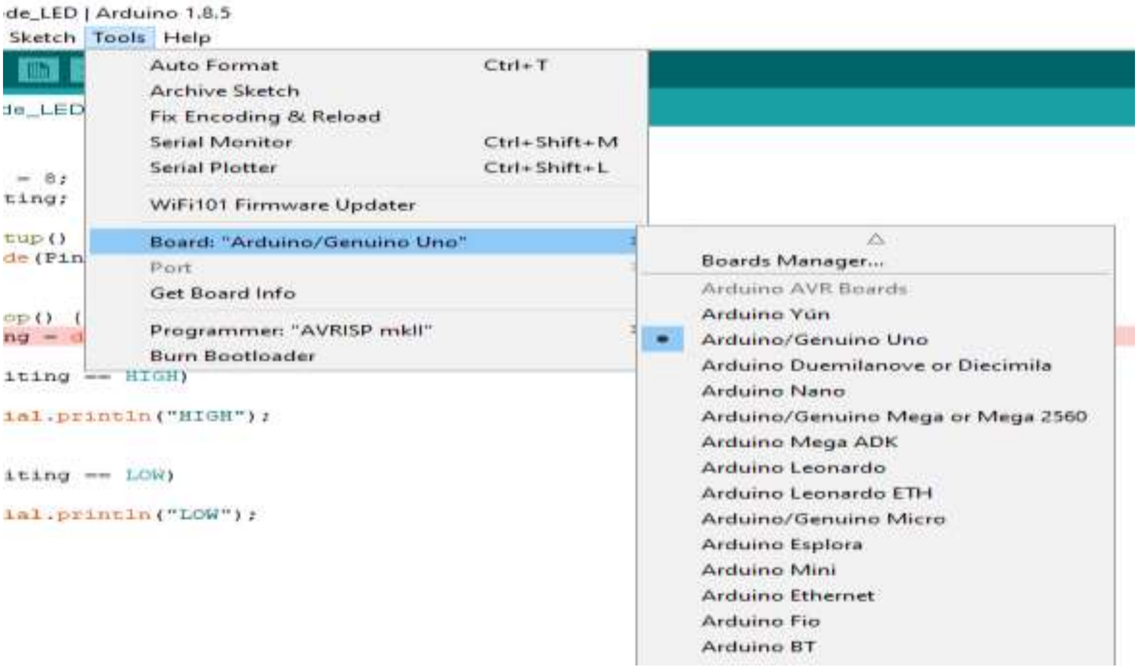


Fig 2.37 Board Selection

- Go to the "Board" section and select the board you aim to work on. Similarly, COM1, COM2, COM4, COM5, COM7 or higher are reserved for the serial and USB board. You can look for the USB serial device in the ports section of the Windows Device Manager.Following figure shows the COM7 that we have used for our project, indicating the Arduino Uno with COM7 port at the right bottom corner of the screen.

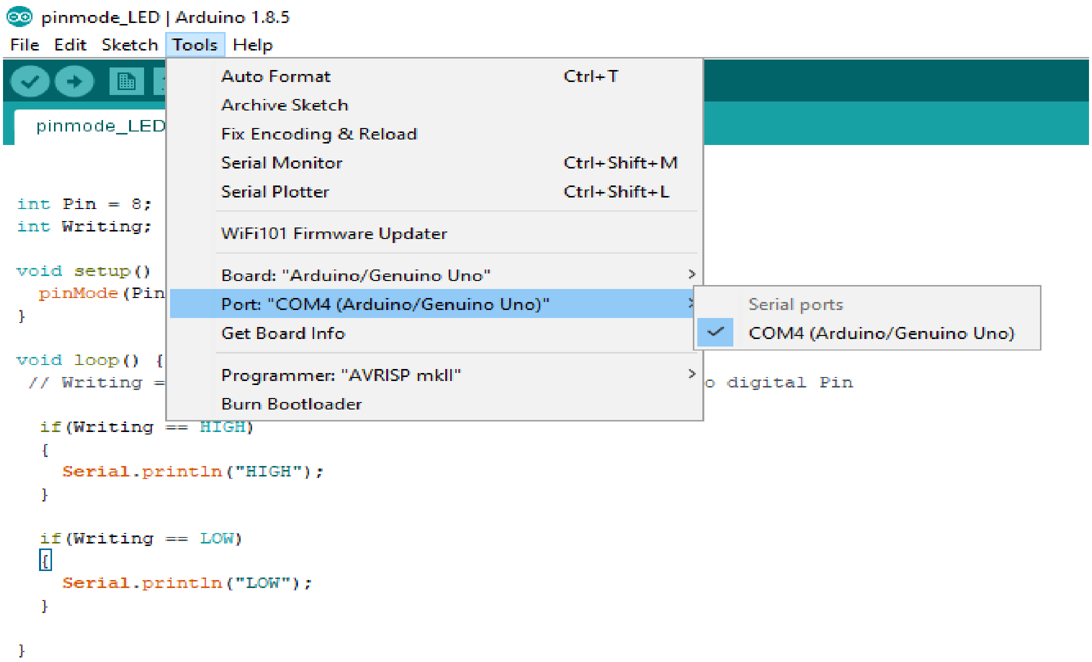


Fig 2.38 Port Selection

- After correct selection of both Board and Serial Port, click the verify and then upload button appearing in the upper left corner of the six button section or you can go to the Sketch section and press verify/compile and then upload.
- The sketch is written in the text editor and is saved with the file extension .ino.
- It is important to note that the recent Arduino Modules will reset automatically as you compile and press the upload button the IDE software, however, older version may require the physical reset on the board.
- Once you upload the code, TX and RX LEDs will blink on the board, indicating the desired program is running successfully.
- The port selection criteria mentioned above is dedicated for Windows operating system only, you can check this Guide if you are using MAC or Linux.
- The amazing thing about this software is that no prior arrangement or bulk of mess is required to install this software, you will be writing your first program within 2 minutes after the installation of the IDE environment.
- As you go to the Tools section, you will find a bootloader at the end. It is very helpful to burn the code directly into the controller, setting you free from buying the external burner to burn the required code.

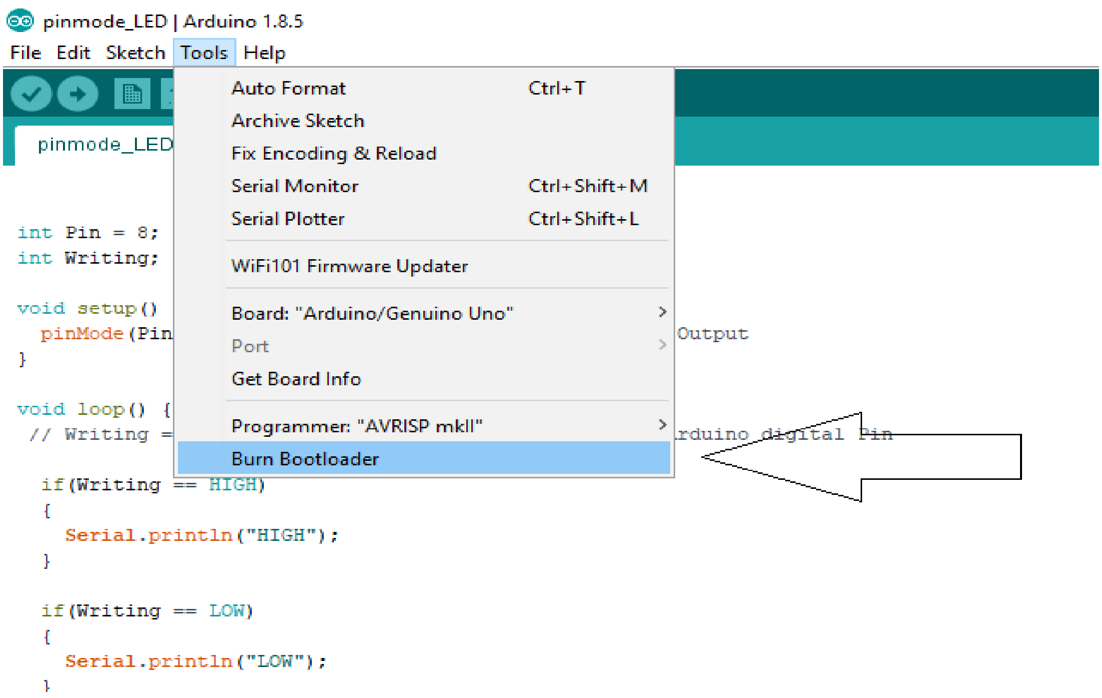


Fig 2.39 Burn Bootloader

Blynk App

Blynk was designed for the Internet of Things. It can control hardware remotely, it can display sensor data, it can store data, visualize it and do many other cool things.

There are three major components in the platform:

- Blynk App - allows to you create amazing interfaces for your projects using various widgets we provide.
- Blynk Server - responsible for all the communications between the Smartphone and hardware. You can use our Blynk Cloud or run your Private Blynk server locally. Its open-source could easily handle thousands of devices and can even be launched on a Raspberry Pi.
- Blynk Libraries - for all the popular hardware platforms - enable communication with the server and process all the incoming and out coming commands.

Now imagine every time you press a Button in the Blink app, the message travels to the Blynk Cloud, where it magically finds its way to your hardware. It works the same in the opposite direction and everything happens in a blynk of an eye.

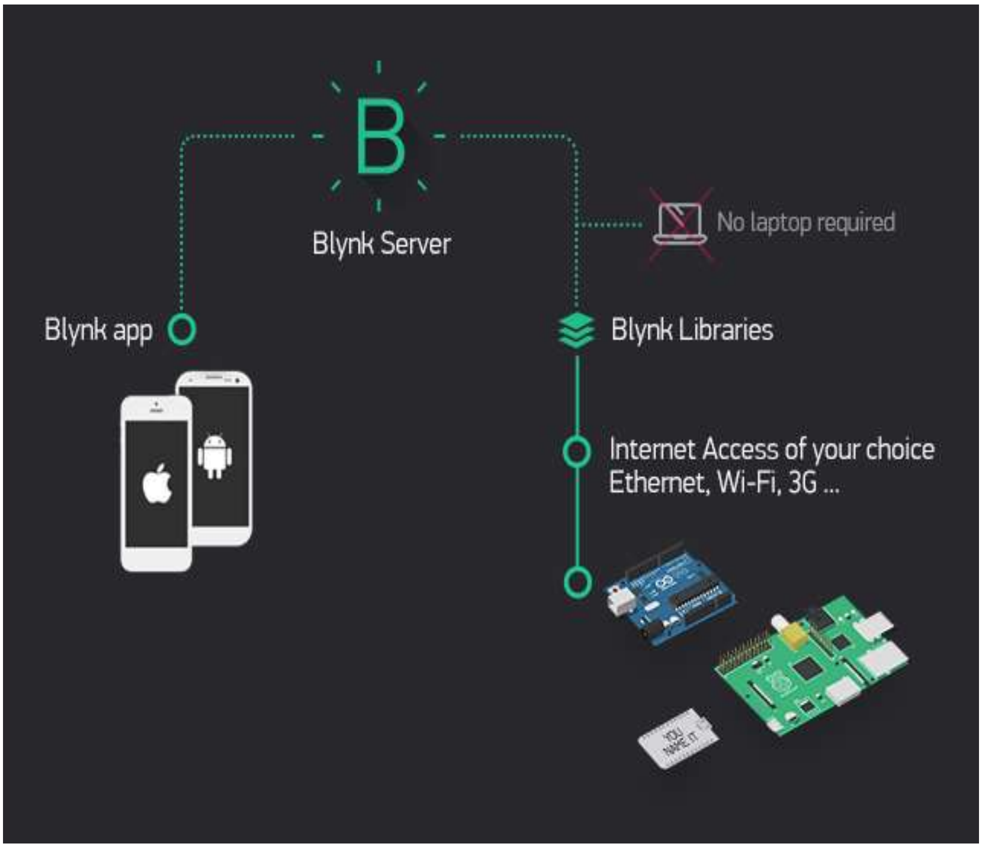


Fig 2.40 Interfacing with Blynk app

Features

Connection to the cloud using:

- Wi-Fi
- Bluetooth and BLE
- Ethernet
- USB (Serial)
- GSM
- Set of easy-to-use Widgets
- Direct pin manipulation with no code writing
- Easy to integrate and add new functionality using virtual pins
- History data monitoring via Super Chart widget
- Device-to-Device communication using Bridge Widget
- Sending emails, tweets, push notifications, etc.

