A

MAJOR PROJECT REPORT

ON

Anti-Theft Vehicle Tracking System Using GPS

Submitted in partial fulfilment of the Requirements for the award of Degree

Of

Bachelor of Technology

In

ELECTRONICS & COMMUNICATION ENGINEERING

By

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Under the esteemed guidance

Of

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CHRISTU JYOTHI INSTITUTE OF TECHNOLOGY AND SCIENCE

(Affiliated to JNTU,Hyderabad)

Colombonagar, Yeshwanthapur, Jangaon Dist

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CHRISTU JYOTHI INSTITUTE OF TECHNOLOGY AND SCIENCE
(Affiliated to JNTU, Hyderabad)
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DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

CERTIFICATE

This is to certify that the work which is being presented in the B.Tech. Mini project entitled "**ANTI-THEFT VEHICLE TRACKNG SYSTEM USING GPS**" being submitted by **MUSKU ARCHANA (22681A0441), DEVARABOINA VARSHA (22681A0417), BOLLU RAHUL (22681A0412), RAYABARAPU PAVANKUMAR (22681A0462)** impartial fulfilment of the requirements for the award of Bachelor of Technology in **"ELECTRONICS &COMMUNICATION ENGINEERING "** and submitted to the Department of Electronics & Communication Engineering of Christu Jyothi Institute of Technology and Science, Jangaon.

This is to certify that above statement made by the candidate is correct to the best of my knowledge.

Signature of Guide	**Signature of HOD**
Mr. D. Jagan	Mr. Allanki Sanyasi Rao
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Signature of External Examiner

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DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

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- Provide highest quality learning environment to our students for their greater well-being so as to equip them with highest technical and professional ethics.
- Produce engineering graduates fully equipped to meet the ever-growing needs of industry and society

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- Organize trainings and activities towards Overall personality development in time with industrial need.
- Promote innovation towards sustainable solutions with multi discipline team work with ethics

HEAD OF DEPARTMENT

DECLARATION

We hereby declare that the project entitled**"Anti-Theft vehicle tracking system using GPS"**, which us being submitted as Major Project in Electronics and Communication Engineering to Christu Jyothi Institute of Technology & Science, is an authentic record of our genuine work done under the guidance of Mr. D. Jagan, Assistant Professor & HOD of ECE Dept.

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ABSTRACT

Anti-theft vehicle tracking system, proposed work is an attempt to design an advanced vehicle safety system that is to prevent theft and to determine the location of vehicle. Today theft is happening on the parking or in some insecure places. The safety of the vehicle is exceptionally essential. It deals with the design & development of an embedded system/IoT, which is being used to prevent /control the theft of a vehicle. The developed instrument is IoT based on GPS/GSM technology. The proposed architecture utilizes a GPS module to continuously acquire the vehicle's location coordinates (latitude and longitude). A Vibration Senso**r** is employed for instant detection of suspicious activity, such as unauthorized towing or impact. The central ESP32 unit processes data from the GPS and vibration sensor and uses its integrated Wi-Fi capability to transmit alert messages and location data to a cloud server or a dedicated mobile application.

Upon detecting a theft, the system immediately triggers a local audible alarm using a Buzzer for deterrence. Concurrently, it sends an alert to the owner. The owner can then remotely send a command back to the ESP32 to activate the anti-theft measures. These measures include:

Immobilization: Actuating a Relay to interrupt the vehicle's ignition or fuel supply, effectively stopping a DC Motor or vehicle engine.

Locking Mechanism: Engaging a Servo Motor to physically control a door, steering, or transmission lock for an added layer of security.

The instrument is installed in the engine of the vehicle. When someone tries to steal the car then microcontroller gets an interrupt and send the SMS, the owner receives a SMS that his car is being stolen then the owner sends back the SMS to 'STOP', while the vehicle will be stopped .The control instruction is given to the microcontroller through interface, the output from which activates a relay driver to trip the relay that disconnects the ignition of the automobile resulting in stopping the vehicle.

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LIST OF FIGURES

ACRONYMS

ADC	Analog to Digital Converter
ARES	Analog Reference Pin
ASCII	American Standard Code for Information Interchange
AVR	Automatic Voltage Regulator
CPU	Central Processing Unit
CRT	Cathode Ray Tube
DRAM	Dynamic Random Access Memory
GND	Ground
IDE	Integrated Development Environment
LED	Light Emitting Diode
LCD	Liquid Crystall Display
MISO	Master In Slave Out
MOSI	Master Out Slave In
PWR	Power
PWM	Power Width Modulation
PAN	Personal Area Network
RAM	Random Access Memory
ROM	Read Only Memory
RXD	Received Data
SCK	Serial Clock
SDA	Serial Dat
SPI	Serial Peripheral Interface
SPD	Sensory Processing Disorder

CHAPTER – 1

INTRODUCTION

1.1 INTRODUCTION

A vehicle tracking system collects the fleet data from the vehicle and tells about the location. Present-day vehicle tracking systems use GPS technology to trace the vehicle. The origin of the tracking system is established in the shipping industry. The corporations of the owner found the difficulty of tracking fleets when the fleet was extended over the broad area of oceans. They required a remote system to track where the vehicle is located and how long it has traveled. The need of this system is to prevent any sort of theft and also can help the police to find the stolen vehicle by using tracking reports. There are several types of vehicle tracking devices are currently available. "Passive" devices store GPS speed, location and trigger event like On/Off of the keys and Open/Close of the doors in the vehicle. Once the vehicle reaches the predetermined point, the device will be detached, and the information is downloaded to a system for evaluation. Passive systems transfer the data through the wireless download. However, the passive system does not prevent the vehicle from being stolen.

To overcome this problem, the developments of active systems has progressed. Actual time vehicle tracking system could transfer the information to the monitoring station when it is required. It transfers the real-time vehicles data to a satellite network or remote monitoring station for evaluation. Now a days automatic vehicle tracking systems are available to locate a vehicle. It is done by finding coordinates position of the vehicle and transferring the data to remotely monitored station.

1.2 PROPOSED SYSTEM

An anti -theft vehicle tracking system using GPS.This system combines the power of GPS technology to enhance the vehicle security and enable efficient tracking.

GPS, which stands for Global Positioning System, utilizes satellites to determine the precise location of a vehicle. It provides accurate and real-time positioning information, allowing owners or authorities to track the vehicle's movements. This is particularly useful in case of theft or unauthorized use.

The vehicle is equipped with GPS tracking device that constantly receives signals from GPS satellites, determining its exact coordinates. This information is then sent to the central monitoring system. The central monitoring system can be accessed by the vehicle owner or authorized personnel, providing them with real-time updates on the vehicle's location.

In the event of a theft, the owner can quickly notify the authorities and provide them with the them with the vehicle's precise GPS coordinates. This enables law enforcement agencies to track and recover the stolen vehicle more efficiently. Additionally, the system can be programmed to send alerts or notifications to the owner if the vehicle moves outside a predefined area or if any unauthorized activity is detected.

The benefits of this proposed system are numerous. It provides an added layer of security to vehicles, giving owners peace of mind. It also acts as a deterrent to potential thieves, as they know that the vehicle can be easily tracked and recovered. Moreover, the system can help insurance companies reduce premiums, as it increases the chances of recovering stolen vehicles.

It's important to note that the effectiveness of the system depends on factors such as GPS signal availability and the reliability of the tracking device. Regular maintenance and updates are crucial to ensure optimal performance.

In conclusion, the proposed system for an anti-theft vehicle tracking system using GPS and the power of GPS technology to enhance vehicle security and enable efficient tracking. It provides real-time location updates, improves the chances of recovering stolen vehicles, and offers peace of mind to vehicle owners.

1.3 METHODOLOGY

The anti-theft vehicle tracking system using GPS is a comprehensive security solution that combines the power of GPS technology with the communication time tracking and monitoring.

1. GPS Module Installation: The first step is to install a GPS module in the vehicle. This module receives signals from multiple satellites to determine the precise location
of the vehicle. It collects latitude, longitude, and altitude data, which are crucial for tracking purposes.

2. Central Monitoring System Setup: The central monitoring system is the core component of the anti-theft tracking system. It receives the GPS data from the vehicle
via Wi-Fi. The system processes this data and displays the real-time location of the vehicle on a map.

3. Theft Detection and Alerts: The system is designed to detect any unauthorized access or movement of the vehicle. If suspicious activity is detected, the system can send immediate alerts to the vehicle owner or a security service. These alerts can be in
the form of SMS messages or notifications on a mobile app.

5. Remote Control Features: Advanced tracking systems offer remote control capabilities. This includes the ability to remotely lock or unlock the vehicle, disable the engine, or activate an alarm system. These features provide an additional layer of security and control.

6. Recovery Assistance: In the unfortunate event of a vehicle theft, the anti-theft tracking system can aid in recovery. The real-time tracking data collected by the GPS module helps law enforcement agencies locate and retrieve the stolen vehicle quickly. The system can also provide valuable information such as the vehicle's last known location and route taken.

7. Data Storage and Analysis: The central monitoring system stores all the tracking data, including historical records of the vehicle's movements. This data can be analysed to identify patterns, optimize routes, and improve overall vehicle security.

CHAPTER - 2

LITERATURE SURVEY

According to research by Smith et al. (2018), GPS-based tracking systems provide accurate real-time location information, while GSM technology enables communication between the tracking device and the user. This combination allows vehicle owners to monitor their vehicles remotely and receive instant alerts in case of unauthorized access or theft.

In a study by Johnson and Brown (2019), it was found that GPS and GSM-based tracking systems have significantly reduced vehicle theft rates. The ability to track stolen vehicles in real-time and share location information with law enforcement agencies has proven instrumental in recovering stolen vehicles and apprehending criminals.

Furthermore, research conducted by Patel et al. (2020) emphasized the importance of software installation and the integration of LCD components in anti-theft vehicle tracking systems. These components enable users to access the tracking system's features, such as location tracking, vehicle immobilization, and emergency notifications, through a user.

Overall, the literature suggests that anti-theft vehicle tracking systems using GPS and GSM technologies have a promising future in deterring vehicle theft and enhancing vehicle security. These systems offer real-time tracking, remote monitoring, and effective recovery options, making them a valuable asset for vehicle owners.

CHAPTER – 3
INTERNET OF THINGS

3.1 INTRODUCTION

Internet of Things (IoT) is an ideal buzzing technology to influence the Internet and communication technologies. IoT allows people and things to be connected anytime, anyplace, with anything and anyone, by using ideally in any path/network and any service. This project introduces a thought or an idea for home computerization utilizing voice acknowledgment, also the development of a prototype for controlling smart homes devices through IoT and controlling of dumb devices through IoT by the means of Wi- Fi driven chipset solution – ESP8266. This is also acknowledged by the need to give frameworks which offers help to matured and physically impaired individuals, particularly individuals who lives alone. Smart home or home automation can be said as the residential extension of building automation, it also involves the automation and controlling of lightings, ACs, ventilation and security which also includes home appliances such as dryers/washers, ovens or refrigerators/freezers which uses Wi-Fi for monitoring via remote for ease of use. Now a day's speed of the processing and communication through smart mobile devices at very affordable costs, to improve the lifestyle concept relevant to smart life, like smart T.V, Smart cities, smart phones, smart life, smart school and Internet of Things.

3.2 INTRODUCTION OF IoT TECHNOLOGY

- The Internet of Things (IoT) refers to the network of interconnected devices that communicate and share data with each other over the internet. These devices can range from everyday household items to industrial machinery.
- The term "Internet of Things" has come to describe a number of technologies and research disciplines that enable the Internet to reach out into the real world of physical objects. The Internet of Things, also called The Internet of Objects, refers to a wireless network between objects. From any time, any place connectivity for anyone, we will now have connectivity for anything.

- IoT involves embedding sensors, software, and other technologies into physical objects, allowing them to collect and exchange data. This connectivity enables devices to be monitored and controlled remotely, creating a smarter and more automated world.