Components needed to use Blynk

1. Hardware

An Arduino, Raspberry Pi, or a similar development kit.Blynk works over the Internet. This means that the hardware you choose should be able to connect to the internet. Some of the boards, like Arduino Uno will need an Ethernet or Wi-Fi Shield to communicate, others are already Internet-enabled: like the ESP8266, Raspberry Pi with Wi-Fi dongle, Particle Photon or Spark Fun Blynk Board. But even if you don't have a shield, you can connect it over USB to your laptop or desktop (it's a bit more complicated for newbie's, but we got you covered). What's cool is that the list of Hardware that works with Blynk is huge and will keep on growing.

2. A Smartphone

The Blynk App is a well designed interface builder. It works on both iOS and Android.

Working With Blynk app

1. Create a Blynk Account

After you download the Blynk App, you'll need to create a New Blynk account as shown in Fig 3.40. This account is separate from the accounts used for the Blynk Forums, in case you already have one.We recommend using a real email address because it will simplify things later.

Fig 2.41 Creating Blynk account

An account is needed to save your projects and have access to them from multiple devices from anywhere. It also a security measure. You can always set up your own private Blynk server and have full control.

2. Create a New Project

After you've successfully logged into your account, start by creating a new project.

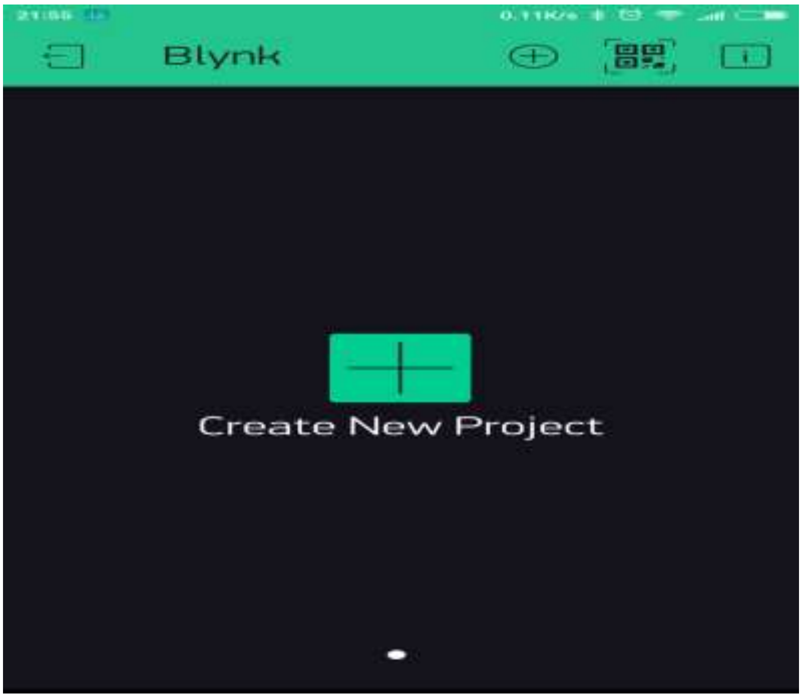


Fig 2.42 Creating New Blynk Project

3. Choose Your Hardware

Select the Hardware model you will use the options to select as shown in fig 2.43

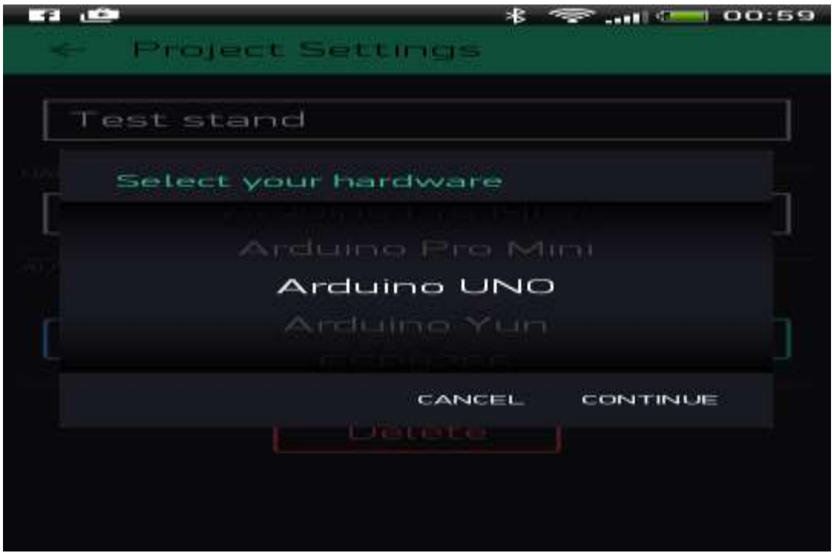


Fig 2.43 Hardware Selection

4. Auth Token

Auth Token is a unique identifier which is needed to connect your hardware to your smartphone. Every new project you create will have its own Auth Token. You'll get Auth Token automatically on your email after project creation. You can also copy it manually.

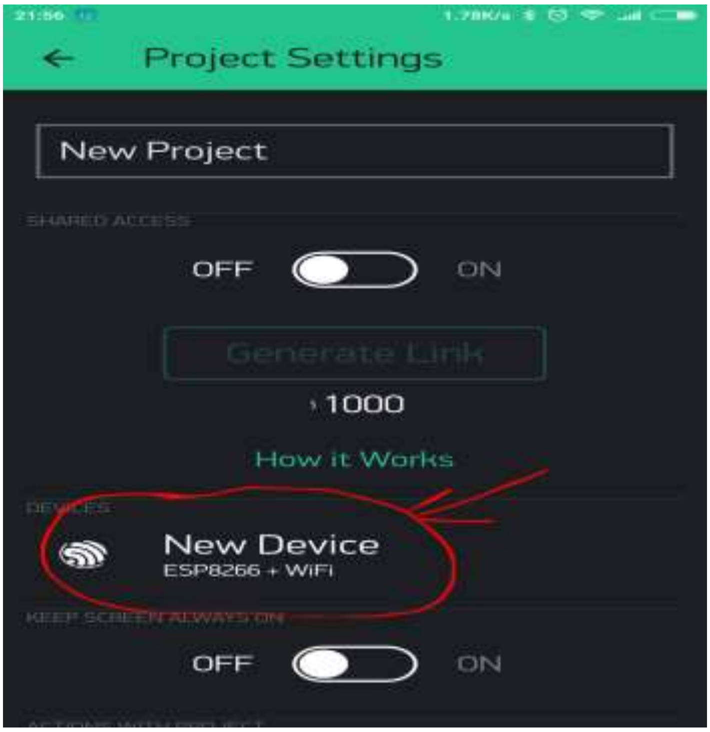


Fig 2.44 Project Settings

And you’ll see the token sent to your mail.

Fig 2.45 Auth Token

It’s very convenient to send it over e-mail. Press the e-mail button and the token will be sent to the e-mail address you used for registration. You can also tap on the Token line and it will be copied to the clipboard.

Now press the “Create” button.

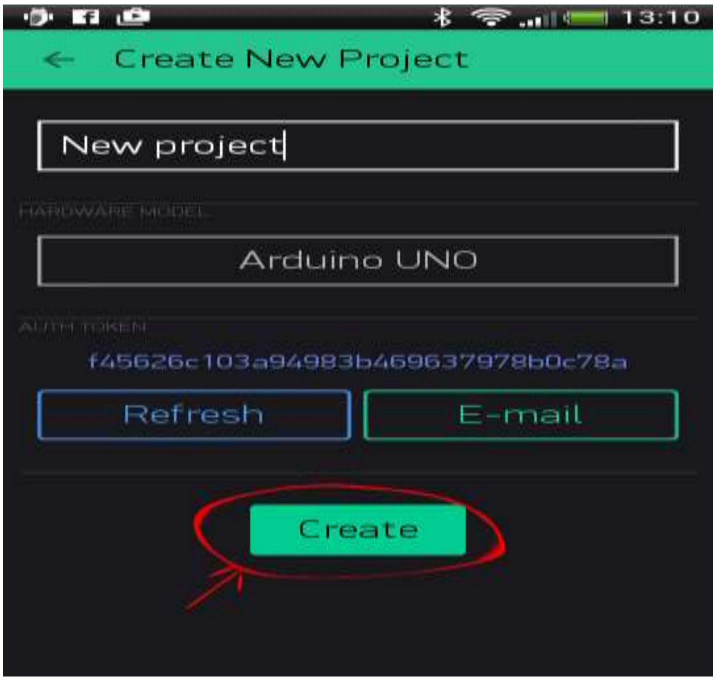


Fig 2.46 New Project Created

5. Add a Widget

Your project canvas is empty, let's add a button to control our LED.Tap anywhere on the canvas to open the widget box. All the available widgets are located here. Now pick a button.

Fig 2.47 Widget Box

Drag-n-Drop - Tap and hold the Widget to drag it to the new position.

Widget Settings - Each Widget has it's own settings. Tap on the widget to get to them.

The most important parameter to set is PIN . The list of pins reflects physical pins defined by your hardware. If your LED is connected to Digital Pin 8 - then select D8(D - stands for Digital).

Fig 2.48 Widget Settings

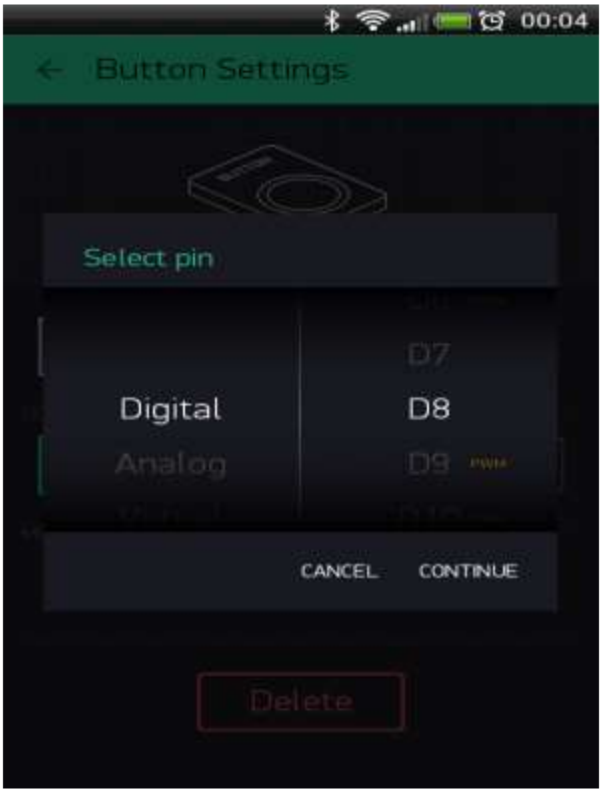


Fig 2.49 Pin Selection

6. Run The project

When you are done with the Settings - press the play button. This will switch you from EDIT mode to PLAY mode where you can interact with the hardware. While in PLAY mode, you won't be able to drag or set up new widgets, press stop and get back to EDIT mode. You will get a message saying "Arduino UNO is offline". We'll deal with that in the next section.

Fig 2.50 Running the Project

3. IMPLEMENTATION

In this chapter, the proposed system design was demonstrated in detail for both the hardware and software units of the project. This design was proposed in such a way to make it available and suitable for use by most people. Furthermore, there are so many arm-bands today that people actually buy and use. Hence this project's function can be simply added to one of these bands along with the main services it offers such as Monitoring Fitness and calculate steps walked daily.

3.1 PROPOSED SYSTEM

The proposed system shown in fig 3.1 consists of a device which is attached to patient body .It consists of sensors from which microcontroller ESP32 reads the data and in the case of emergency through inbuilt wifi alert message will be sent to the caregiver and doctor through Blynk application.