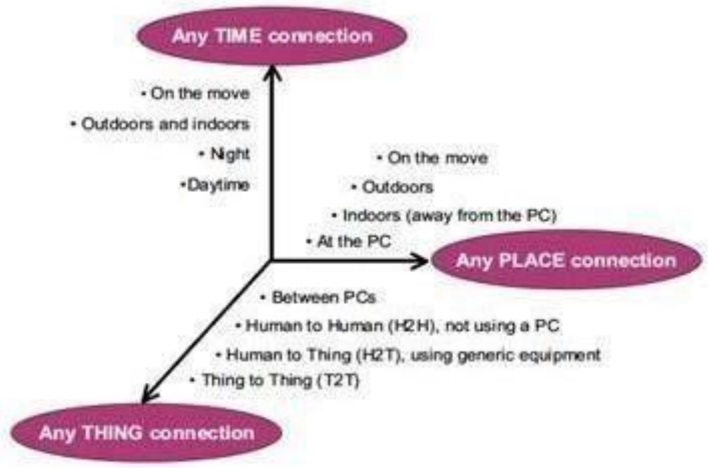


Fig 3.1 IoT Technology

3.3 The Vision

To improve human health and well-being is the ultimate goal of any economic, technological and social development. The rapid rising and aging of population is one of the macro powers that will transform the world dramatically, it has caused great pressure to food supply and healthcare systems all over the world, and the emerging technology breakthrough of the Internet-of-Things (IoT) is expected to offer promising solutions. Therefore, the application of IoT technologies for the food supply chain (FSC) (so-called Food-IoT) and in-home healthcare (IHH) (so called Health-IoT1) have been naturally highlighted in the strategic research roadmaps.

To develop practically usable technologies and architectures of IoT for these two applications is the final target of this work. The phrase "Internet of Things" (IoT) was coined at the beginning of the 21st century by the MIT Auto-ID Centre with special mention to Kevin Ashton and David L. Brock.

As a complex cyber-physical system, the IoT Integrates all kinds of sensing, identification, communication, networking, and informatics devices and systems, and seamlessly connects all the people and things upon interests, so that anybody, at any time and any place, through any device and media, can more efficiently access the information Micro Electro Mechanical Systems (MEMS), mobile internet access, cloud computing, Radio Frequency Identification (RFID), Machine-to-Machine (M2M) communication, human machine interaction (HMI), middleware, Service Oriented Architecture (SOA), Enterprise Information System (EIS), data mining, etc. With various descriptions from various viewpoints, the IoT has become the new paradigm of the evolution of information and communication technology (ICT).

3. 4 Definition of Internet of things (IoT)

"Today computers and, therefore, the Internet are almost wholly dependent on human beings for information. Nearly all of the roughly 50 petabytes (a petabyte is 1,024 terabytes) of data available on the Internet were first captured and created by human being by typing, pressing a record button, taking a digital picture, or scanning a bar code.

Conventional diagrams of the Internet … leave out the most numerous and important routers of all - people. The problem is, people have limited time, attention and accuracy all of which means they are not very good at capturing data about things in the real world. And that's a big deal. We're physical, and so is our environment … You can't eat bits, burn them to stay warm or put them in your gas tank. Ideas and information are important, but things matter much more. Yet today's information technology is so dependent on data originated by people that our computers know more about ideas than things. If we had computers that knew everything there was to know about things using data, they gathered without any help from us we would be able to track and count everything, and greatly reduce waste, loss and cost. We would know when things needed replacing, repairing or recalling, and whether they were fresh or past their best. The Internet of Things has the potential to change the world, just as the Internet did. Maybe even more so".

3.5 Key Components of IoT

Devices/Sensors: These are physical objects embedded with sensors and actuators that collect and transmit data. Examples include smart thermostats, wearable fitness trackers, and industrial sensors.

Connectivity: Devices connect to the internet or other networks using various technologies such as Wi-Fi, Bluetooth, Zigbee, or cellular networks.

Data Processing: The data collected by IoT devices is often processed either on the device itself or sent to a cloud-based server. This data can be analysed to gain insights, make decisions, or trigger actions.

User Interface: Users interact with IoT systems through applications or dashboards, allowing them to monitor and control devices.

3.6 Applications of IoT

Smart Homes: Automate and control home systems like lighting, heating, and security remotely.

Healthcare: Monitor health metrics and track medication adherence with connected devices.

Industrial IoT: Predict equipment failures, optimize manufacturing, and manage supply chains.

Agriculture: Enhance farming with precision tools, automated irrigation, and livestock monitoring.

Transportation: Track and manage vehicles, optimize routes, and support autonomous driving.

Smart Cities: Improve public safety, waste management, and traffic flow with connected infrastructure.

Retail: Manage inventory, personalize customer experiences, and monitor supply chains.

Energy Management: Optimize energy use with smart grids and renewable energy integration.

Environmental Monitoring: Track climate, pollution, and wildlife to better respond to natural events.

3.7 Benefits of IoT

- Improved citizen's quality of life Healthcare from anywhere
- Better safety, security and productivity
- IoT can be used in every vertical for improving the efficiency
- Creates new businesses, and new and better jobs
- Economic growth
- Billions of dollars in savings and new services
- Better environment
- Saves natural resources and trees
- Helps in creating a smart, greener and sustainable planet

3.8 Characteristics for Internet of Things:

- Event driven
- Ambient intelligence
- Flexible structure
- Semantic sharing
- Complex access technology

Anyone who says that the Internet has fundamentally changed society may be right, but at the same time, the greatest transformation actually still lies ahead of us. Several new technologies are now converging in a way that means the Internet is on the brink of a substantial expansion as objects large and small get connected and assume their own web identity.

Following on from the Internet of computers, when our servers and personal computers were connected to a global network, and the Internet of mobile telephones, when it was the turn of telephones and other mobile units, the next phase of development is the Internet of things, when more or less anything will be connected and managed in the virtual world.

Smart connectivity with existing networks and context-aware computation using network resources is an indispensable part of IoT. With the growing presence of Wi-Fi and 4G-LTE wireless Internet access, the evolution towards ubiquitous information and communication networks is already evident. However, for the Internet of Things vision to successfully emerge, the computing paradigm will need to go beyond traditional mobile computing scenarios that use smart phones and portables, and evolve into connecting everyday existing objects and embedding intelligence into our environment. For technology to disappear from the consciousness of the user, the Internet of Things demands: a shared understanding of the situation of its users and their appliances, software architectures and pervasive communication networks to process and convey the contextual information to where it is relevant, and the analytics tools in the Internet of Things that aim for autonomous and smart behaviour. With these three fundamental grounds in place, smart connectivity and context-aware computation can be accomplished.

CHAPTER – 4

CONSTRUCTION

4.1 BLOCK DIAGRAM

The main components that the proposed system consists of are GPS, Vibration Sensor, Servo Lock, DC Motor, Relay, Buzzer, Power Supply

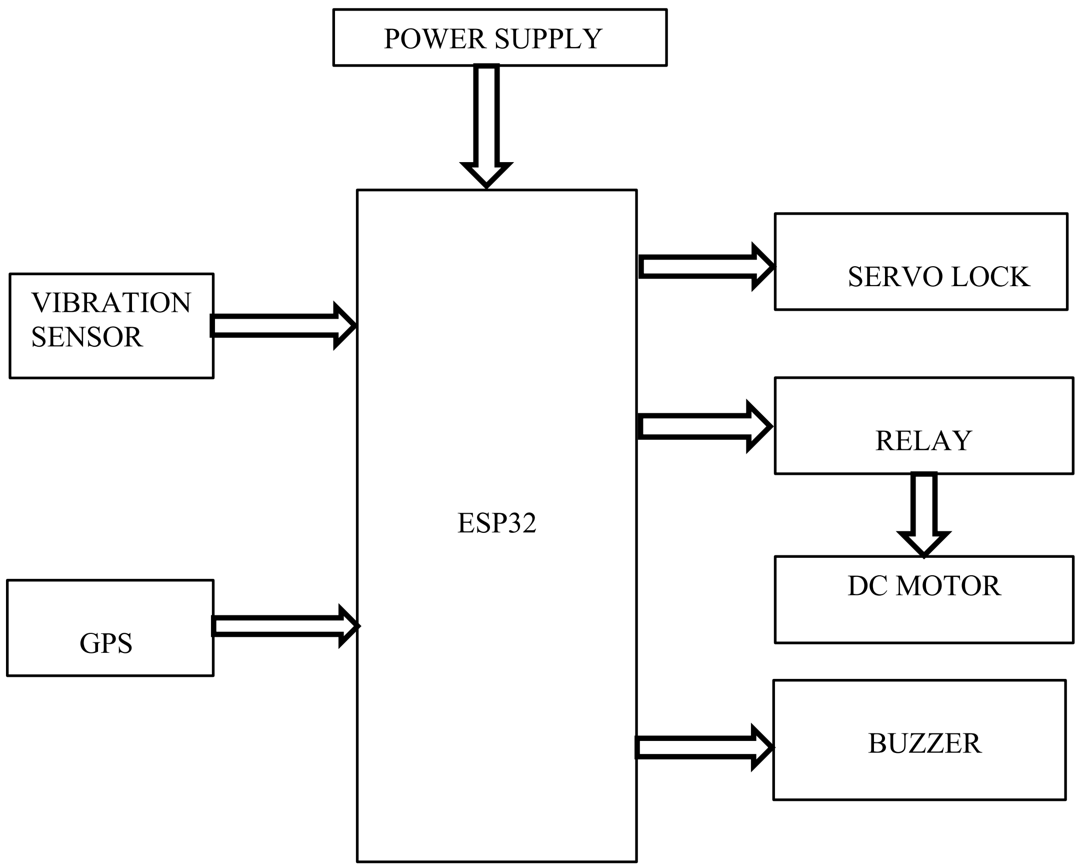


Figure 4.1 Block Diagram of Vehicle Tracking System Using GPS

CHAPTER – 5

HARDWARE IMPLEMENTATION

5.1 ESP32 MICROCONTROLLER

The ESP32 is a collection of affordable, low power SOC microcontrollers with Wi-Fi and Bluetooth. The ESP32 system employs a Ten silica Xtensa LX6 chip in both dual-core and single-core configurations, an Xtensa LX7 dual-core chip, or a single-core RISC-V chip. It also integrates built-in antenna switches, RF balun, power amplifiers, low-noise amplifiers, filters, and power management modules. The ESP32 is manufactured by Expressive Frameworks, a Chinese firm headquartered in Shanghai, using TSMC's 40 nm manufacturing process. The user's text is enclosed in tags. This new device has replaced the ESP8266 microcontroller. ESP32provides Wi-Fi and Bluetooth networks for implanted gadgets. Whereas ESP32 is fair to the chip, the modules and improvement sheets containing this chip are regularly alluded to as "ESP32" by the producer.

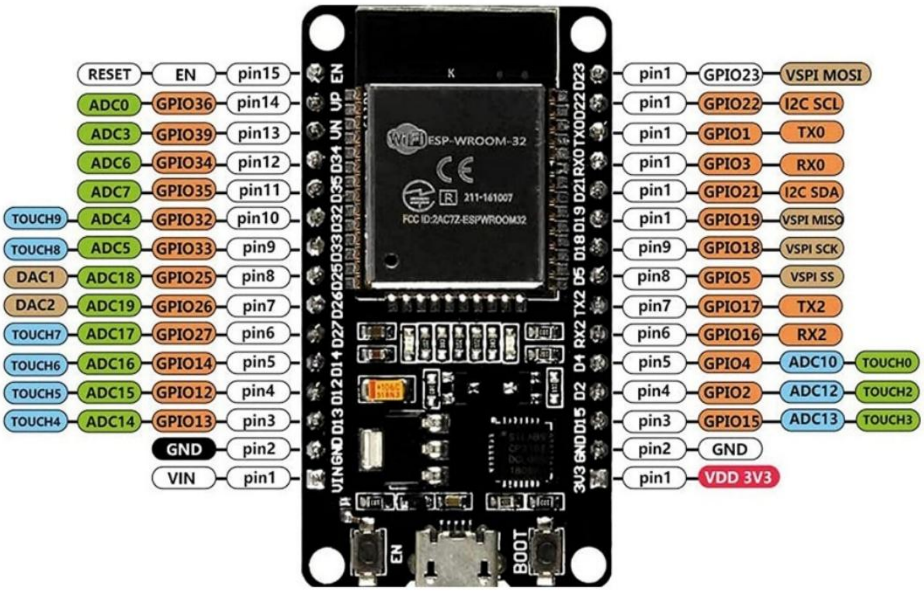


Fig 5.1: ESP32 Microcontroller

The unique ESP32 chip had a single center Ten silica Xtensa LX6 chip. The processor had a clock rate of over 240 MHz, which made for a moderately tall information preparation speed. More recently, modern models have been included, counting the ESP32-C and -S arrangement, which incorporate single and double-center varieties. These two arrangements, moreover, depend on a Risc-V CPU show instead of Xtensa. Risc-V is comparable to the ARM design, which is well-supported and well-known, but Risc-V is open-source and simple to utilize. Risc-V and ARM have great support from GNU compilers, whereas Xtensa requires additional support and improvement to work with the compilers.

The ESP32 is a powerful and versatile microcontroller developed by Espressif Systems, known for its built-in Wi-Fi and Bluetooth capabilities. It is widely used in Internet of Things (IoT) projects and embedded systems because it combines high performance, low power consumption, and rich features in a compact form. The ESP32 is based on a dual-core or single-core Tensilica Xtensa LX6 processor, capable of running at up to 240 MHz, which makes it suitable for multitasking and real-time applications.

The ESP32 includes a wide range of peripherals such as General-Purpose Input/Output (GPIO) pins, Analog-to-Digital Converters (ADC), Digital-to-Analog Converters (DAC), Pulse Width Modulation (PWM) outputs, UART, SPI, I2C, and CAN interfaces. These features allow it to easily interface with sensors, actuators, displays, and other modules. It also supports capacitive touch sensing, temperature sensing, and hardware encryption, making it suitable for secure and advanced electronic designs.

One of the major advantages of the ESP32 is its wireless connectivity, which enables devices to connect to Wi-Fi networks or communicate via Bluetooth Classic and Bluetooth Low Energy (BLE). This makes it ideal for smart home automation, remote monitoring, wearable devices, and industrial control systems. The ESP32 can be programmed using various environments such as the Arduino IDE, Espressif's ESP-IDF, or Micro Python, offering flexibility for both beginners and professionals.

Overall, the ESP32 stands out as a cost-effective and efficient microcontroller for modern IoT and embedded applications due to its powerful processing, connectivity features, and energy efficiency.

5.1.2 USES

The ESP32 microcontroller is widely used in many electronic and IoT (Internet of Things) applications because of its powerful processing capabilities, built-in Wi-Fi, Bluetooth connectivity, and multiple input/output features. It is commonly used for smart home automation systems, such as controlling lights, fans, and appliances through mobile apps or voice assistants. In IoT projects, the ESP32 is used to collect sensor data like temperature, humidity, or vibration and send it to cloud platforms for monitoring and analysis. It is also used in wireless sensor networks, remote data logging, and real-time monitoring systems. In robotics, it can control motors, servos, and sensors to perform automation tasks. The ESP32 is popular in wearable devices, environmental monitoring, and industrial automation due to its low power consumption and reliable wireless communication. Additionally, it is used in GPS tracking systems, security systems, smart irrigation, and health monitoring devices. Because it supports multiple programming environments like Arduino IDE, Micro Python, and ESP-IDF, the ESP32 is an excellent choice for both beginners and advanced developers working on innovative embedded and wireless communication projects.

5.1.3 PIN DESCRIPTION

Power pins: There are four power pins viz. one VIN pin & three 3.3V pins. The VIN pin can be used to directly supply the ESP8266 and its peripherals, if you have a regulated 5V voltage source. The 3.3V pins are the output of an on- board voltage regulator. These pins can be used to supply power to external components.

Gnd: It is a ground pin of ESP8266 Node MCU development board.

I2c: These are used to hook up all sorts of I2C sensors and peripherals in your project. Both I2C Master and I2C Slave are supported. I2C interface functionality can be realized programmatically, and the clock frequency is 100 kHz at a maximum. It should be noted that I2C clock frequency should be higher than the slowest clock frequency of the slave device.

GPIO Pins: ESP8266 Node MCU has 17 GPIO pins which can be assigned to various functions such as I2C, I2S, UART, PWM, IR Remote Control, LED Light and Button programmatically. Each digital enabled GPIO can be configured to internal pull-up or pull-down, or set to high impedance.

ADC Pins: The Node MCU is embedded with a 10-bit precision SAR ADC. The functions can be implemented using ADC viz. Testing power supply voltage of VDD3P3 pin and testing input voltage of TOUT pin. However, they cannot be implemented.

UART PINS: ESP8266 Node MCU has 2 UART interfaces, i.e. UART0 and UART1, which provide asynchronous communication (RS232 and RS485), and can communicate at up to 4.5 Mbps. UART0 (TXD0, RXD0, RST0 & CTS0 pins) can be used for communication. It supports fluid control. However, UART1 (TXD1 pin) features only data transmit signal so, it is usually used for printing log.

SPI Pins: ESP8266 features two SPIs (SPI and HSPI) in slave and master modes. These SPIs also support the following general-purpose SPI features:

- Timing modes of the SPI format transfer
- Up to 80 MHz and the divided clocks of 80 MHz
- Up to 64-Byte FIFO

5.2 GPS (GLOBAL POSITIONING SYSTEM)

GPS, or Global Positioning System, is a satellite-based navigation system that consists of a network of satellites orbiting the Earth. These satellites continuously transmit signals that can be received by GPS receivers, such as the one installed in an anti-theft tracking device.

When the tracking device receives signals from multiple GPS satellites, it uses the information contained in those signals to calculate its position on Earth. This calculation is based on the time it takes for the signals to travel from the satellites to the tracking device.

By comparing the time, it takes for the signals to reach the tracking device from different satellites, the device can determine its distance from each satellite. With this information, the device can triangulate its position and accurately determine its latitude and longitude coordinates [2].

A Global Positioning System (GPS) is a satellite-based navigation system that provides accurate information about location, speed, and time anywhere on Earth. It works by receiving signals from multiple satellites orbiting the Earth and calculating the exact position of the receiver through a process called triangulation. A GPS module typically includes an antenna to capture satellite signals and a processor to decode them and determine the coordinates — usually given as latitude and longitude.

GPS technology is widely used in various applications such as vehicle tracking, navigation systems, surveying, mapping, military operations, and personal location services. In modern embedded systems, GPS modules are often integrated with microcontrollers or smartphones to enable real-time tracking and monitoring. It can also be used with GSM or IoT systems for data transmission to remote servers. The main advantages of GPS are its global coverage, high accuracy, and ability to operate in all weather conditions. With advancements in technology, GPS has become essential in transportation, disaster management, agriculture, and communication systems, making it one of the most important innovations in modern electronics and navigation.

5.2.1 Features of a GPS Module:

1. Location tracking: Provides accurate location information, including latitude, longitude, altitude, and speed.
2. Satellite signal reception: Receives signals from GPS satellites and uses them to calculate its location.

3. Data output: Typically provides data output in formats such as NMEA, UART, or I2C.

4. Power consumption: Usually low power consumption, making it suitable for battery- powered devices.

5. Compact size: Often small in size, making it easy to integrate into various devices.

5.2.2 Applications of GPS Modules:

1. Navigation systems: Used in vehicles, aircraft, and marine vessels for navigation.

2. Tracking devices: Used for tracking people, animals, or objects.

3. Wearable devices: Used in smartwatches, fitness trackers, and other wearable devices.

4. Drones: Used for navigation and control of drones.

5. IOT devices: Used in various IoT devices, such as asset trackers and environmental monitors.

Fig 5.2: GPS

5.3 VIBRATION SENSOR

A vibration sensor is an electronic device used to detect, measure, and monitor vibrations or oscillations from mechanical objects or systems. It plays an essential role in various applications such as industrial machinery monitoring, automotive systems, building safety, and consumer electronics. The main function of a vibration sensor is to convert the mechanical motion or vibration of an object into an electrical signal that can be analyzed or processed by a microcontroller or monitoring system. These sensors are particularly useful for identifying imbalance, misalignment, loosened components, or wear and tear in machines, allowing for preventive maintenance and early fault detection.

Vibration sensors come in different types, including piezoelectric sensors, accelerometers, MEMS sensors, and strain gauge sensors, each operating on different physical principles. Piezoelectric sensors generate voltage when subjected to mechanical stress, making them highly sensitive and suitable for industrial machines and engines. Accelerometers measure changes in acceleration and are widely used in mobile phones, drones, and automotive systems. MEMS (Micro-Electro-Mechanical Systems) vibration sensors are miniature versions built using semiconductor technology and are ideal for portable and consumer electronics. Strain gauge and capacitive sensors, on the other hand, are used in precision measurement and robotics where high accuracy is required.

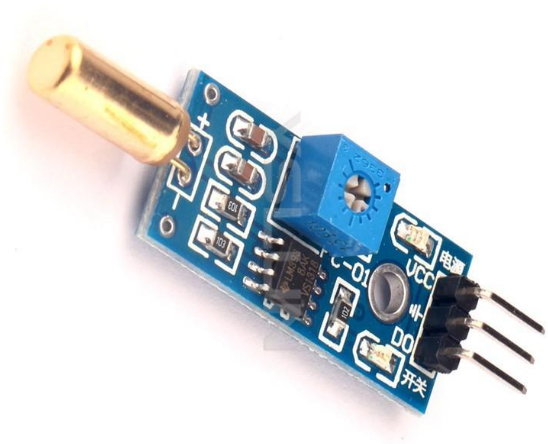


Fig 5.3: Vibration Sensor

Important characteristics of vibration sensors include sensitivity, frequency range, measurement range, and resonant frequency, which determine how effectively the sensor can detect and interpret vibration signals. In industrial environments, vibration sensors are used to monitor motors, pumps, compressors, and turbines to prevent costly breakdowns by providing real-time condition monitoring. In structural engineering, they help detect vibrations caused by earthquakes, wind, or heavy loads in bridges and buildings. In consumer electronics, they are used for motion sensing, gaming controls, and screen orientation detection.

Overall, vibration sensors are a key component in predictive maintenance systems, safety monitoring, and automation technologies, helping industries and devices operate more efficiently, safely, and reliably by continuously tracking and analysing mechanical movements.

A vibration sensor detects and converts mechanical vibrations into an electrical signal. It’s widely used in industrial, automotive, consumer electronics, and structural monitoring applications to detect misalignment, or mechanical faults.

5.3.1 Features:

1.High Sensitivity:
It can accurately detect even small vibrations or the motion changes in machinery or structures.

2.Wide Frequency Range:
Capable of sensing vibrations over broad range of frequencies, suitable for different applications from low-speed machines to high-speed engines.

3.Fast Response Time:
Provides quick detection and output of vibration signals, allowing for real-time monitoring and control.

4.Compact Size:
Many vibration sensors, especially MEMS types, are small and lightweight, making them easy to integrate into portable or embedded systems.

5. Durability and Reliability:
Designed to withstand harsh environmental conditions such as high temperature, dust, and mechanical shock, ensuring long operational life.

6.Low Power Consumption:
Especially in modern MEMS-based sensors, power usage is minimal, which makes them ideal for battery-operated devices.

7. Analog and Digital Output Options:

Some sensors provide an analog voltage output proportional to vibration level, while others offer digital output for direct interfacing with microcontrollers.

8.Easy Integration:

Compatible with popular development boards like Arduino, ESP32, and Raspberry Pi for quick prototyping and project implementation.

9.Self-Diagnostic Capability (in advanced models):

Some industrial-grade sensors include built-in self-test features to ensure reliable operation and easy maintenance.

10.Versatile Applications:

Used in machinery monitoring, vehicle systems, building safety, security alarms, and electronic gadgets to detect motion or shocks.

5.4 DC MOTOR

A DC motor (Direct Current motor) is an electrical machine that converts direct electrical energy into mechanical energy. It works on the principle that when a current-carrying conductor is placed in a magnetic field, it experiences a mechanical force. The direction of this force is given by Fleming's left-hand rule. A DC motor mainly consists of two parts: the stator (which provides the magnetic field) and the rotor or armature (which rotates when current flows through it). The commutator and brushes are used to ensure that the current direction in the armature windings changes at the right time to maintain continuous rotation. DC motors are widely used in applications requiring variable speed and torque control, such as in electric vehicles, robotics, and industrial machines. Their ability to provide smooth and precise motion makes them essential components in many modern electrical and mechanical systems.

Fig 5.4: DC Motor

5.4.1 Specifications:

1. **Operating Voltage:** 3V to 12V DC (commonly 6V or 12V)
2. **Rated Speed:** 1000 to 6000 RPM (depends on motor type)
3. **Rated Current:** 100 mA to 500 mA (no load), higher under load
4. **Torque**: 0.1 to 1.5 kg·cm (varies with size and design)
5. **Power Output:** Typically ranges from 0.5W to 25W
6. **Direction of Rotation:** Reversible (by changing polarity)
7. **Type:** Brushed DC motor (common) or Brushless DC motor (BLDC)
8. **Shaft Diameter:** Usually, 3mm to 6mm
9. **Body Material:** Metal or plastic casing
10. **Mounting Type:** Screw holes or brackets for easy installation

5.5 RELAY

A transfer module is a circuit board that houses one or more transfers. These modules come in differing shapes and sizes, with the most common setups being rectangular sheets containing 2, 4, or 8 transfers. Each transfer module has different components, such as pointer LEDs, assurance diodes, transistors, and resistors. The essential data around a transfer module, counting its input voltage rating, switch voltage, and current restrain, is ordinarily printed on its surface for simple reference. At its center, a transfer is an electrical switch that works beneath the control of an electromagnet. When this electromagnet is enacted, it can open or near the switch, permitting or avoiding the current stream through the circuit. The convenience of transfer modules expands distant past the effortlessness of their work. From the consolation of domestic robotization frameworks that brighten rooms at a clap to the immovable exactness of mechanical apparatus that carves out showstoppers, hand-off modules demonstrate significance. They are essential in guaranteeing that the different components inside a framework can consistently and securely communicate, handle loads, and perform assignments with synchronized nimbleness. The essential work of a transfer module is to switch electrical gadgets or frameworks on and off. It, too, serves to separate control circuits, guaranteeing that low-power gadgets, such as microcontrollers, can securely control higher voltages and streams. This capability is especially advantageous in scenarios where a little control flag from a microcontroller needs to switch to higher streams. A hand off module opens up this control flag in quintessence, empowering it to oversee more considerable electrical loads. It is fundamental to separate between a transfer and a transfer module. Whereas a transfer is a single gadget comprising an electromagnet and a switch, a hand-off module includes numerous transfers and extra components. These additional components included layers of segregation and security, guaranteeing the module's secure and proficient operation.