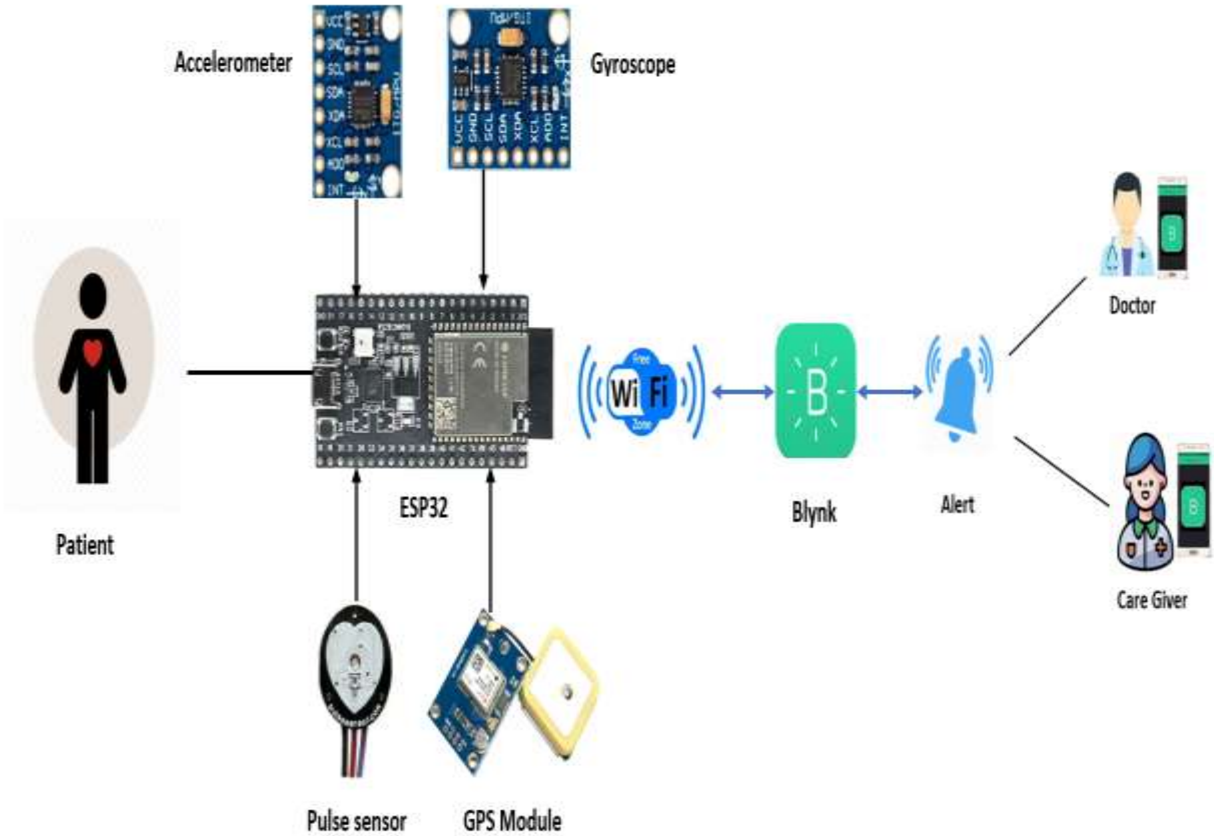


Fig 3.1 Structure of Proposed system

3.2 HARDWARE IMPLEMENTATION

The implimentation is done to test the overall system functionalities, the hardware is implemented as it was discussed throughout this chapters with aid of figures including all components and using the software Arduino IDE.

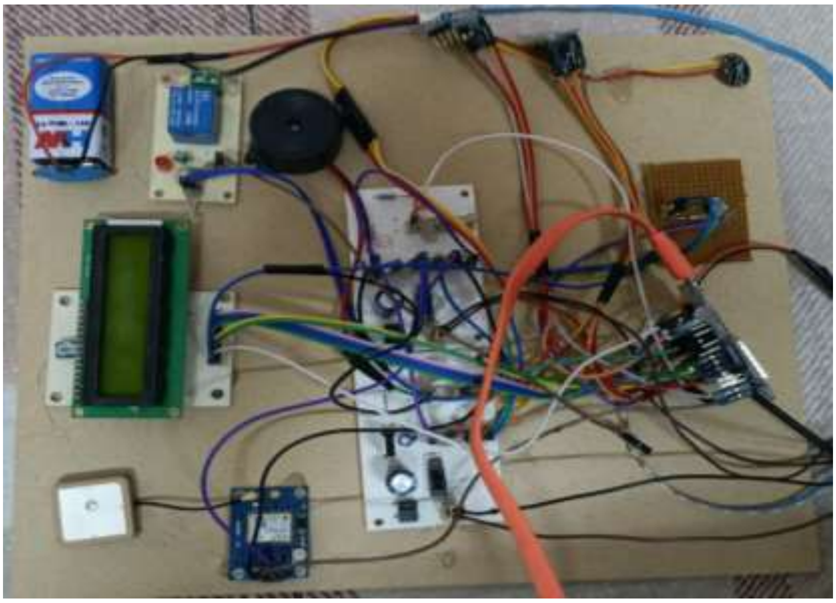


Fig 3.2 Implementation of Overall System

3.3 SOFTWARE IMPLEMENTATIONS

The software used for this project are

1. Arduino IDE
2. Blynk App

3.3.1 SETTING UP ARDUINO IDE

To install the ESP32 board in your Arduino IDE, follow these next instructions:

1. In your Arduino IDE, go to File> Preference

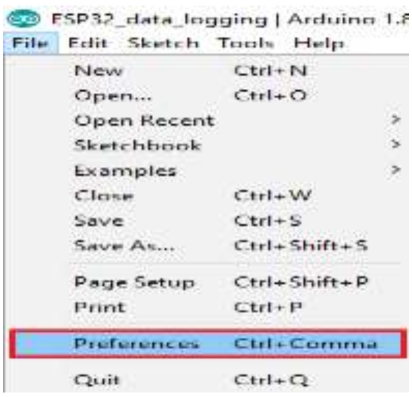


Fig 3.3 Preferences

2. Enter https://dl.espressif.com/dl/package_esp32_index.json into the "Additional Board Manager URLs" field as shown in the figure below. Then, click the "OK" button:

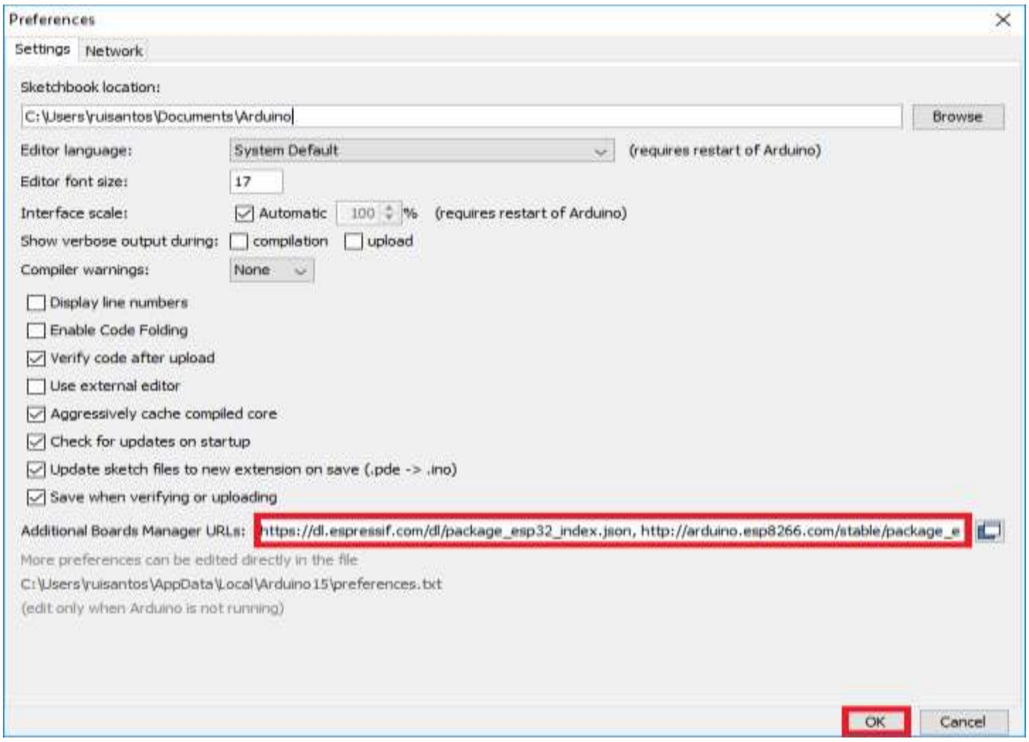


Fig 3.4 Including Board URL

3. Open the Boards Manager. Go to Tools > Board > Boards Manager…

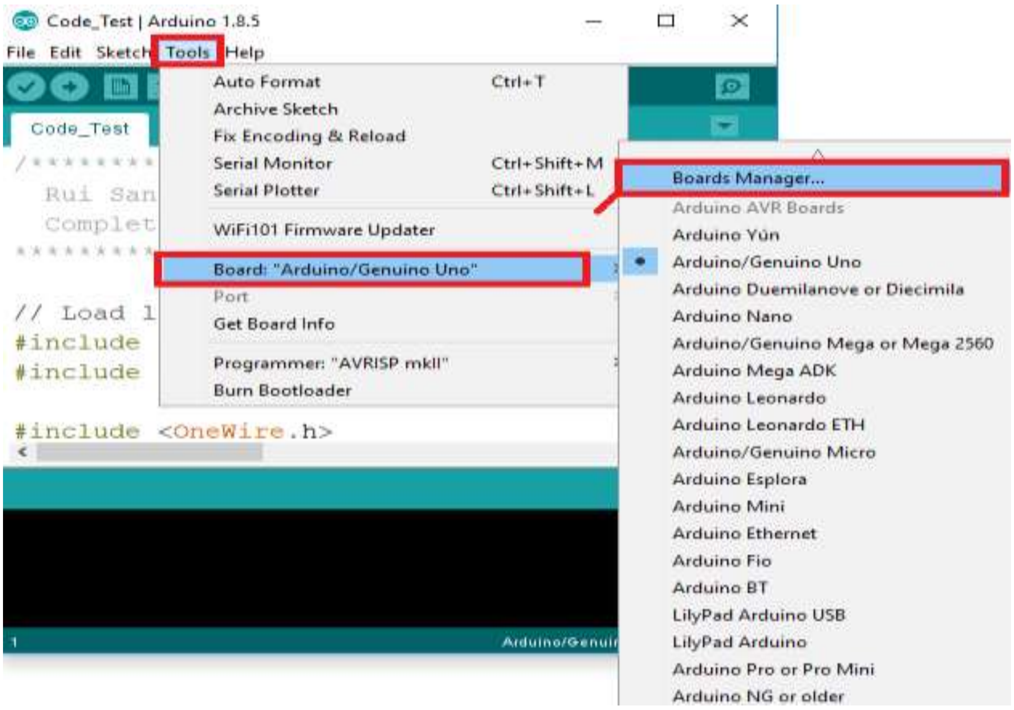


Fig 3.5 Board Manager

4. Search for ESP32 and press install button for the “ESP32 by Espressif Systems“:

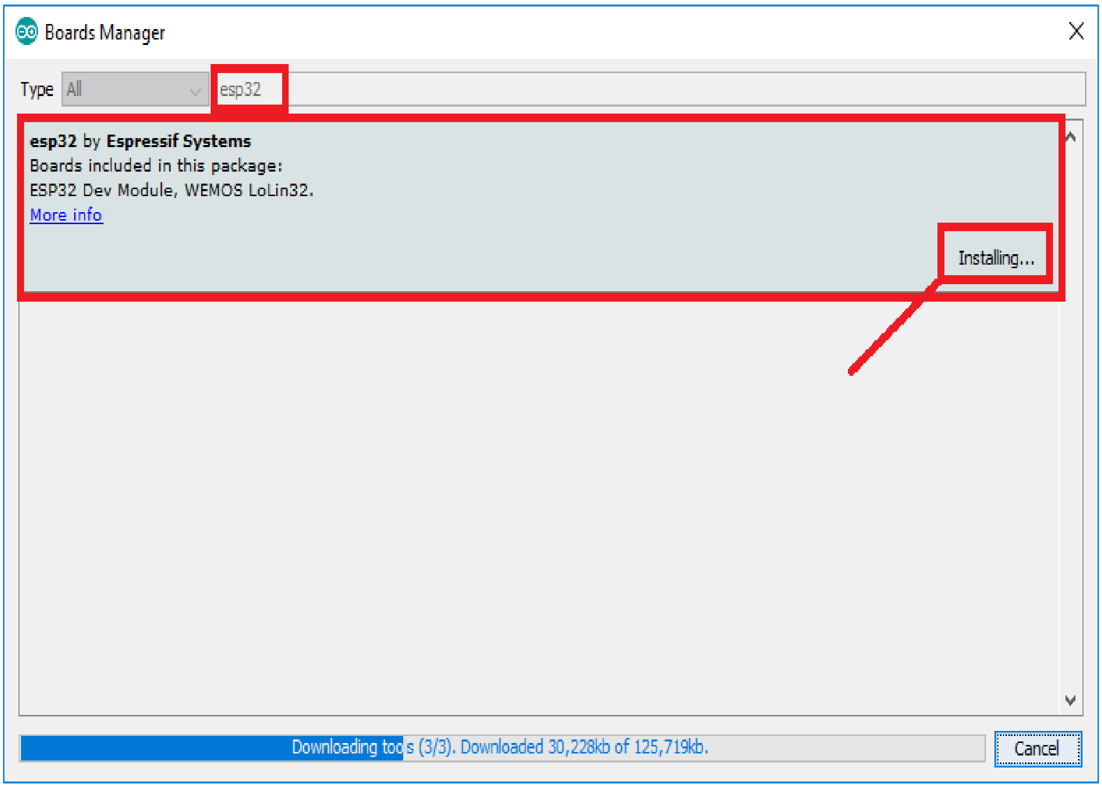


Fig 3.6 Installing ESP32

5. That’s it. It should be installed after a few seconds.

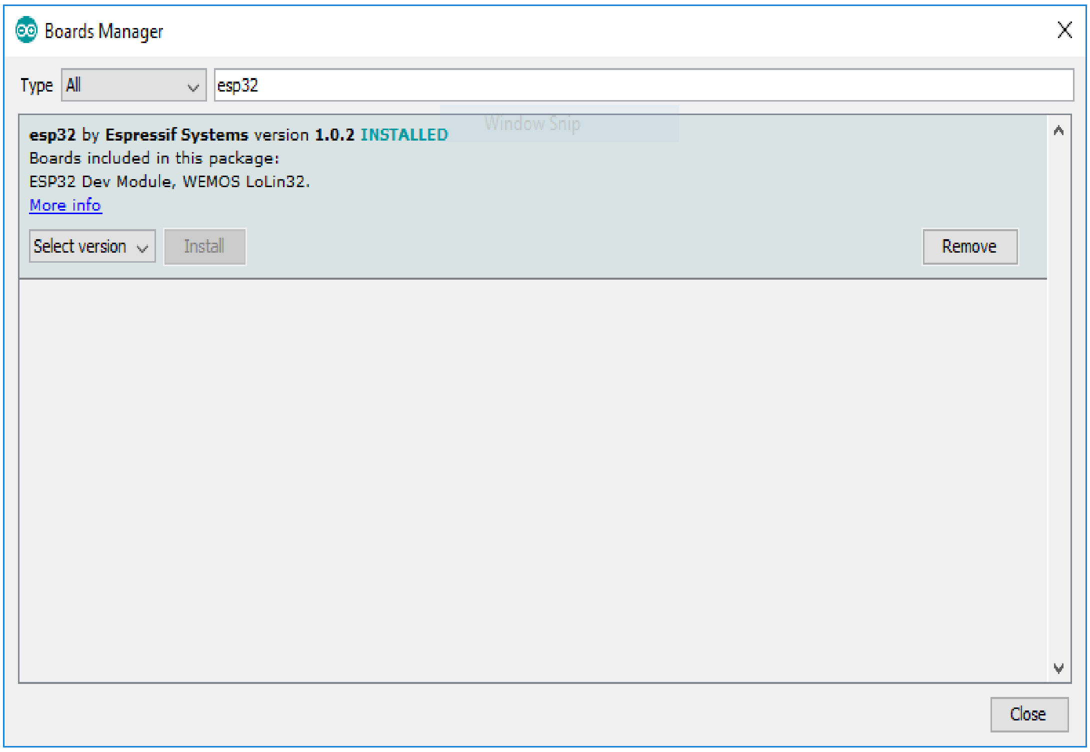


Fig 3.7 ESP32 is Installed

3.3.2 TESTING THE INSTALLATION

Plug the ESP32 board to your computer. With your Arduino IDE open, follow these steps:

1. Select your Board in Tools > Board menu (in my case it's the DOIT ESP32 DEVKIT)

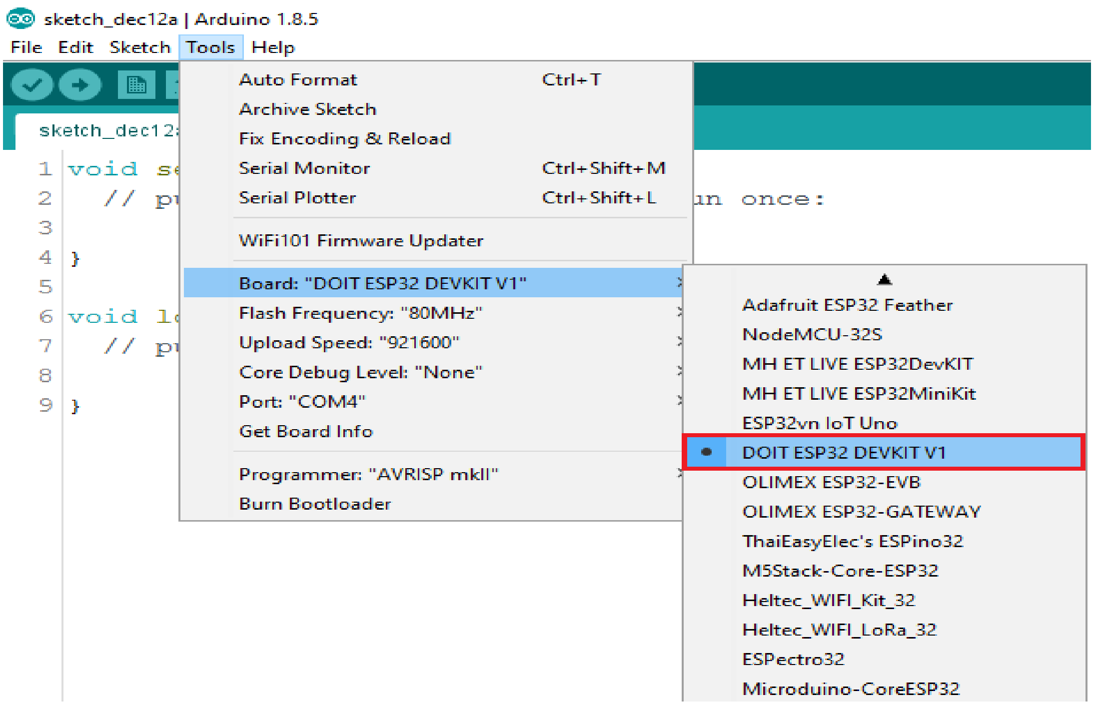


Fig 3.8 Selecting Board in Tools

2. Select the Port (if you don't see the COM Port in your Arduino IDE, you need to install the CP210x USB to UART Bridge VCP Drivers):