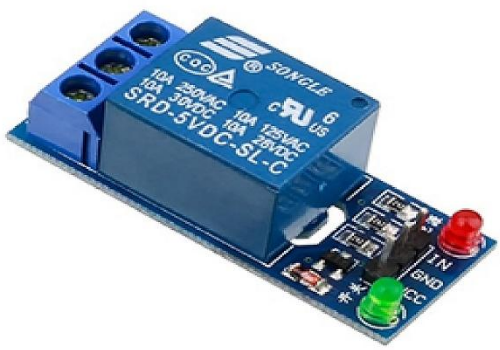


Fig 5.5: Relay

A relay is an electromechanical switch that uses a small electrical signal to control a larger electrical load. It operates on the principle of electromagnetism. When current passes through the coil of the relay, it creates a magnetic field that attracts an armature, causing the contacts to either open or close the circuit. This allows a low-voltage control signal to switch on or off a high-voltage or high-current device without direct electrical connection between the two circuits, providing isolation and protection.

Relays are widely used in automation, communication systems, power control circuits, and safety devices. They can control lights, motors, heaters, and other electrical equipment. There are different types of relays such as electromagnetic relays, solid-state relays, thermal relays, and time delay relays, each designed for specific applications. Relays are valued for their reliability, fast response, and ability to handle multiple circuits simultaneously. In modern systems, relays play a crucial role in providing automatic control, ensuring electrical safety, and improving system performance.

5.6 BUZZER

It is a device that converts electrical signal into sound signal. It needs DC voltage and is used in clocks, printers, alarms, etc. Depending on the many plans available, it can produce various tones such as alerts, chimes, and sirens. The stick setup of buzzer has appeared underneath. It incorporates two pins to be specific, anode and cathode. The anode terminal with the '+' image or a longer terminalis given 6Volts, while the cathode terminal with the '-' image is associated with the ground. Working voltage ranges from 3V to 24V DC. This buzzer can be interfered with a DC control source with a voltage extending from 4V to 9V. An essential 9V battery can also control it, but utilizing a directed +5V or +6V DC supply is superior for ideal execution. Ordinarily, the buzzer is combined with an exchanging circuit to control when it turns on or off as required, either at particular times or intervals.

Fig 5.6: Buzzer

A buzzer is an electronic sound-producing device commonly used to alert or signal users through audible tones. It converts electrical energy into sound energy using piezoelectric or electromagnetic principles. When an electric current passes through the buzzer, it causes a vibration in a diaphragm, producing a buzzing or beeping sound. Buzzers are widely used in various applications such as alarms, timers, electronic toys, home appliances, and automotive systems to provide warnings or notifications.

There are mainly two types of buzzers — active and passive. An active buzzer has a built-in oscillator and produces sound automatically when powered, while a passive buzzer requires an external circuit or signal to generate sound. Buzzers are preferred for their simplicity, low power consumption, and reliability. They can operate on both AC and DC power sources and come in different sizes and frequencies depending on the application. In embedded systems and security devices, buzzers are often used as indicators to alert users about events like motion detection, errors, or completed processes, making them an essential component in many electronic and automation projects.

5.7 SERVO LOCK

A servo lock is an electromechanical locking mechanism that uses a servo motor to control the movement of a lock or latch. The servo motor operates based on electrical signals and can precisely rotate to a specific angle to engage or disengage the lock. In vehicle security or access control systems, a servo lock helps secure the system by physically locking or unlocking a component, such as a door or compartment, based on authorized commands.

The servo motor receives control signals, usually in the form of pulse-width modulation (PWM), from a microcontroller such as the ESP32 or Arduino. When the system detects a theft attempt or an unauthorized vibration, the controller activates the servo motor. The motor then rotates (typically 0° to 90°) to move the locking mechanism into a locked or unlocked position. Once the lock position is achieved, the servo remains in place, applying torque to hold its position — this is known as the locked state.

Servo locks are widely used in anti-theft systems, robotics, automated doors, and smart security systems due to their precision, reliability, and fast response time. In vehicle tracking or anti-theft systems, the servo lock can be connected to the ignition or door mechanism to prevent the vehicle from starting or moving when unauthorized access is detected. It ensures that only valid signals from the controller can release the lock, thereby enhancing the safety and security of the vehicle.

Fig 5.7: Servo Lock

Servo locks are compact, lightweight, and highly efficient compared to traditional mechanical locks. They provide accurate control, quick operation, and can be easily integrated with sensors, GPS modules, and microcontrollers for smart automation. Their ability to hold position with minimal power consumption makes them ideal for battery-powered security applications.

5.7.1 Working Principle

When the microcontroller detects a trigger — for example, a vibration signal from a vibration sensor indicating a theft attempt — it sends a PWM signal to the servo lock. The duty cycle of the PWM signal determines the rotation angle of the servo motor.

Locked position: The servo rotates the latch to close or block the mechanical linkage, securing the system.

Unlocked position: The servo rotates back to the open position, releasing the latch. The feedback system inside the servo ensures that it maintains its position even under external force, providing a stable and reliable locking mechanism.

5.7.2 Construction

A typical servo lock consists of three main parts — a servo motor, a locking latch or arm, and an electronic control circuit.

- The servo motor is usually a small DC motor equipped with position feedback

sensor (potentiometer) that helps determine the motor's angular position.

- The gearbox connected to the motor reduces speed and increases torque, allowing the servo to hold or move the lock with precision.

- The locking arm or latch is a mechanical component attached to the servo shaft, which rotates between two angles (commonly 0° for unlocked and 90° for locked positions).

- The control circuit processes PWM (Pulse Width Modulation) signals from the controller (like ESP32 or Arduino) to move the servo to a specific angle.

5.8 POWER SUPPLY

The power supply for this system is shown below.

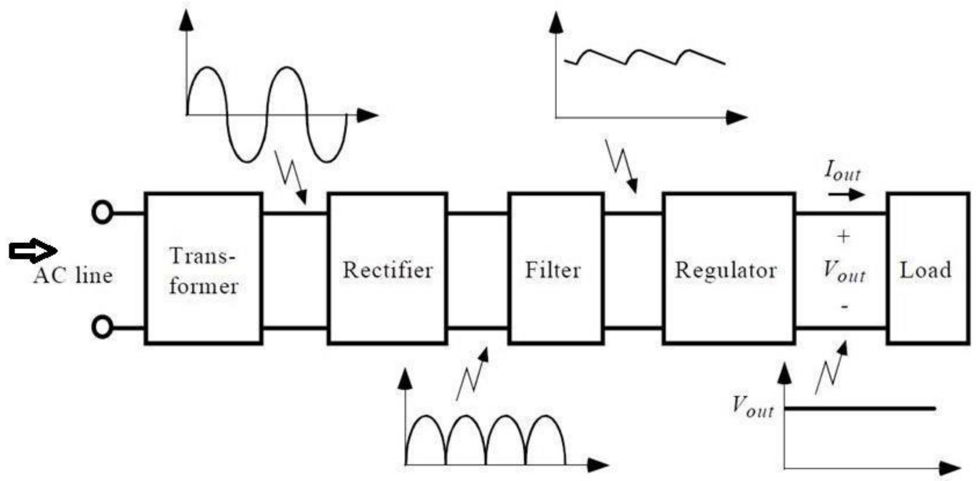


Fig 5.8: Power Supply

5.8.1 Transformer:

Transformer is a static device used to convert the voltage from one level to another level without change its frequency. There are two types of transformers

1.Step-up transformer

2.Step-down transformer

Step-down transformer is designed to reduce the voltage from primary to secondary. The transformation ratio of a transformer will be equal to the square root of its primary to secondary inductance ratio. The transformer converts high-voltage AC into low-voltage AC. The input and output power remain same. A step-down transformer decreases the voltage at the secondary windings relative to the primary side.

Step-up transformer converts low voltage level into high voltage level without change its frequency. Step-down transformer converts high voltage level into low voltage level without change its frequency. In this project we using step-down transformer which converts 230V AC to 12V AC [or] 230V AC to 5V as shown below.

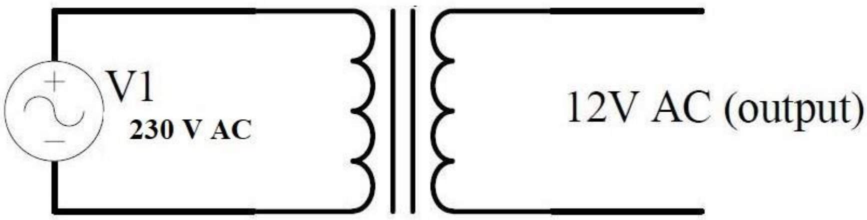


Fig 5.9: Transformers

5.8.2 Rectifier

The purpose of a rectifier is to convert an AC waveform into a DC waveform (OR) Rectifier converts AC current or voltages into DC current or voltage. There are two different rectification circuits, known as 'half-wave' and 'full-wave' rectifiers. Both use components called diodes to convert AC into DC.

The Half-wave Rectifier:

The half-wave rectifier is the simplest type of rectifier since it only uses one diode, as shown in figure.

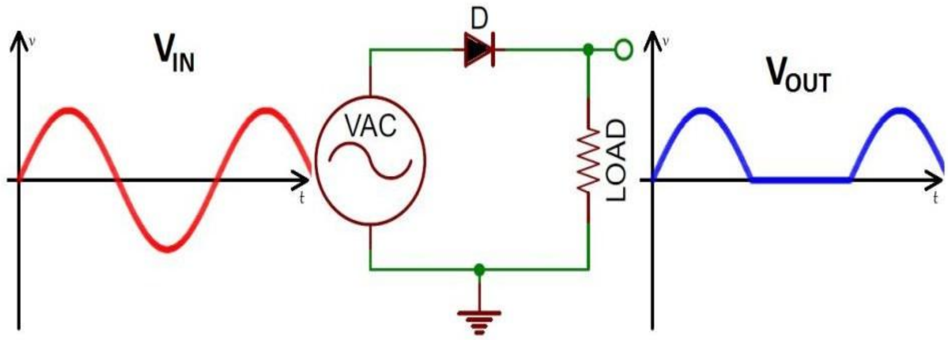


Fig 5.10: Half Wave Rectifier

The AC input waveform to this circuit and the resulting output. As you can see, when the AC input is positive, the diode is forward-biased and lets the current through. When the AC input is negative, the diode is reverse-biased and the diode does not let any current through, meaning the output is 0V. Because there is a 0.7V voltage loss across the diode, the peak output voltage will be 0.7V less than Vs.

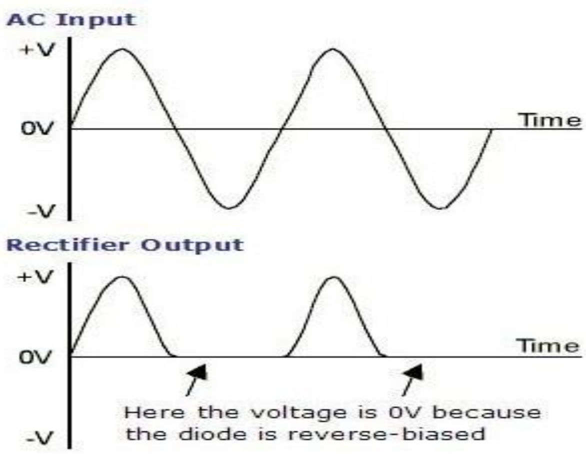


Fig 5.11: Half Wave Rectification

While the output of the half-wave rectifier is DC (it is all positive), it would not be suitable as a power supply for a circuit. Firstly, the output voltage continually varies between 0V and Vs-0.7V, and secondly, for half the time there is no output at all.

The Full-wave Bridge Rectifier:

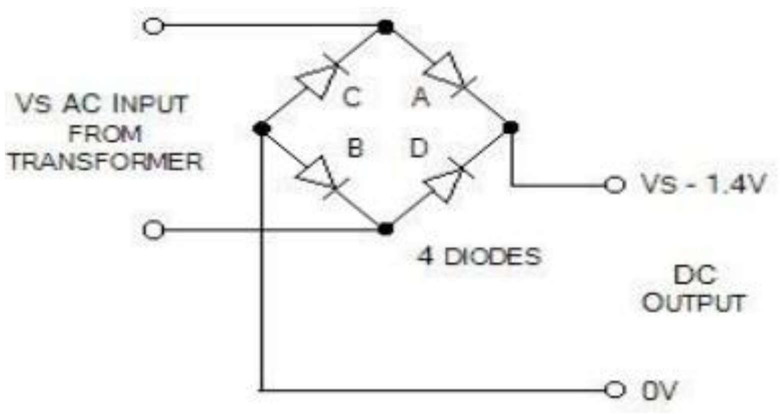


Fig 5.12: Full Wave Rectifier

The circuit addresses the second of these problems since at no time is the output voltage 0V. This time four diodes are arranged so that both the positive and negative parts of the AC waveform are converted to DC. The resulting waveform is shown in figure.

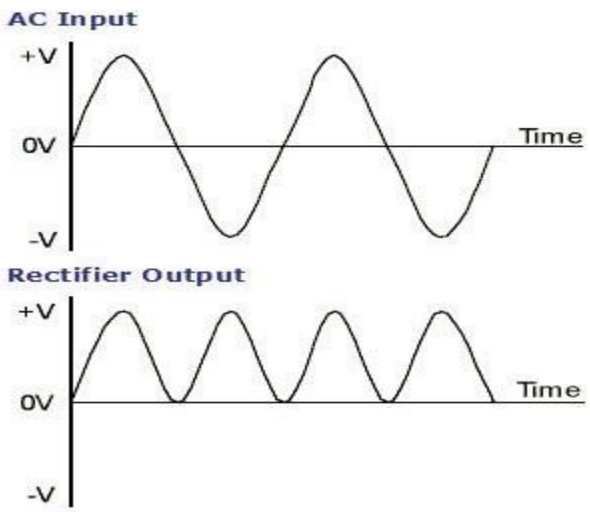


Fig 5.13: Full Wave Rectification

When the AC input is positive, diodes A and B are forward-biased, while diodes C and D are reverse biased. When the AC input is negative, the opposite is true - diodes C and D are forward-biased, while diodes A and B are reverse-biased. While the full- wave rectifier is an improvement on the half-wave rectifier, its output still isn't suitable as a power supply for most circuits since the output voltage still varies between 0V and Vs-1.4V. So, if you put 12V AC in, you will 10.6V DC out.

5.8.3 Capacitor Filter

The capacitor-input filter, also called "Pi" filter due to its shape that looks like the Greek letter pi, is a type of electronic filter. Filter circuits are used to remove unwanted or undesired frequencies from a signal.

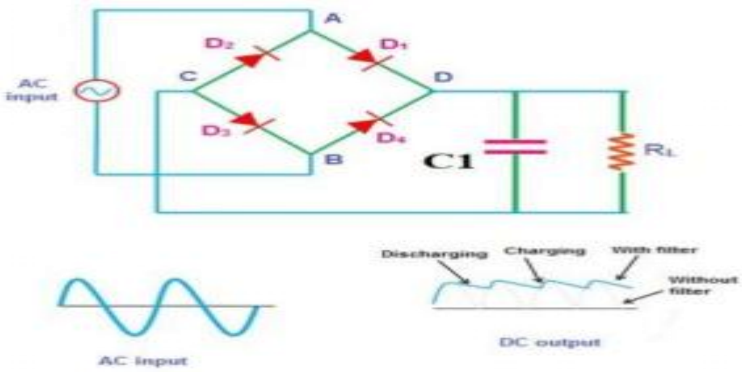


Fig 5.14: Full-Wave Rectifier with a Capacitor Filter

A typical capacitor input filter consists of a filter capacitor C1, connected across the rectifier output. The capacitor C1 offers low reactance to the AC component of the rectifier output while it offers infinite reactance to the DC component. As a result, the AC components are going to ground. At that time DC components are feed to Regulator.

5.8.4 Voltage Regulator

A voltage regulator is an electrical regulator designed to automatically maintain a constant voltage level. It may use an electromechanical mechanism, or passive or active electronic components. Depending on the design, it may be used to regulate one or more AC or DC voltages. There are two types of regulators they are.

• Positive Voltage Series (78xx) and

• Negative Voltage Series (79xx)

78xx:’78’ indicate the positive series and xx’ indicates the voltage rating. Suppose 7805 produces the maximum 5V.’05’indicates the regulator output is 5V.

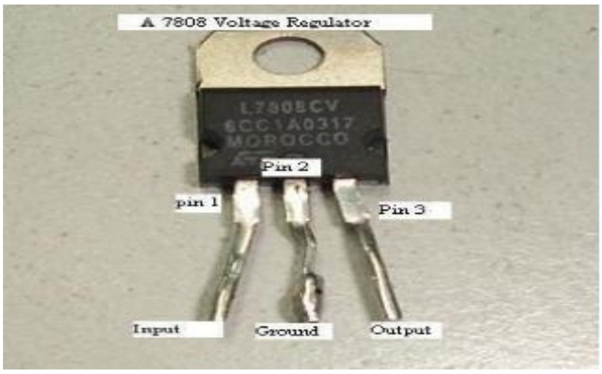


Fig 5.15: Regulator

79xx:’78’ indicate the negative series and ‘xx’ indicates the voltage rating. Suppose 7905 produces the maximum -5V.’05’indicates the regulator output is -5V. These regulators consist the three pins.

CHAPTER – 6

SOFTWARE IMPLEMENTATION

6.1 INTRODUCTION TO ARDUINO IDE

Arduino is a prototype platform (open-source) based on an easy-to-use hardware and software. It consists of a circuit board, which can be programmed (referred to as a microcontroller) and a ready-made software called Arduino IDE (Integrated Development Environment), which issued to write and upload the computer code to the physical board.

The key features are:

- Arduino boards are able to read analog or digital input signals from different Sensors and turn it into an output such as activating a motor, turning LEDon/off, connect to the cloud and many other actions.

- You can control your board functions by sending a set of instructions to the microcontroller on the board via Arduino IDE (referred to as uploading software).

- Unlike most previous programmable circuit boards, Arduino does not need an extra piece of hardware (called a programmer) in order to load a new code onto the board. You can simply use a USB cable.

- Additionally, the Arduino IDE uses a simplified version of C++, making it easier to learn to program.

- Finally, Arduino provides a standard form factor that breaks the functions of the microcontroller into a more accessible package.

After learning about the main parts of the Arduino UNO board, we are ready to learn how to set up the Arduino IDE. Once we learn this, we will be ready to upload our program on the Arduino board.

Arduino Data Types:

Data types in C refers to an extensive system used for declaring variables or functions of different types. The type of a variable determines how much space it occupies in the storage and how the bit pattern stored is interpreted.

Example: void, Boolean, char, Unsigned char, Byte, Unsigned int, Word, Long, Float, Double.

Void:

The void keyword is used only in function declarations. It indicates that the function is expected to return no information to the function from which it was called.

Example:

```
Void Loop ()

{

// rest of the code

}
```

Boolean: A Boolean holds one of two values, true or false. Each Boolean variable occupies one byte of memory.

Char: A data type that takes up one byte of memory that stores a character value. Character literals are written in single quotes like this: 'A' and for multiple characters, strings use double quotes: "ABC".

However, characters are stored as numbers. You can see the specific encoding in the ASCII chart. This means that it is possible to do arithmetic operations on characters, in which the ASCII value of the character is used. For example, 'A' + 1 has the value 66, since the ASCII value of the capital letter A is 65.

Unsigned char is an unsigned data type that occupies one byte of memory. The unsigned char data type encodes numbers from 0 to 255.

Byte: A byte stores an 8-bit unsigned number, from 0 to 255.

int: Integers are the primary data-type for number storage. **int** stores a 16-bit (2-byte) value. This yields a range of -32,768 to 32,767 (minimum value of -2^15 and a maximum value of (2^15) - 1). The int size varies from board to board. On the Arduino Due, for example, an int stores a 32-bit (4-byte) value.

Unsigned int: Unsigned ints (unsigned integers) are the same as int in the way that they store a 2byte value. Instead of storing negative numbers, however, they only store positive values, yielding a useful range of 0 to 65,535 (2^16) - 1). The Due stores a 4-byte (32-bit) value, ranging from 0 to 4,294,967,295 (2^32 - 1).

Word: On the Uno and other ATMEGA based boards, a word stores a 16-bit unsigned number. On the Due and Zero, it stores a 32-bit unsigned number.

Long: Long variables are extended size variables for number storage, and store 32 bits (4 bytes), from 2,147,483,648 to 2,147,483,647.

Unsigned long: Unsigned long variables are extended size variables for number storage and store 32 bits (4 bytes). Unlike standard longs, unsigned longs will not store negative numbers, making their range from 0 to 4,294,967,295 (2^32 - 1).

Short: A short is a 16-bit data-type. On all Arduinos (ATMega and ARM based), a short stores a 16-bit (2-byte) value. This yields a range of -32,768 to 32,767 (minimum value of -2^15 and a maximum value of (2^15) - 1).

Float: Data type for floating-point number is a number that has a decimal point. Floating-point numbers are often used to approximate the analog and continuous values because they have greater resolution than integers. Floating-point numbers can be as large as 3.4028235E+38 and as low as 3.4028235E+38. They are stored as

32 bits (4 bytes) of information.

Double: On the Uno and other ATMEGA based boards, Double precision floating-point number occupies four bytes. That is, the double implementation is exactly the same as the float, with no gain in precision. On the Arduino Due, doubles have 8-byte (64 bit) precision.

In this section, we will learn in easy steps, how to set up the Arduino IDE on our computer and prepare the board to receive the program via USB cable.

Step 1: First you must have your Arduino board (you can choose your favorite board) and a USB cable. In case you use Arduino UNO, Arduino Duemilanove, Nano, Arduino Mega2560, or Diecimila, you will need a standard USB cable (A plug to B plug), the kind you would connect to a USB printer as shown in the following image.

Fig 6.1: USB Cable

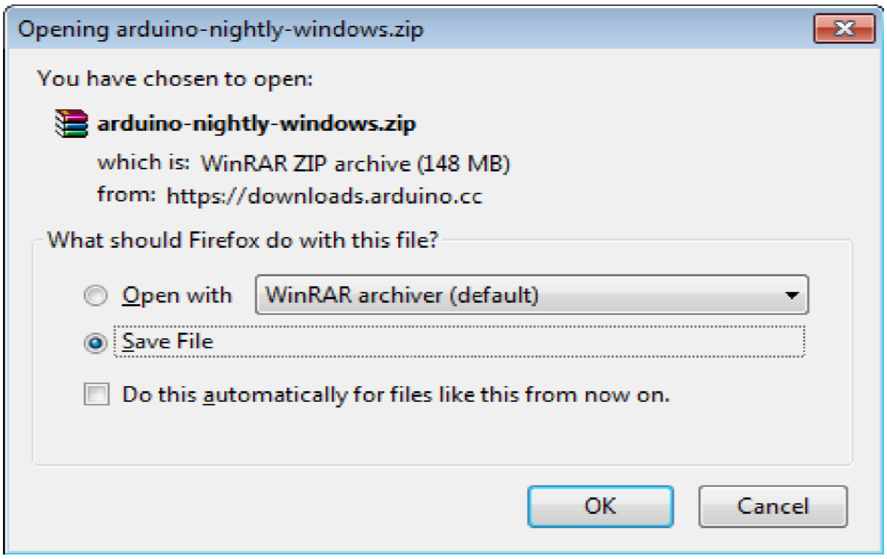
Step 2: Download Arduino IDE Software.

You can get different versions of Arduino IDE from the Download page on the Arduino Official website. You must select your software, which is compatible with your operating system (Windows, IOS, or Linux). After your file download is complete, unzip the file.