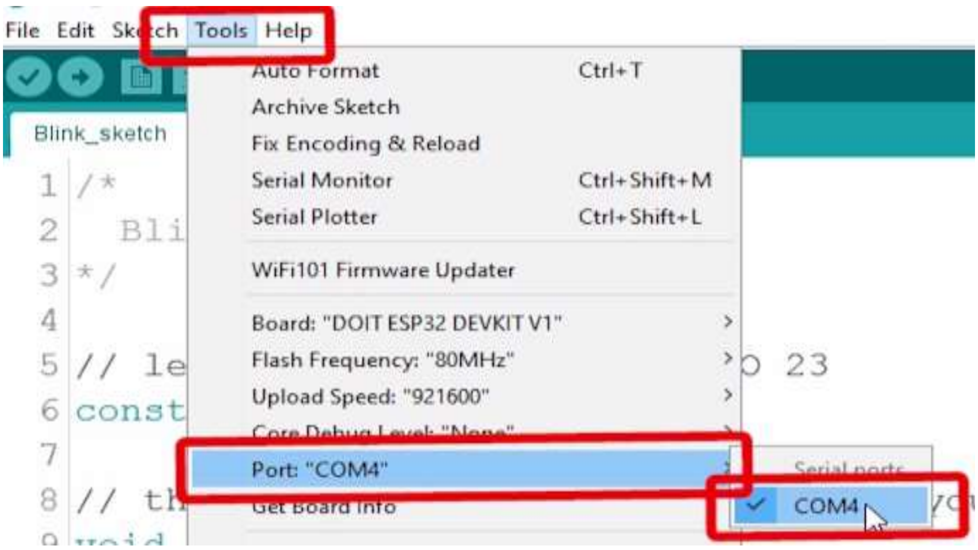


Fig 3.9 Port Selection

3. Open the following example under File > Examples > WiFi (ESP32) > WiFiScan

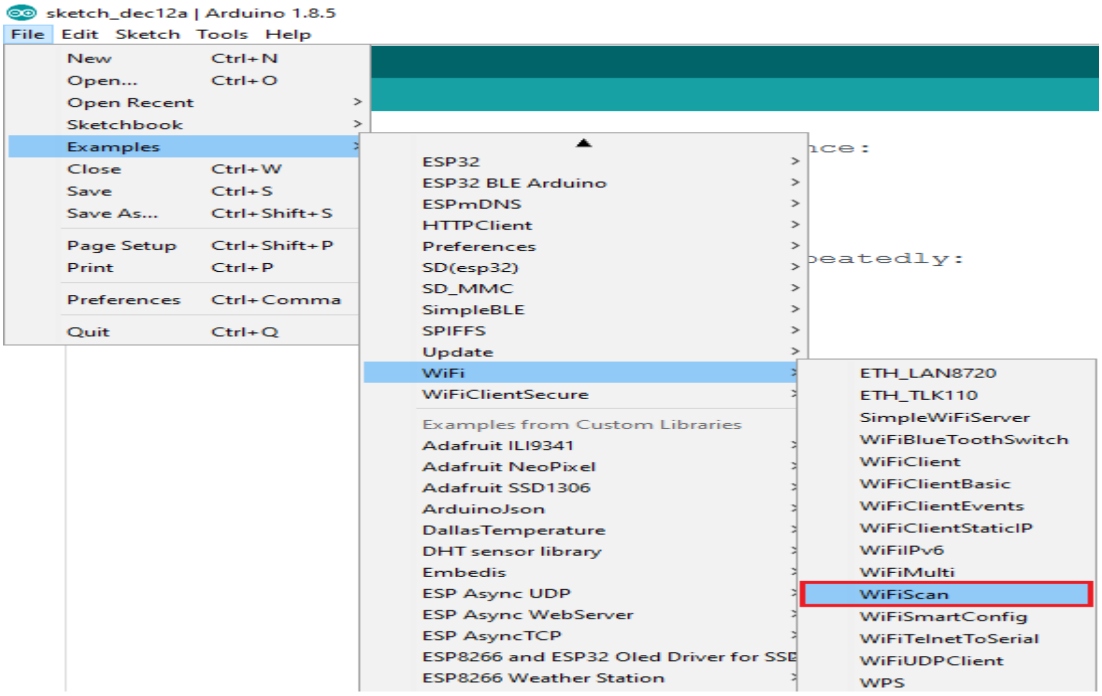


Fig 3.10 WiFi Scanning

4. A new sketch opens in your Arduino IDE:

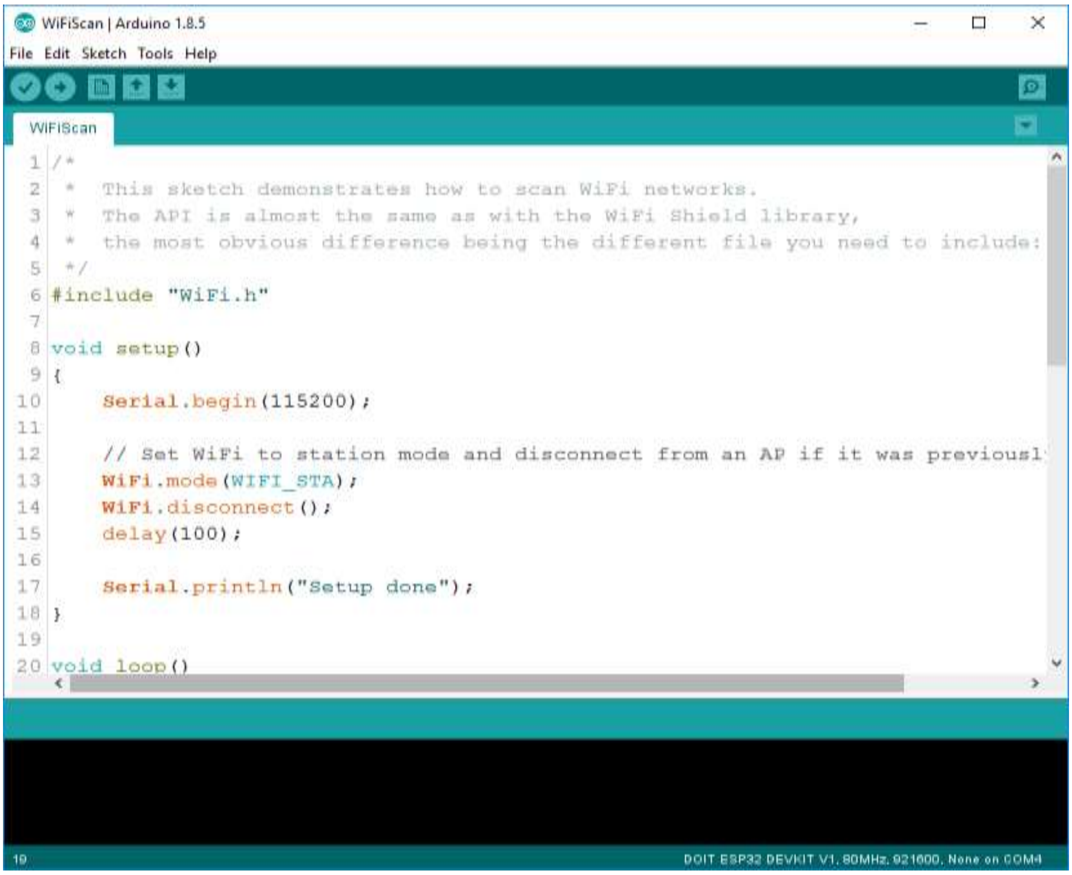


Fig 3.11 Example Sketch

5. Press the Upload button in the Arduino IDE. Wait a few seconds while the code compiles and uploads to your board.

6. If everything went as expected, you should see a "Done uploading." message.

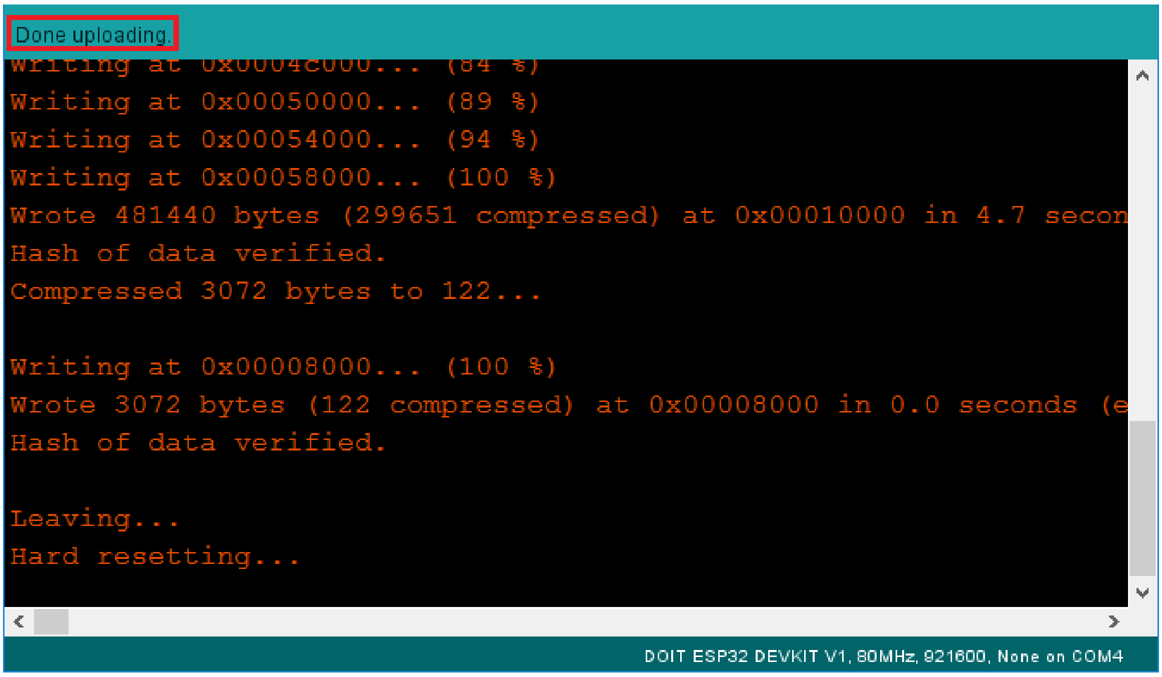
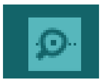


Fig 3.12 Message Box Display

7. Open the Arduino IDE Serial Monitor at a baud rate of 115200:



8. Press the ESP32 on-board Enable button and you should see the networks available near your ESP32:

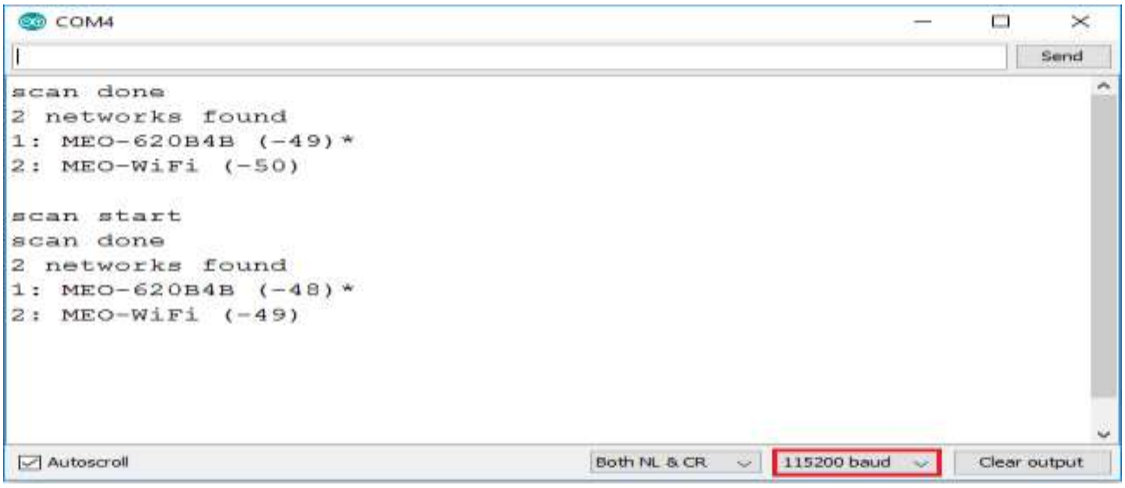


Fig 3.13 Serial Monitor Display

3.3.3 SETTING UP MAP IN BLYNK APP

1. Below fig 3.14 shows the project created. Now click on plus sign to add widget(Map).

Fig 3.14 Adding Widget

2. Now select Map

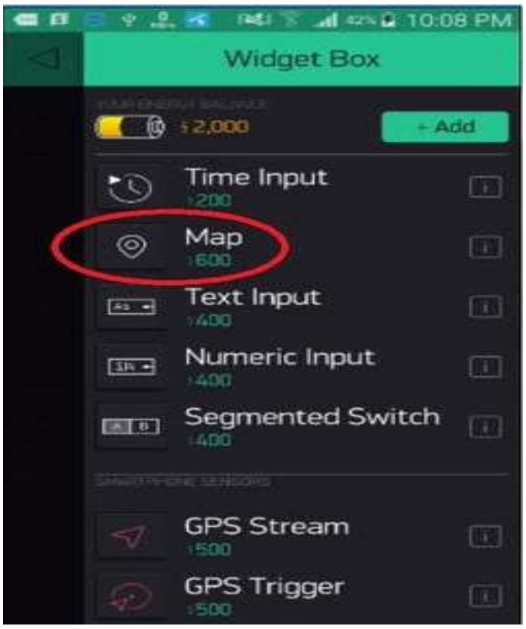


Fig 3.15 Selecting Map

3. After selecting map show like this interface

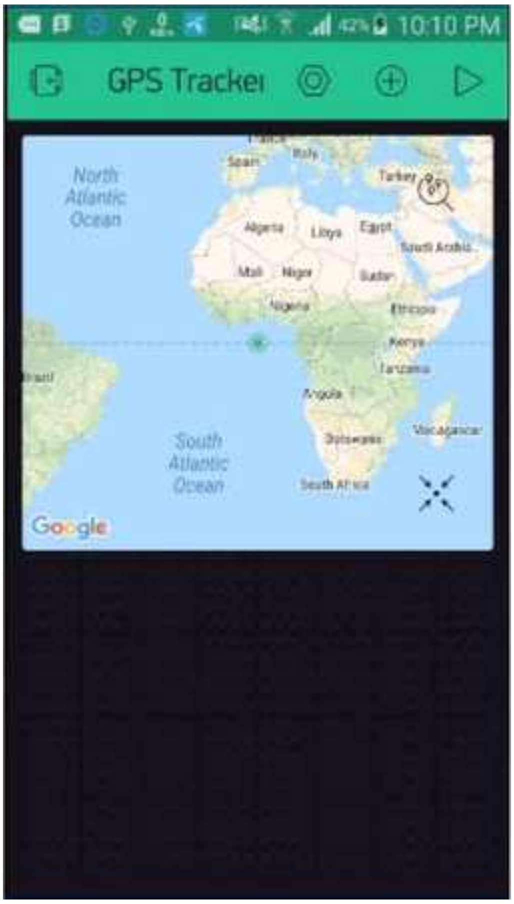


Fig 3.16 Map on Blynk Screen

4. Go to map setting select virtual pin VO

Fig 3.17 Pin Selection

5. Complete your app setting now you have to need Arduino setting. Now go to your mail copy auth and past on arduino char auth[] this position.