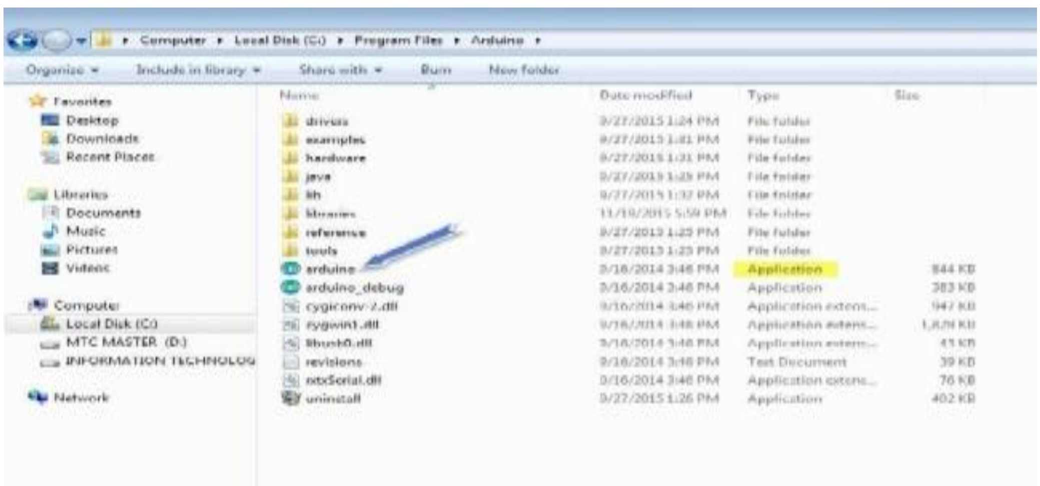
Step 3: Power up your board.

The Arduino Uno, Mega, Duemilanove and Arduino Nano automatically draw power from either, the USB connection to the computer or an external power supply. If you are using an Arduino Diecimila, you have to make sure that the board is configured to draw power from the USB connection. The power source is selected with a jumper, a small piece of plastic that fits onto two of the three pins between the USB and power jacks. Check that it is on the two pins closest to the USB port. Connect the Arduino board to your computer using the USB cable. The green power LED (labelled PWR) should glow.

Step 4: Launch Arduino IDE.



After your Arduino IDE software is downloaded, you need to unzip the folder. Inside the folder, you can find the application icon with an infinity label (application.exe). Double click the icon to start the IDE.

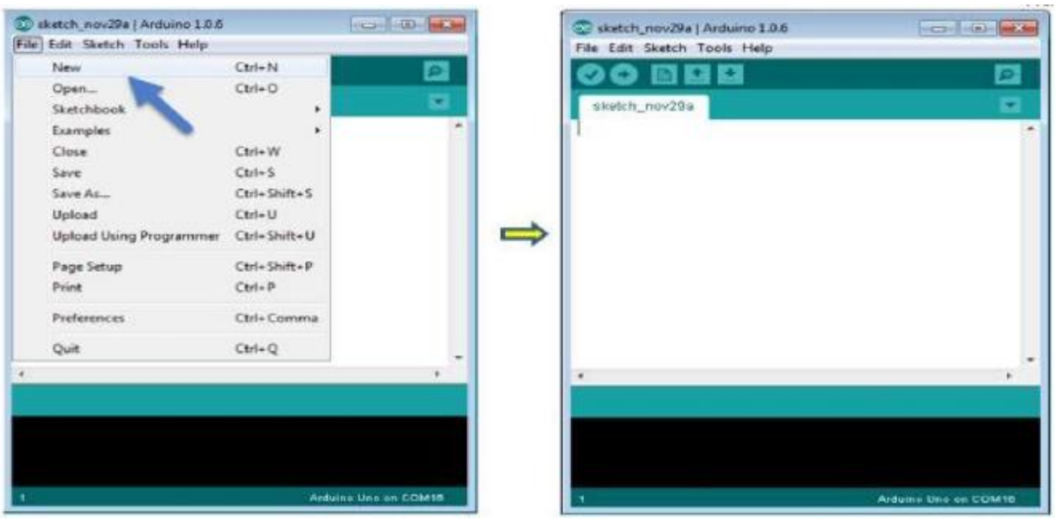


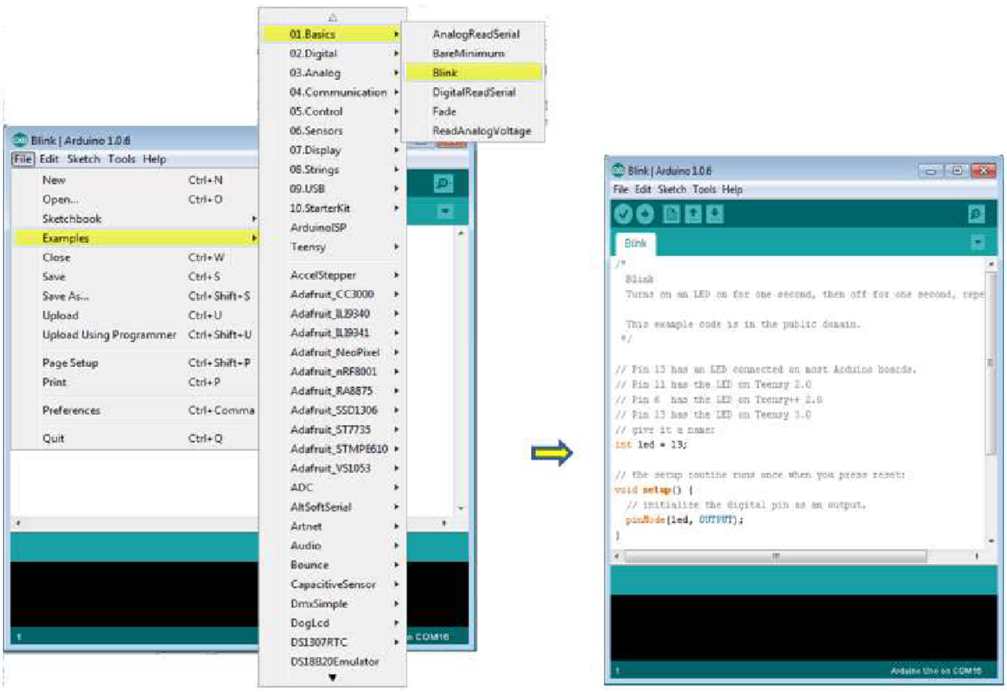
Step 5: Open your first project.

Once the software starts, you have two options:

- Create a new project.
- Open an existing project example.

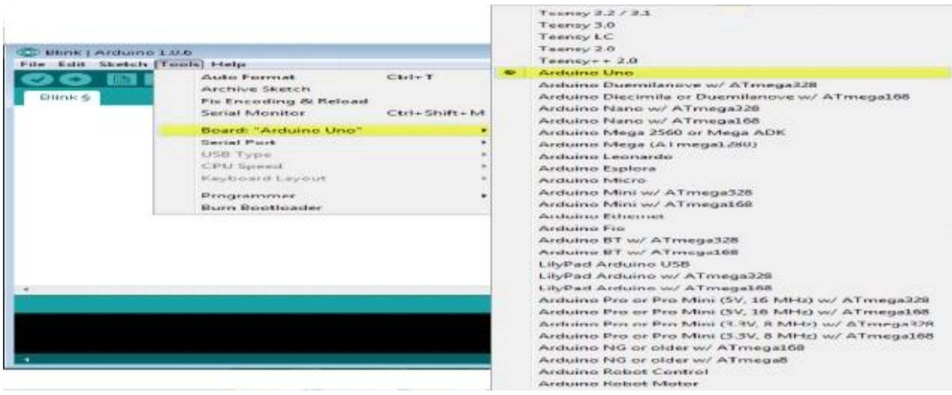
To create a new project, select File --> New. To open existing project example, select File -> Example -> Basics -> Blink.





Here, we are selecting just one of the examples with the name Blink. It turns the LED on and off with sometime delay. You can select any other example from the list.

Step 6: Select your Arduino board.

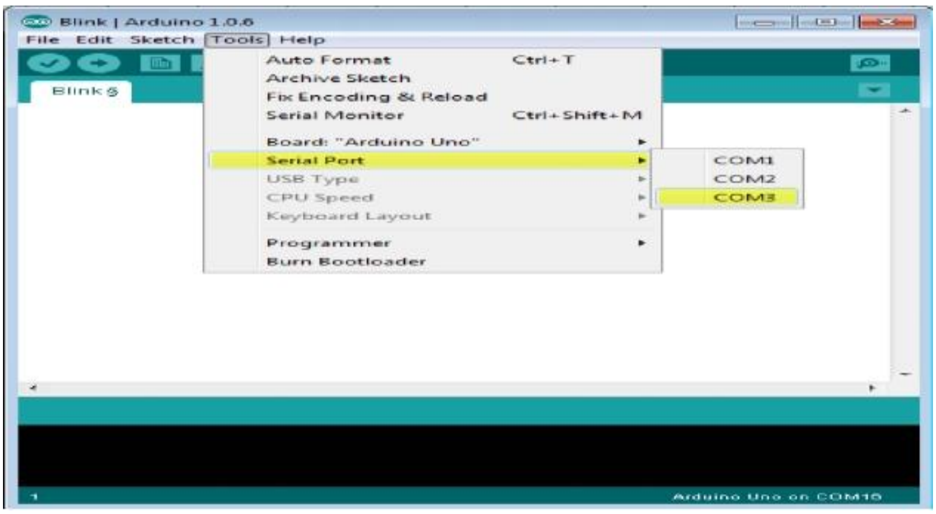


To avoid any error while uploading your program to the board, you must select the correct Arduino board name, which matches with the board connected to your computer.

Go to Tools -> Board and select your board

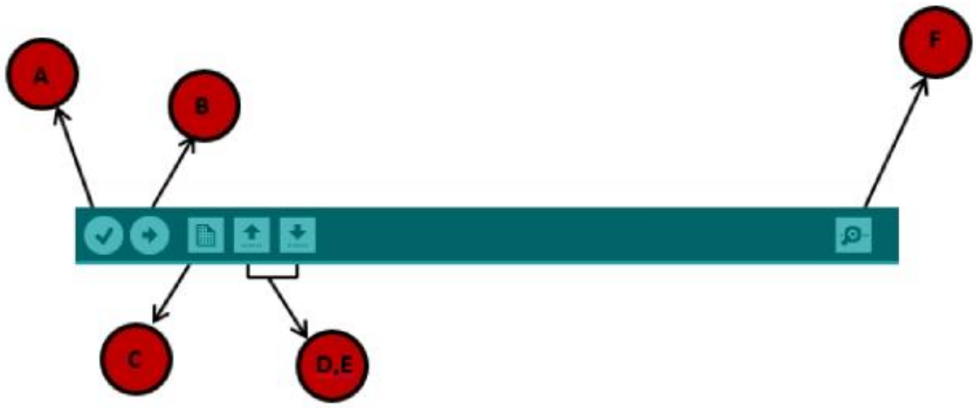
Here, we have selected Arduino Uno board according to our tutorial, but you must select the name matching the board that you are using

Step 7: Select your serial port.



Select the serial device of the Arduino board. Go to **Tools** ->**Serial Port** menu. This is likely to be COM3 or higher (COM1 and COM2 are usually reserved for hardware serial ports). To find out, you can disconnect your Arduino board and re-open the menu, the entry that disappears should be of the Arduino board. Reconnect the board and select that serial port.

Step 8: Upload the program to your board. Before explaining how we can upload our program to the board, we must demonstrate the function of each symbol appearing in the Arduino IDE toolbar.



A- Used to check if there is any compilation error.

B- Used to upload a program to the Arduino board.

C- Shortcut used to create a new sketch.

D- Used to directly open one of the example sketch.

E- Used to save your sketch.

F- Serial monitor used to receive serial data from the board and send the serial data to board.

Now, simply click the "Upload" button in the environment. Wait a few seconds; you will see the RX and TX LEDs on the board, flashing. If the upload is successful, the message "Done uploading" will appear in the status bar.

Note: If you have an Arduino Mini, NG, or other board, you need to press the reset button physically on the board, immediately before clicking the upload button on the Arduino Software.

Arduino programming structure

In this chapter, we will study in depth, the Arduino program structure and we will learn more new terminologies used in the Arduino world. The Arduino software is open-source. The source code for the Java environment is released under the GPL and the C/C++ microcontroller libraries are under the LGPL.

Sketch: The first new terminology is the Arduino program called "**sketch**".

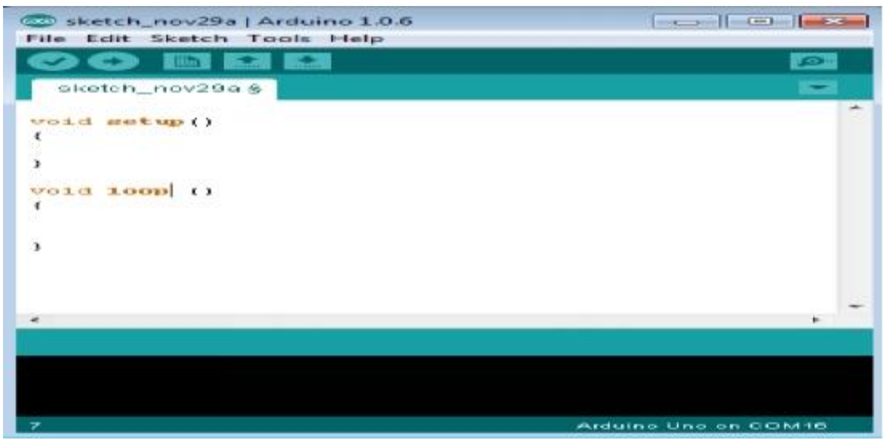
Structure: Arduino programs can be divided in three main parts: **Structure**, **Values** (variables and constants), and **Functions**. In this tutorial, we will learn about the Arduino software program, step by step, and how we can write the program without any syntax or compilation error.

Let us start with the **Structure**. Software structure consists of two main functions:

- Setup () function
- Loop () function

Void setup ()

{}



PURPOSE:

The setup () function is called when a sketch starts. Use it to initialize the variables, pin modes, start using libraries, etc. The setup function will only run once, after each power up or reset of the Arduino board.

INPUT

OUTPUT

RETURN

Void Loop ()

{

}

PURPOSE:

After creating a setup () function, which initializes and sets the initial values, the loop () function does precisely what its name suggests, and loops executively, allowing your program to change and respond. Use it to actively control the Arduino board.

CHAPTER – 7

WORKING PRINCIPLE

1. Introduction

The anti-theft vehicle tracking system operates on the principle of real-time location monitoring and theft prevention using a combination of sensors, communication modules, and control mechanisms. The main objective of this system is to detect unauthorized access or motion of a vehicle, alert the owner, and provide the exact location of the vehicle to help in recovery.

2.GPS Module Operation

GPS data acquisition refers to the process of obtaining and collecting data from GPS satellites to determine the location, velocity, and time information of a GPS receiver. The GPS receiver receives signals from multiple satellites in orbit around the Earth. These signals contain precise timing information and the satellite's location. By measuring the time, it takes for the signals to reach the receiver, along with the known positions of the satellites, the receiver can calculate its own position. This process is known as trilateration. The receiver collects data from multiple satellites to improve the accuracy of the calculated position. The acquired GPS data can then be used for various applications, such as navigation, mapping, and tracking.

When the system is powered on, the GPS (Global Positioning System) module continuously receives signals from satellites and determines the precise location (latitude and longitude) of the vehicle. This data is sent to the microcontroller, such as the ESP32, which processes and transmits the information through an IoT platform or communication network (like Blynk or GSM). The ESP32 acts as the central processing unit that coordinates between all components including the vibration sensor, relay, servo lock, and buzzer.

3.Data Processing

The collected data from GPS and GSM sources are combined and integrated by the microcontroller or microprocessor. This integration ensures that the system has accurate and up-to-date information about the vehicle's location and other relevant parameters. The microcontroller or microprocessor analyses the integrated data to identify any suspicious activities or security breaches. It compares the current location and movement patterns with predefined parameters or user-defined settings to determine if any unauthorized actions are taking place.

4. Theft Detection Using Vibration Sensor

If the vibration sensor detects any unusual vibration or shock (such as someone trying to break into or move the vehicle without authorization), it sends a signal to the ESP32. The controller immediately triggers the buzzer to produce a loud alarm, warning the owner and nearby people of a possible theft attempt. At the same time, the system can activate the servo lock to physically lock the vehicle’s ignition or steering mechanism, preventing the vehicle from starting or moving.

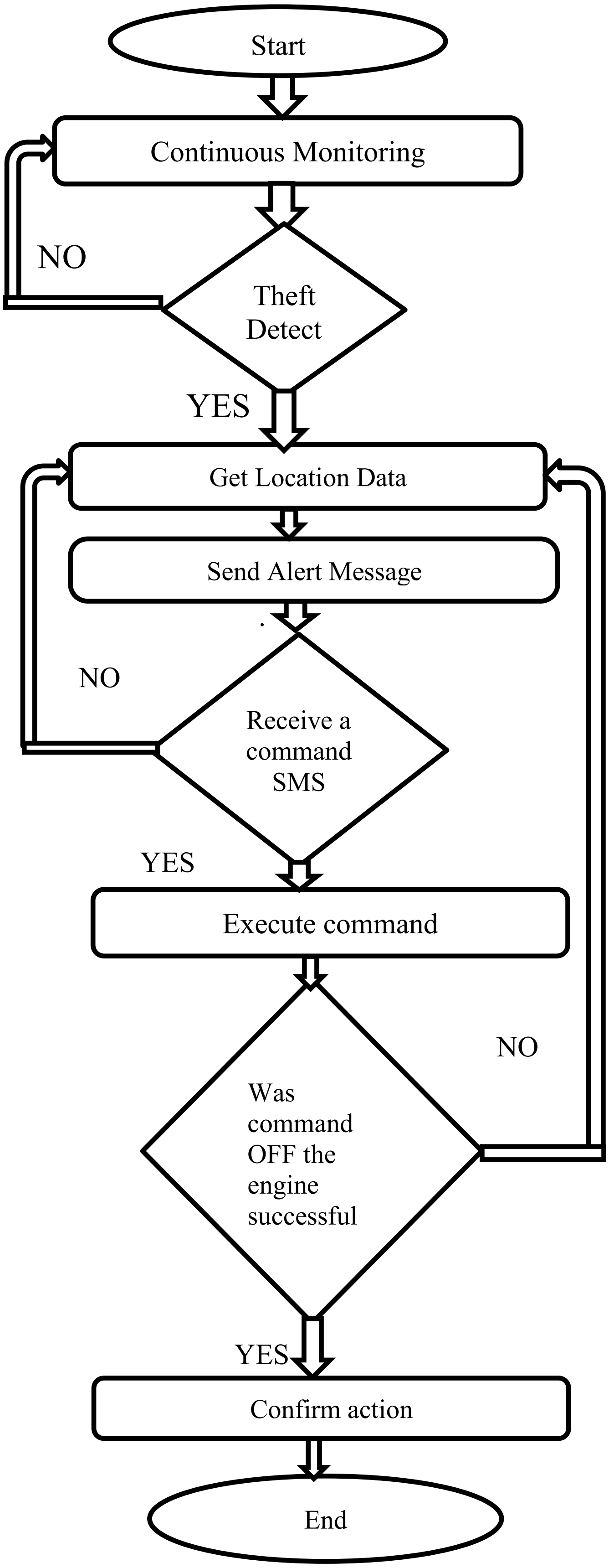
4.Real-Time Location Tracking

Simultaneously, the GPS module updates the current location of the vehicle, and this information is transmitted to the owner’s smartphone through the Blynk application or other IoT-based monitoring platforms. The owner can view the vehicle’s location on a map in real time, allowing them to track its movement or share the details with authorities if the vehicle is stolen.

5.Role of Relay Module

The relay module in the circuit acts as a switching device that can cut off the power supply to the ignition system when a theft attempt is detected. This ensures that even if a thief tries to start the engine, the system automatically disables it.

7.1 FLOW CHART



Start

The system is powered ON and ready to monitor the vehicle's status.

Continuous Monitoring

The system (using sensors, GPS, GSM modules, etc.) constantly keeps track of the vehicle's condition — like ignition, movement, or unauthorized access. This is an automatic and ongoing process.

Theft Detect

The system checks if any abnormal or unauthorized activity is detected. Vehicle moved without key ignition. GPS shows movement in restricted area. If NO theft detected, the system continues monitoring. If YES, go to the next step.

Get Location Data

Once theft is detected, the system immediately fetches the vehicle's real-time GPS coordinates (latitude and longitude). This data helps track where the vehicle is currently located.

Send Alert Message

The system sends an alert SMS (or app notification) to the vehicle owner and/or authorities.

The message usually contains:

Theft alert, Vehicle location link, Time and date

Receive a Command SMS

The system waits for a control command from the owner via SMS.

For example:

"STOP" – to turn off the vehicle's engine

"LOC" – to get live location again

"RESET" – to restart the tracking system

If no command is received → the system keeps waiting or resends the alert message.

If a command is received → go to the next step.

Execute Command

The system performs the requested action.

Example: if the command was "STOP", it will send a signal to the vehicle's control relay to turn off the engine.

Was Command OFF the Engine Successful?

The system checks whether the command was executed correctly:

If the engine was successfully turned off → go to the next step.

If not → reattempt execution or send an error alert to the owner.

Confirm Action

The system confirms that the action (like stopping the engine) was successful.

Sends confirmation message to the owner — e.g.,

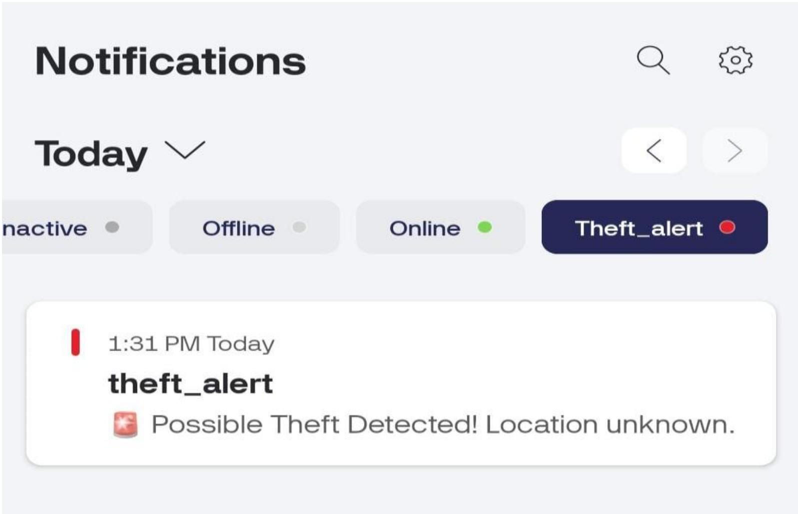
“Engine stopped successfully. Vehicle immobilized.”

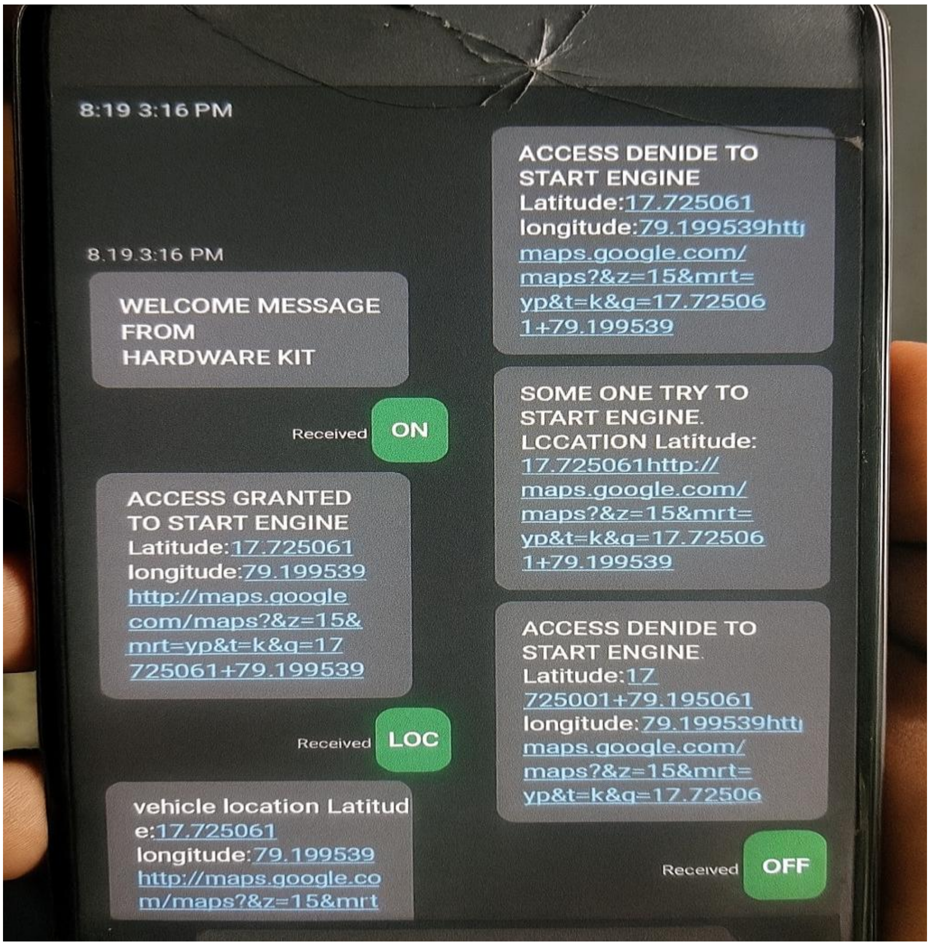
End

The process ends once the theft is handled and confirmation is sent.