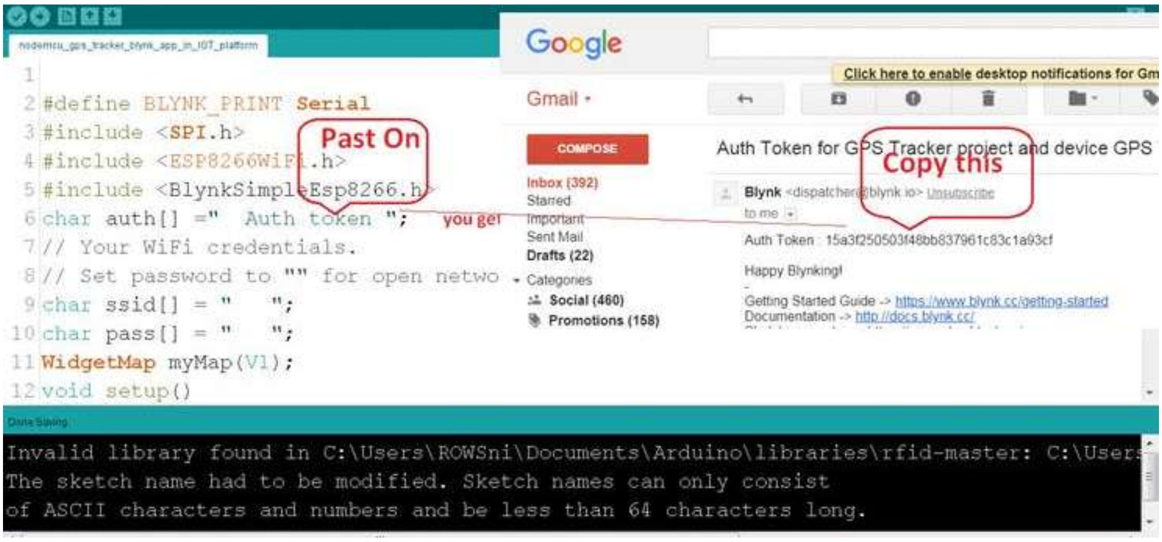


Fig 3.18 Arduino Code Settings

6. Final display of Map on Blynk app is as shown in fig 3.19

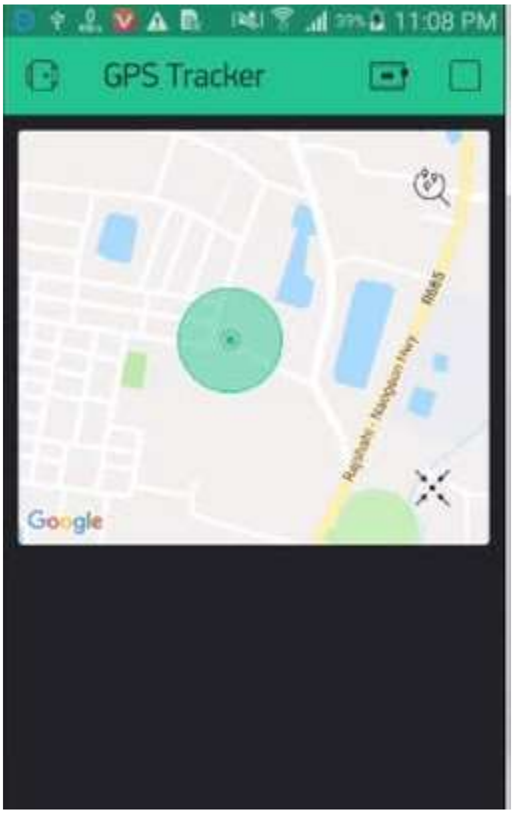


Fig 3.19 GPS Tracker final interface

3.4 WORKING PROCESS OF THE SYSTEM

The flow of the project is as shown in the fig 3.20. It starts with the power supply which we give.Which leads to the turning ON of the micro controller ESP32. This Micro controller is connected to the sensors for different operations. Firstly, MEMS(i.e., Micro Electromechanical systems) Gyroscope and Accelerometer which helps us in fall detection which is a common problem for the Alzheimer's Patient whenever he gets panic.Gyroscope used for measurement of rate of rotation or the angular velocity about the three axes. Angular velocity. which is the change in the angle of rotation per time unit. measured in degrees per second,The(ADXL335) is an accelerometer that used for measuring the acceleration force.Acceleration defined as the rate of change of velocity in the three axes with respect to the unit of time. Its measurement is according to the gravity force which also knowing as the (g force). Measured in g unit.So,we are using these two sensors continously measure the linear and rotional motion of the patient in X,Y,Z directions. Whenever it exceeds the threshold value then an alert message(notification) is send to the caregiver,doctor and family member using WiFi to the Blynk app in these ppl's mobile. The Buzzer and alert messages to Blynk app happens at the same time parallelly whenever threshold is exceeded.

Coming to GPS module, as we got to know that the person cannot remember things so we have to track him continously so that he doesn't go missing.The GPS module is used to measure the latitude and longitude values at a particular place.So, here we are using it to track him continously and the Caregiver can see that location in our Blynk app using WiFi.Lastly is our Heart beat sensor which is used to measure the heart beat of a person. Alzhemeir's Patient Usually have abnormal heart beat which is about 10% more than the normal healthy person so we have to track heart beat as well. A thresho ld is set if it exceeds that an alert message will be sent to the caregiver. Apart from this we also included LED blinking which is like first aid to the patient before anyone comes to his aid.LED blinking helps in stimulating the functioning of neurons which is weak usually for any Alzheimer's patient. After a person comes to his aid during emergencies our flow ends. Apart from this we included LED blinking treatment which we got to know from a doctor. Using which we are trying to stimulate the neuron working.This LED can be operated by the Caregiver using BLynk app in his mobile.

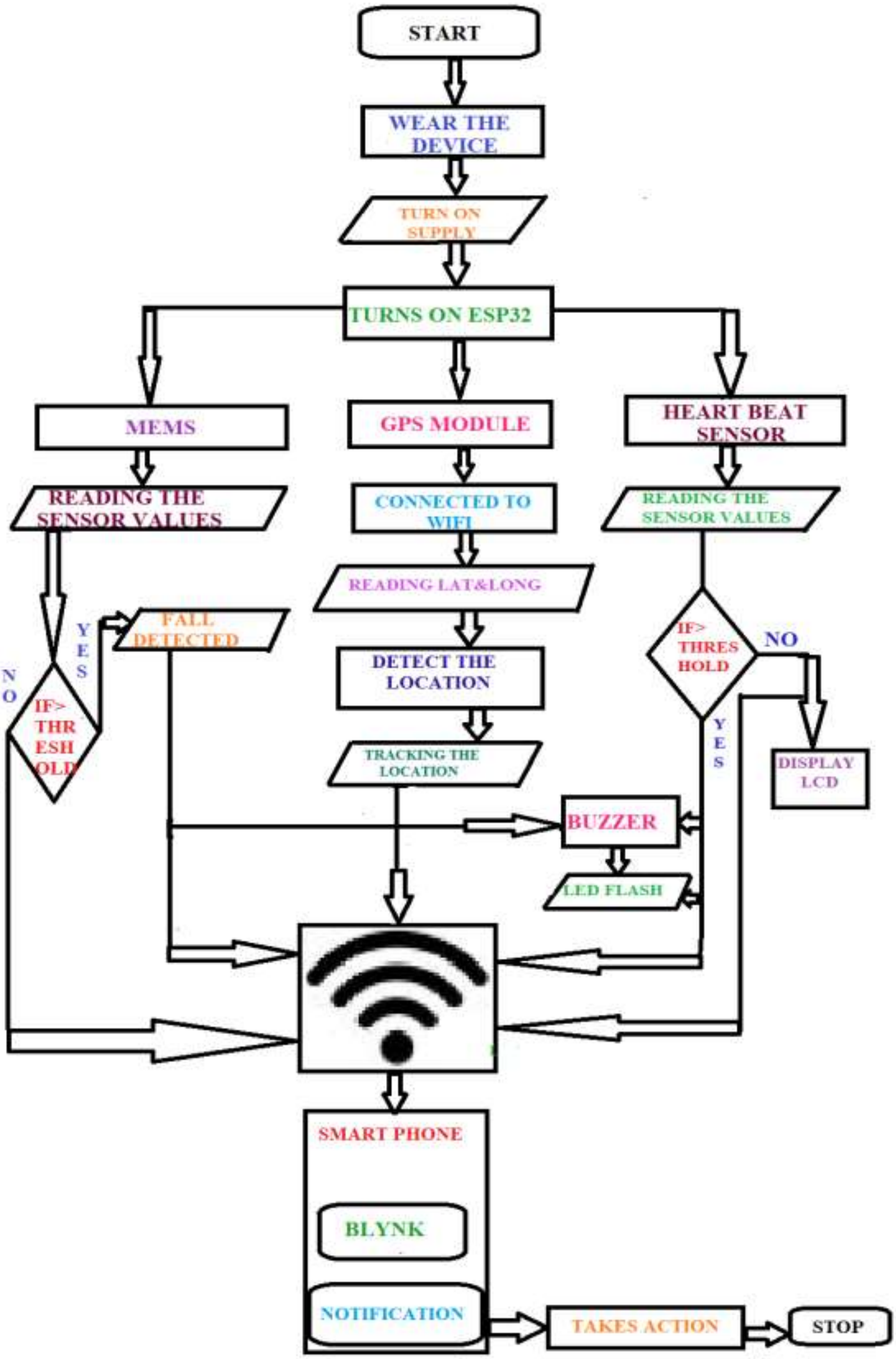


Fig 3.20 Flow Chart of ALZOT

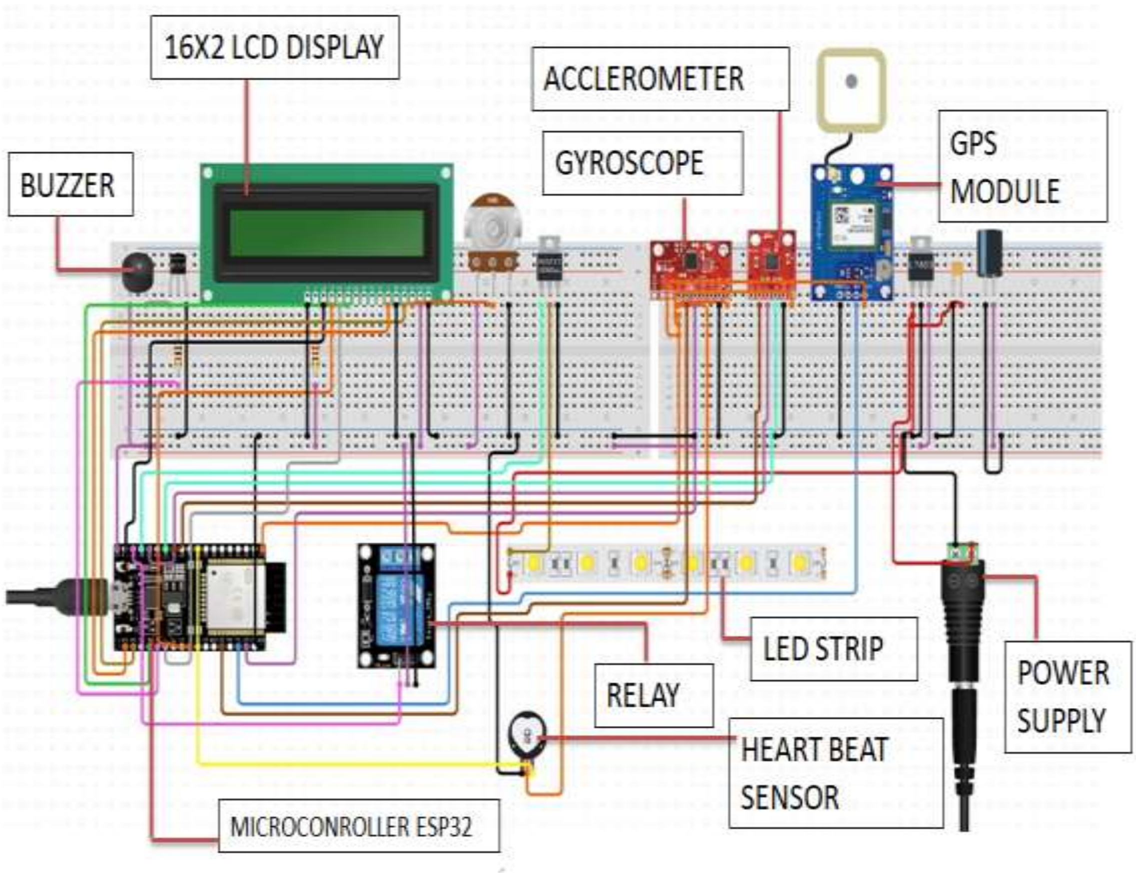


Fig 3.21 Schematic Diagram of ALZOT

This is the circuit diagram of our system , ESP32 is main component of the system it consists of dual core or single core variation with inbuilt WiFi , bluetooth modules and I2C interfacing so through I2C serial communication to reads the values from both accelerometer and gyroscope, we have included wire.h library which is used to interface with I2C devices in our code and accordingly it will ring the buzzer , similarly the analog signal from pulse sensor is read by ESP32 and when pulse rate is abnormal buzzer will Ring and LEDs will Blink according to our code , ESP32 has 3 serial UART ports through which it receives signal from GPS module and Tinygps++ is library used for this sensor, 16x2 LCD is used to display the pulse rate and status of the patient. Here we are using Regulated power supply which consists of voltage regulator , capacitor and rectifier which converts 230v AC to 5v Dc and this voltage is supplied to all the modules.

4. RESULTS AND OBSERVATIONS

In this chapter the proposed system results were analyzed and observations proved our proposed idea.

4.1 DESIGN METHODOLOGY

Our project is based on the practicability of using a smartphone as a trustful device for monitoring a patient's heart rate, body moment and location over the internet by using the android app. In order to work on the project, we carried out a literature review and made an analysis of the technology available on the android application market.