CHAPTER – 8

RESULTS





CHAPTER – 9

ADAVANTAGES DISADVANTAGES & APPLICATIONS

ADVANTAGES

1. **Real-time tracking:** Allows vehicle owners to track their vehicle's location in real-time.

2. **Theft Prevention:** Acts as a deterrent to potential thieves and reduces the risk of vehicle theft.

3. **Recovery of stolen vehicles:** Increases the chances of recovering stolen vehicles quickly and efficiently.

4. **Improved vehicle security:** Provides an additional layer of security for vehicles, especially in high-risk areas.

5. **Increased driver accountability:** Allows fleet owners to monitor driver behaviour and improve driver accountability.

6. **Efficient fleet management:** Helps fleet owners to manage their vehicles more efficiently, reducing operational costs

7. **Reduced insurance premiums:** Some insurance companies offer discounts for vehicles equipped with anti-theft tracking systems.

DISADVANTAGES

1. **High upfront cost:** Installing an anti-theft vehicle tracking system can be expensive.

2. **Monthly subscription fees:** Many tracking systems require monthly subscription fees, which can add up over time**.**

3. **Dependence on satellite signals:** Tracking systems rely on satellite signals, which can be affected by weather conditions or satellite outages.

4. **Potential for hacking:** Like any connected device, anti-theft tracking systems can be vulnerable to hacking and data breaches.

5. **Additional complexity:** Some tracking systems can be complex to install and use, requiring technical expertise.

6. **Battery drain:** Some tracking devices can drain the vehicle's battery if not properly installed or maintained.

7. **Potential for driver privacy concerns:** Some drivers may view tracking systems as an invasion of their privacy.

APPLICATIONS

1.Vehicle Recovery: GPS tracking system help law enforcement agencies locate and recover stolen vehicles.

2. Fleet Management: Businesses can track and manage their vehicle fleets efficiently, improving logistics and productivity.

3. Cargo Security: Tracking systems can monitor the location and condition of valuable cargo, ensuring its safe delivery.

4. Construction Equipment Protection: GPS tracking systems can protect expensive construction machinery from theft.

5. Motorcycle Security: GPS and GSM tracking systems can safeguard motorcycles from theft and aid in their recovery.

6. Asset Tracking: Valuable assets, such as generators or trailers, can be tracked and protected using these systems.

7. Personal Vehicle Security: Individuals can secure their cars, motorcycles, or other vehicles with GPS and GSM tracking.

8. Aviation Security: Aircraft tracking systems using GPS and GSM technology enhance aviation security and safety.

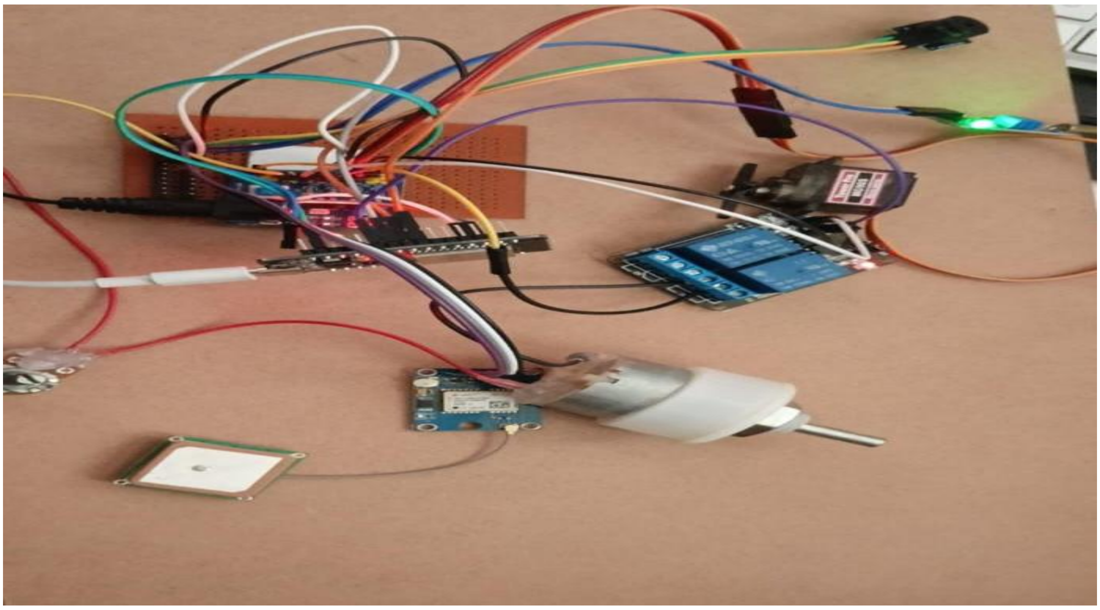
CHAPTER – 10

CONCLUSION AND FUTURE SCOPE

10.1 CONCLUSION

The Anti-Theft Vehicle Tracking System provides an efficient, reliable, and cost-effective solution for enhancing vehicle security. The system is capable of detecting unauthorized access, tracking the vehicle's real-time location, and preventing theft through automatic locking and alert mechanisms.

This system not only helps vehicle owners monitor their vehicles remotely but also enables quick recovery in case of theft. Its IoT-based design ensures user-friendly operation, minimal maintenance, and easy scalability for different types of vehicles. Overall, the project demonstrates how modern embedded systems and communication technologies can be effectively combined to ensure vehicle safety, real-time monitoring.



10.2 FUTURE SCOPE

The future scope of anti-theft vehicle tracking systems using GPS technology is quite promising. As technology continues to advance, we can expect to see several advancements in this field. Some potential future developments include:

1. **Enhanced Accuracy:** Improvements in GPS technology can lead to even more precise location tracking, making it easier to locate stolen vehicles.

2. **Artificial Intelligence Integration:** AI algorithms can be integrated into tracking systems to analyse patterns, predict thefts, and provide proactive security measures.

3. **Integration with Smart Cities:** Anti-theft tracking systems can be integrated into smart city infrastructure, allowing for seamless coordination between vehicles, law enforcement, and traffic management systems.

4. **IoT Integration:** Integration with the Internet of Things (IoT) can enable real-time communication and data exchange between vehicles, tracking systems, and other devices, enhancing overall security.

5. **Advanced Data Analytics:** Utilizing big data analytics, tracking systems can identify trends, patterns, and potential vulnerabilities, leading to more effective theft prevention strategies.

6. **Mobile App Enhancements:** Mobile applications can offer more features and functionality, such as remote vehicle control, geofencing, and customized alerts, providing users with greater control and convenience.
7. **Integration with Smart Home Security:** Anti-theft tracking systems can be integrated with smart home security systems, allowing for seamless monitoring and control of vehicles from within the home.
8. **Collaborative Efforts:** Collaboration between vehicle manufacturers, insurance companies, and law enforcement agencies can lead to standardized and more effective anti-theft solutions.

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APPENDIX

Source Code

```
#define BLYNK_TEMPLATE_ID "TMPL3pCK3p8gK"
#define BLYNK_TEMPLATE_NAME "ANTI THEFT VEHICLE TRACKIING"
#define BLYNK_AUTH_TOKEN "ggUNkpnpEHZGaEFd9Z8Exi1_61FxMD8j"

#include <WiFi.h>
#include <WiFiClient.h>
#include <BlynkSimpleEsp32.h>
#include <TinyGPSPlus.h>
#include <ESP32Servo.h>

// ---------- Pin Definitions ----------
#define VIBRATION_SENSOR 26
#define BUZZER 25
#define RELAY 27
#define SERVO_PIN 33
#define GPS_RX_PIN 3
#define GPS_TX_PIN 1

// ---------- Blynk Virtual Pins ----------
#define VPIN_VIBRATION V0
#define VPIN_RELAY     V1
#define VPIN_SERVO     V2
#define VPIN_LAT       V3
#define VPIN_LON       V4
#define VPIN_STATUS    V5

// ---------- WiFi & Blynk Credentials ----------
char auth[] = BLYNK_AUTH_TOKEN;
char ssid[] = "rpi06";
char pass[] = "raspberry";
```

```
// ---------- Globals ----------
TinyGPSPlus gps;
HardwareSerial GPSSerial(1);
Servo lockServo;
volatile bool vibrationTriggered = false;
String lastKnownLat = "0.000000";
String lastKnownLon = "0.000000";

// ---------- Notification Cooldown ----------
unsigned long lastNotifyTime = 0;
const unsigned long NOTIFY_COOLDOWN = 120000UL; // 2 minutes

// ---------- ISR for Vibration ----------
void IRAM_ATTR vibrationISR() {
  vibrationTriggered = true;
}

// ---------- Setup ----------
void setup() {
  Serial.begin(115200);
  delay(100);

  pinMode(VIBRATION_SENSOR, INPUT);
  pinMode(BUZZER, OUTPUT);
  pinMode(RELAY, OUTPUT);
  digitalWrite(RELAY, LOW);  // Engine OFF initially
  digitalWrite(BUZZER, LOW);

  lockServo.attach(SERVO_PIN);
  lockServo.write(0); // Unlocked initially

  attachInterrupt(digitalPinToInterrupt(VIBRATION_SENSOR), vibrationISR, RISING);
```

```
  GPSSerial.begin(9600, SERIAL_8N1, GPS_RX_PIN, GPS_TX_PIN);
  Blynk.begin(auth, ssid, pass);

  Serial.println(F("Anti-Theft Vehicle Tracking System Started"));
  blynkStatus("System Started");
}

// ---------- Loop ----------
void loop() {
  Blynk.run();
  readGPS();
  handleVibration();
}

// ---------- Read GPS ----------
void readGPS() {
  while (GPSSerial.available()) {
    gps.encode(GPSSerial.read());
  }

  if (gps.location.isUpdated() || gps.location.isValid()) {
    if (gps.location.isValid()) {
      lastKnownLat = String(gps.location.lat(), 6);
      lastKnownLon = String(gps.location.lng(), 6);
      Blynk.virtualWrite(VPIN_LAT, lastKnownLat);
      Blynk.virtualWrite(VPIN_LON, lastKnownLon);
      Serial.print("GPS: ");
      Serial.print(lastKnownLat);
      Serial.print(", ");
      Serial.println(lastKnownLon);
    }
  }
}
```

```
// ---------- Handle Vibration ----------
void handleVibration() {
  if (vibrationTriggered) {
    vibrationTriggered = false;
    Serial.println("⚠️ Vibration Detected - Possible Theft!");
    digitalWrite(BUZZER, HIGH);
    Blynk.virtualWrite(VPIN_VIBRATION, 1);

    unsigned long now = millis();
    if (now - lastNotifyTime > NOTIFY_COOLDOWN) {
      lastNotifyTime = now;
      sendTheftAlert();
    } else {
      Serial.println("Notification suppressed (cooldown)");
    }

    delay(2000);
    digitalWrite(BUZZER, LOW);
    Blynk.virtualWrite(VPIN_VIBRATION, 0);
  }
}

// ---------- Theft Alert ----------
void sendTheftAlert() {
  String msg = "🚨 Possible Theft Detected!";
  if (lastKnownLat != "0.000000" && lastKnownLon != "0.000000") {
    msg += " Location: " + lastKnownLat + ", " + lastKnownLon;
    msg += " (https://maps.google.com/?q=" + lastKnownLat + "," + lastKnownLon + ")";
  } else {
    msg += " Location unknown.";
  }

  Serial.println("Sending Theft Alert:");
  Serial.println(msg);
```

```
  Blynk.logEvent("theft_alert", msg);
  blynkStatus("Theft Alert Sent");
}

// ---------- Relay Control ----------
BLYNK_WRITE(VPIN_RELAY) {
  int state = param.asInt();
  digitalWrite(RELAY, state);
  Serial.print("Engine Relay: ");
  Serial.println(state ? "ON" : "OFF");
  blynkStatus(state ? "Engine Started" : "Engine Stopped");
}

// ---------- Servo Control ----------
BLYNK_WRITE(VPIN_SERVO) {
  int lockState = param.asInt(); // 0 or 1
  if (lockState == 1) {
    lockServo.write(90); // Lock
    Serial.println("Servo: LOCKED");
    blynkStatus("Vehicle Locked");
  } else {
    lockServo.write(0);  // Unlock
    Serial.println("Servo: UNLOCKED");
    blynkStatus("Vehicle Unlocked");
  }
}

// ---------- Helper ----------
void blynkStatus(const char *msg) {
  Blynk.virtualWrite(VPIN_STATUS, String(msg));
  Serial.println(msg);
}
```