4.2 DATA COLLECTION AND OBSERVATIONS

Table 4.1 MEMS Readings

SNo.	MEMS Readings	Output
1.	Gx= -1056, Gy= -562, Gz= -157 X= 128,Y= 124, H=0	Normal
2.	Gx= 1, Gy= -1, Gz= -1 X= 110, Y= 22, H=0	Alert Message Sent
3.	Gx= -1049, Gy= -532, Gz= -143 X= 103, Y= 23, H=0	Alert Message Sent
4.	Gx= 1, Gy = -1, Gz= -1 X= 130, Y= 127, H=0	Alert Message Sent

Table 4.2 Heart Beat Readings

SNo.	Heart Beat Reading	Output
1.	64	Alert Message Sent
2.	75	Normal
3.	89	Alert Message Sent

The above table 4.1 shows the MEMS sensor readings and how it responds when the value exceeds the threshold. Similarly, table 4.2 shows the heart beat readings and its response after exceeding the threshold value. Buzzer will ring whenever MEMS sensor or heart beat sensor exceeds threshold values. Whereas, LED flickering(at 40Hz) happens whenever heart beat is abnormal and as a treatment this LED can also be controlled by caregiver using Blynk app.

4.3 EXPERIMENTAL RESULTS

After analyzing the project these are different outputs we got from all the sensors that we used in our circuit.

4.3.1 ACCELEROMETER AND GYROSCOPE SENSOR READINGS

Fig 4.1 Accelerometer Readings **Fig 4.2 Gyroscope Readings**

The above fig 4.1 and fig 4.2 shows the accelerometer and gyroscopre readings when the patient is in his steady state. These readings are recorded in Blynk app for further analysis of his treatment. The below fig 4.3 shows the alert message or notification sent to the caregiver , doctor or family member's blynk app in their respective mobile phones. This happens whenever the sensor readings i.e, accelerometer and gyroscope readings exceeds the threshold value.This helps the caregiver to come to the patient's aid during emergencies.

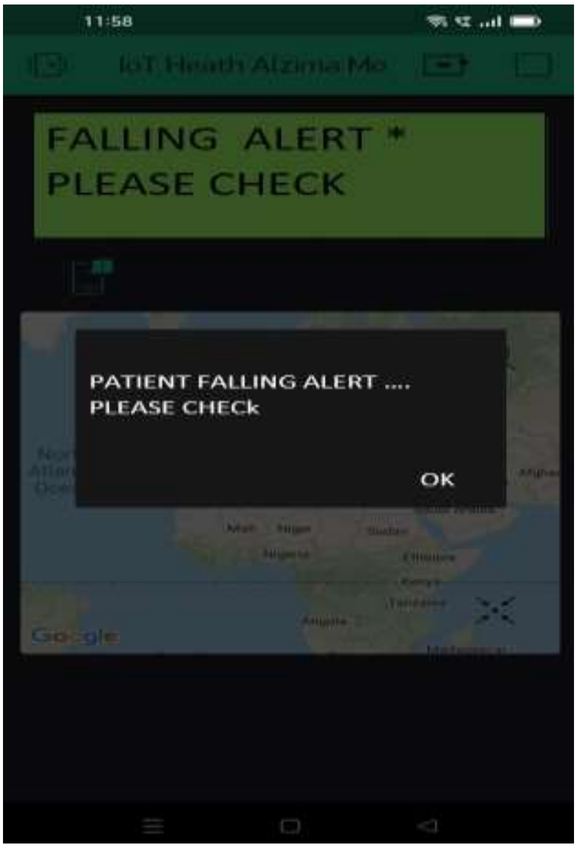


Fig 4.3 Fall Detected Alert Message

4.3.2 GPS TRACKING

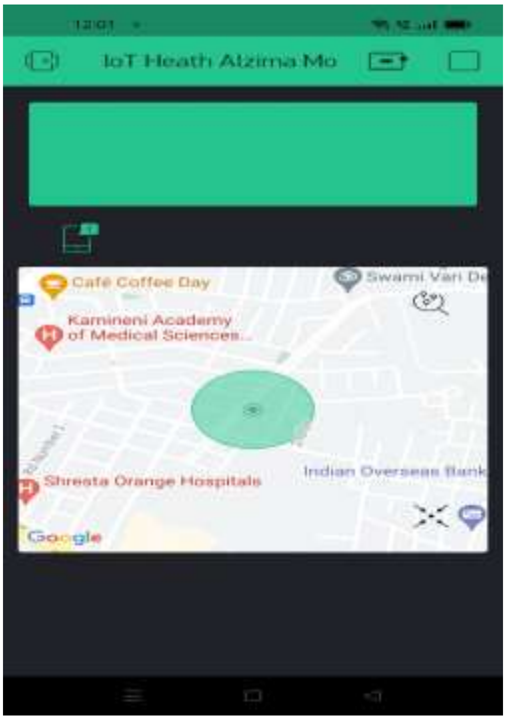


Fig 4.4 GPS Tracked Location

4.3.3 PULSE SENSOR OUTPUT

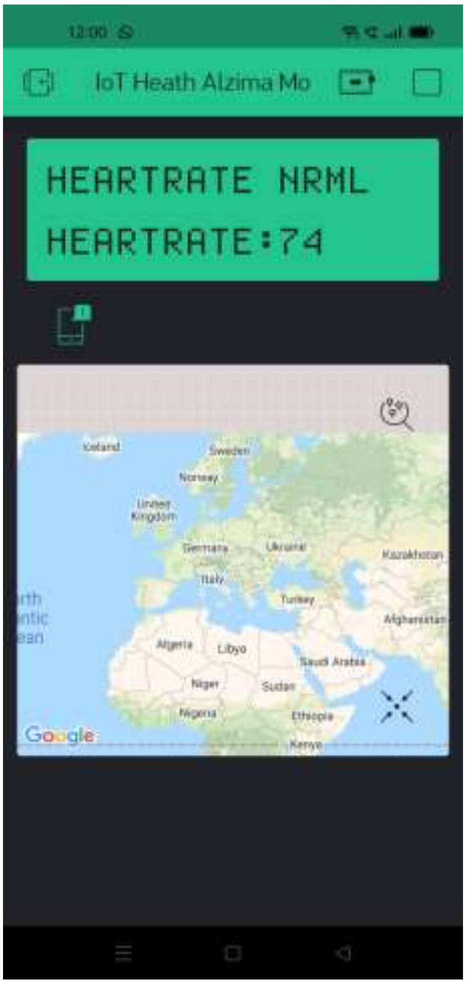


Fig 4.5 Heart Beat Normal Condition Readings

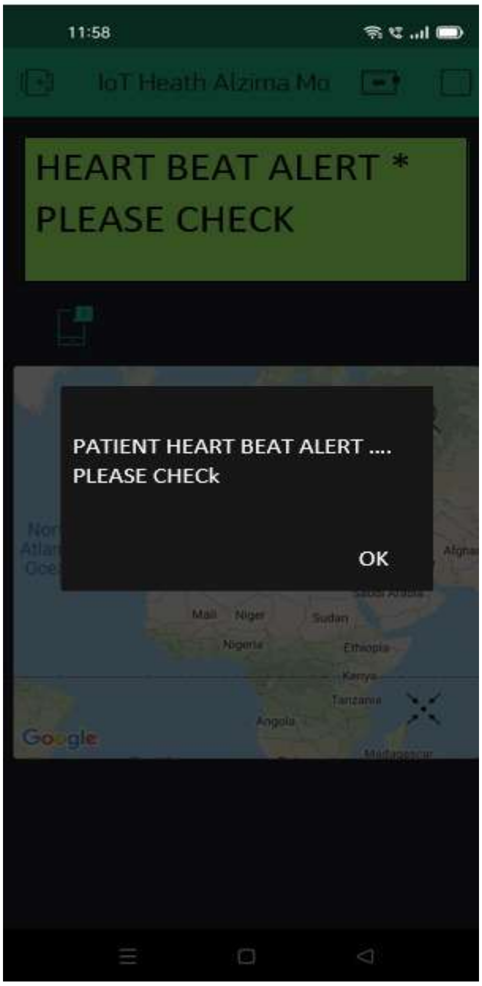
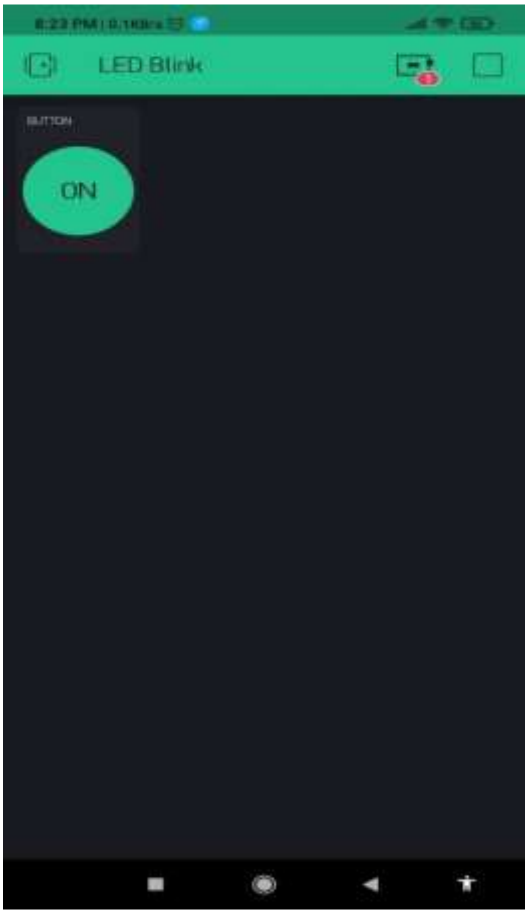


Fig 4.6 Abnormal Alert Message

In section 4.3.2, fig 4.4 shows the GPS location of patient on the Blynk app. This helps the caregiver in tracking the patient continuosly so that we can easily find him out when he goes missing. The above fig 4.5 shows the heart beat reading of the patient in normal condition. We are recording these values in the Blynk app which helps the doctor to understand the variations in patient's heart beat which is usually 10% higher in Alzheimer's patient compared to healthy person. The fig 4.6 shows the alert message or notification when the heart beat of Alzheimer's patient goes higher or lower the threshold value. Along with the alert message the buzzer will ring and also LED flickers to calm down the patient.

4.3.4 CONTROLLING LED REMOTELY



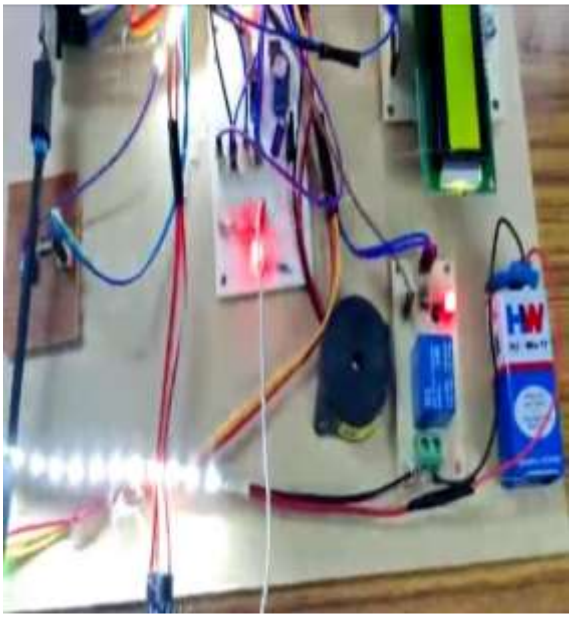


Fig 4.7 Button to ON/OFF LED in Blynk app **Fig 4.8 LED Blinking**

The neurological change associated with Alzheimer's disease is the build-up of toxic amyloid plaques that form outside cells, and mass(tangles) of proteins within the neurons themselves. Both appear to cause desruption on our neurons and their connections that allow our neurons to communicate with each other. Alzheimer's patients have particularly weak gamma waves, compared to healthy people. The light flickering on patient's retina triggers a tremendous microglia response. Microglia are the brain's immune cells that clear cell debris and toxic waste including amyloid by eating the plaques that disrupt the brain, so we are including a flickering light in this device that can be used to decrease the amyloid plaques and tau protien levels improves some behavioural changes in patient like recognize objects, remember events and navigate to places. This LED can be remotely controlled by caregiver using a button in the Blynk App. The above fig 4.7 Shows the LED ON/OFF button in the Blynk app and fig 4.8 shows the flickering of LED light.

4.4 ADVANTAGES

- Objectivity: It means that the ALZOT is not influenced by user's perspective and learning effects i.e,.it doesn't allow the user to control the functioning of device.
- Detecting patient condition in critical situation and informing the caregiver remotely.
- As we are using GPS module we can easily track the patient and find him out if he goes missing.
- Low patient burden, which can lead to higher adherence.
- Patient condition can be easily diagnosed by the doctor.
- All around technological enhancement:The Technology enhancement and sustainability can be defined as 'improving the result of higher education through the user of information and communication technologies in a sustainable way'.
- Accessibility: The quality of being able to reach, obtain and understandable by the user.
- Cost Effective: One of the greatest advantages of ALZOT is that efficient autonomous systems will cost less to manage an 'employ' in longrun.Things are even better when it comes to patient cost saving due to fewer hospital journeys as well as accelerated diagnostics and treatment.
- Portable: Able to easily carried or moved, especially because being of a lighter and smaller version than usual.
- LED flickering helps in reducing the amyloid plaques in neurons and improves some behavioural changes in patient like recognize objects, remember events and navigate to places.
- Instead of going to hospital for treatment, through this device itself the light flashing therapy can be given to the patient remotely.
- Handling the stress and emotional toll on self- caregiver can monitor the patient offline and reduces the work load to the caretaker.

4.5 DISADVANTAGES

- GPS alert message whenever patient goes missing is not included.
- Privacy and authorization issues need to be carefully implemented.

5. CONCLUSION

The current study aims to design a smart assistive device for helping Alzheimer's patients or generally elder people using inexpensive components and make it as easy use as possible. For achieving this purpose, a motion processing unit composed of gyroscope and accelerometer used and showed a really good accuracy in detecting the fall conditions. A (GPS) module prove its accuracy and dependency to provide location information. By comparing the device it's functionality to its cost we can say it fulfill the required job which is built for, by providing: the easy use, low cost, light weight and can be used by large number of people in the society.

6. FUTURE SCOPE

In future we can also include a memory device using which we can record an audio clip and music accordingly to calm down the patient during abnormal conditions. Whenever the patient is out of his confined area then we can send a voice message to control the patient not to get panic and to stay at the same place. We can also check the status of patient whether he is walking, standing , sleeping etc.

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APPENDIX

Arduino IDE Code

```
#define memsx 34    //x axis
#define memsy 35  //y axis
#define hb 32      //heart beat
#include<gps.h>
#define rel 2 //light
#define buz 4 //buzzer
#define BLYNK_PRINT Serial
#include <WiFi.h>
#include <WiFiClient.h>
#include <BlynkSimpleEsp32.h>
#include <LiquidCrystal.h>
#include <Wire.h>
#include <SoftwareSerial.h>
const int MPU_addr=0x68;  // I2C address of the MPU-6050
int16_t AcX,AcY,AcZ,Tmp,GyX,GyY,GyZ;
//LiquidCrystal lcd (34, 35, 32, 33, 25, 26);
//LiquidCrystal lcd (5, 18, 19, 21, 22, 23);
LiquidCrystal lcd (5, 18, 19, 13, 12, 14);
//int rr1=0,yy1=0,bb1=0, r11=0,r22=0,r33=0;
int x11=0,y11=0,hb11=0,h=0;
char auth[] = "Tp1kB8CErXhBR07NtfqELVH1s1KNn1Ta";
char ssid[] = "XSTW";                     // Your Wi-Fi Credentials
char pass[] = "123456";
WidgetLCD lcd1(V0);
//BLYNK_WRITE(V1)
//{
//  int   p = param.asInt(); // assigning incoming value from pin V1 to a variable
//  if(p==1)
//  {
//    digitalWrite(23,HIGH);
```

```
//    digitalWrite(22,LOW);
//    digitalWrite(21,HIGH);
//    digitalWrite(19,LOW);
//  }
//}
void beep()
{
digitalWrite(buz, HIGH);digitalWrite(rel, HIGH);delay(300);digitalWrite(buz, LOW);digitalWrite(rel, LOW);delay(300);
digitalWrite(buz, HIGH);digitalWrite(rel, HIGH);delay(300);digitalWrite(buz, LOW);digitalWrite(rel, LOW);delay(300);
digitalWrite(buz, HIGH);digitalWrite(rel, HIGH);delay(300);digitalWrite(buz, LOW);digitalWrite(rel, LOW);delay(300);
}
void check()
{
  lcd.clear ();
  lcd.setCursor (0, 0);lcd.print ("x=");lcd.setCursor (2, 0);lcd.print (x11);
  lcd.setCursor (6, 0);lcd.print ("y=");lcd.setCursor (8, 0);lcd.print (y11);
  lcd.setCursor (12, 0);lcd.print ("H=");lcd.setCursor (14, 0);lcd.print (h);
  lcd.setCursor (0, 1);lcd.print ("--------------------------");
  lcd1.clear();
  lcd1.print(0, 0, "X=");lcd1.print(2, 0, x11);
  lcd1.print(6, 0, "Y=");lcd1.print(8, 0, y11);
  lcd1.print(12, 0, "H=");lcd1.print(14, 0, h);
  lcd1.print(0, 1, "---------------------");
  delay(1000);
  lcd.clear ();
  lcd.setCursor (0, 0);lcd.print ("Gx=");lcd.setCursor (3, 0);lcd.print (GyX);
  lcd.setCursor (9, 0);lcd.print ("Gy=");lcd.setCursor (12, 0);lcd.print (GyY);
  lcd.setCursor (3, 1);lcd.print ("Gz=");lcd.setCursor (6, 1);lcd.print (GyZ);
  lcd1.clear();
  lcd1.print(0, 0, "Gx=");lcd1.print(3, 0, GyX);
  lcd1.print(9, 0, "Gy=");lcd1.print(12, 0, GyY);
```

```
  lcd1.print(3, 1, "Gz=");lcd1.print(6, 1, GyZ);
  delay(1000);
}
void setup()
{
  pinMode(rel, OUTPUT);
  pinMode(buz, OUTPUT);
  pinMode(memsx, INPUT);
  pinMode(memsy, INPUT);
  pinMode(hb, INPUT);
  digitalWrite(rel, LOW);
  digitalWrite(buz, LOW);
  lcd.begin(16, 2);
 // Serial.begin(9600);
  delay(10);
  gps.init();
  lcd.clear ();
  lcd.setCursor (0, 0);
  lcd.print ("IOT ALZ-HEALTH ");
  lcd.setCursor (0, 1);
  lcd.print ("MONITORING SYS");
  delay (1500);
  Serial.begin(115200);
 Wire.begin();
 Wire.beginTransmission(MPU_addr);
 Wire.write(0x6B);  // PWR_MGMT_1 register
 Wire.write(0);     // set to zero (wakes up the MPU-6050)
 Wire.endTransmission(true);
 Serial.println("Wrote to IMU");
 Serial.print("Connecting to ");
 Serial.println(ssid);
 WiFi.begin(ssid, pass);
 int wifi_ctr = 0;
while (WiFi.status() != WL_CONNECTED) {
```

```
    delay(500);
    Serial.print(".");
    Serial.println("WiFi connected");
      }
Blynk.begin(auth, ssid, pass);
lcd1.clear();
lcd1.print(0, 0, "IOT ALZ-HEALTH ");
lcd1.print(0, 1, "MONITORING SYS");
 delay(2000);
 Blynk.notify("WELCOME!!!IOT ALZHEIMER'S HEALTH MONITORING SYSTEM!");
}
void loop() {
Blynk.run();
x11= analogRead(memsx);
y11= analogRead(memsy);
hb11= digitalRead(hb);
x11=x11/10;
y11=y11/10;
Serial.print("x=");Serial.println(x11);
Serial.print("Y=");Serial.println(y11);
Serial.print("HB=");Serial.println(h);
//delay(700);
mpu_read();
//Serial.print("AcX :"); Serial.println(AcX);
//Serial.print("AcY :"); Serial.println(AcY);
//Serial.print("AcZ :"); Serial.println(AcZ);
Serial.print("GyX :"); Serial.println(GyX);
Serial.print("GyY :"); Serial.println(GyY);
Serial.print("GyZ :"); Serial.println(GyZ);
delay(700);
check();
Blynk.run();
//1st heart beat sensor detection alert****
```

```
if(digitalRead(hb)==0)
  {
     h=getdata();
    if((h<69)||(h>100))
  {
        lcd.clear ();
        lcd.setCursor (0, 0);
        lcd.print ("HEARTRATE ALERT");
        lcd.setCursor (0, 1);
        lcd.print("HEARTRATE:"+String(h));
        lcd1.clear();
        lcd1.print(0,0,"HEARTRATE ALERT");
        lcd1.print(0,1,"HEARTRATE:"+String(h));
        Blynk.notify("HEARTBEAT ALERT.. Please Check");
        beep();
        delay(1000);
   }
   else
   {
         lcd.clear ();
         lcd.setCursor (0, 0);
         lcd.print ("HEARTRATE NRML");
         lcd.setCursor (0, 1);
         lcd.print("HEARTRATE:"+String(h));
         lcd1.clear();
         lcd1.print(0,0,"HEARTRATE NRML");
         lcd1.print(0,1,"HEARTRATE:"+String(h));
         delay(1000);
   }
  }// HEARTRATE END------
// The serial connection to the GPS module
SoftwareSerial ss(4, 3);
void loop{
   while (ss.available() > 0)   // get the byte data from the GPS
```

```
{
    byte gpsData = ss.read();
    Serial.write(gpsData);
  }
}
//2ND MEMS SENSOR ALERT------------------
else if(((x11<100)||(x11>150))||((y11<100)||(y11>150)))
{
  lcd.clear ();
  lcd.setCursor (0, 0);
  lcd.print (" FALLING ");
  lcd.setCursor (0, 1);
  lcd.print ("ALERT*PLS CHECK");
  lcd1.clear();
  lcd1.print(0, 0, "FALLING ");
  lcd1.print(0, 1, "ALERT*PLS CHECK");
  Blynk.notify("PATIENT FALLING ALERT** PLEASE CHECK");
  beep();
  delay (1500);
}
//3RD GYRO SENSOR ALERT------------------
else if((GyX>5000)||(GyY>5000)||(GyZ>5000))
{
  lcd.clear ();
  lcd.setCursor (0, 0);
  lcd.print (" GYRO SENSOR  ");
  lcd.setCursor (0, 1);
  lcd.print ("ALERT*PLS CHECK");
  lcd1.clear();
  lcd1.print(0, 0, "FALLING");
  lcd1.print(0, 1, "ALERT*PLS CHECK");
  Blynk.notify("PATIENT FALLNG ALERT—PLEASE CHECK");
  beep();
  delay (1500);
```

```
}
 Blynk.run();
}//loop--------------
void mpu_read(){
 Wire.beginTransmission(MPU_addr);
 Wire.write(0x3B);  // starting with register 0x3B (ACCEL_XOUT_H)
 Wire.endTransmission(false);
 Wire.requestFrom(MPU_addr,14,true);  // request a total of 14 registers
 AcX=Wire.read()<<8|Wire.read();
 AcY=Wire.read()<<8|Wire.read();
 AcZ=Wire.read()<<8|Wire.read();
 Tmp=Wire.read()<<8|Wire.read();
 GyX=Wire.read()<<8|Wire.read();
 GyY=Wire.read()<<8|Wire.read();
 GyZ=Wire.read()<<8|Wire.read();
 Serial.print("Accelerometer Values: \n");
 Serial.print("AcX:   ");   Serial.print(AcX);   Serial.print("\nAcY:   ");   Serial.print(AcY);
Serial.print("\nAcZ: "); Serial.print(AcZ);
Serial.print("\nGyroscope Values: \n");
Serial.print("GyX:   ");   Serial.print(GyX);   Serial.print("\nGyY:   ");   Serial.print(GyY);
Serial.print("\nGyZ: "); Serial.print(GyZ);
Serial.print("\n");
delay(3000);
 }
```