NEXT-GEN RAILWAY TRACK MONITORING AND CONTROLLED BY IOT

A PROJECT REPORT

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BONAFIDE CERTIFICATE

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ABSTRACT

This paper proposes a new method for monitoring the irregularities in railway tracks by updating the status of the tracks in the cloud. The IoT based Railway Track Monitoring System (IoT-RMS) is proposed for monitoring the condition of the railway track. The system identifies any abnormality in the tracks at an early stage. It is intended to propose a device which can automatically detect any cracks in railway tracks. The created device will be attached into the train engine and it consists of a sensor that will detect crack a few meters away and as soon as any crack is detected the train driver will get a signal so he can apply emergency brakes along with it the authorities will be notified with the correct location at which the fault is detected. The proposed approach is benign because the Indian Railway is the biggest railway network in Asia so there should be an efficacious methodology to detect and correct any kind of mishap due to railway tracks. The proposed system is different from others because the device is embedded in the train itself, which could reduce manual work and labour wages. a new hybrid method is proposed for locating irregularities on a track; even in the absence of a GPS signal. Pre-processing of the GPS signal is carried out effectively because the sensors used in IoT-RMS are capable of functioning in a high noise environment. The IoT-RMS updates the location of the abnormality in the cloud and shares it with other trains that will be passing through that location. This project aims at the eradication of any kind of casualty in Indian Railway and if this system creates, even if a small refinement it will make a difference in the nation.

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LIST OF ABBREVIATION

WORDS	ABBREVIATION
IR Sensor	Infrared Remote Sensor
RF Receiver	Radio Frequency Receiver
LCD	Liquid-Crystal Display
IoT	Internet of Things
WSN	Wireless Sensor Network
GPS	Global Positioning System
Node MCU	Node Microcontroller Unit
PWM	Pulse Width Modulation

CHAPTER 1

INTRODUCTION

In today's world transport which is one of people's biggest consumers, is of utmost importance for its sustainability and safety. Railway transport occupies a leading position in India in reducing a fast-growing economy's growing needs. None the less, if we find the criteria of reliability and health, India has still not achieved the global standard. The main problem is that there is no reliable and affordable equipment to diagnose train track issues and the lack of proper maintenance. The proper functioning and maintenance of transport infrastructure however has a significant impact on the economy. This model speaks of a proposed test train design for detecting obstacles and cracks, similar to the line following the test train. The proposed test train is convenient and shorter analytical time. With this proposed system it is easy to identify the exact position of the faulty train track, so that many lives can be saved.

In this paper, the IoT-based railway track condition monitoring system is introduced for establishing continuous monitoring of the railway tracks. The PCA (Principal Component analysis) method was chosen for its simple software redundancy technique and false alarm reducing methods. If any abnormality is detected in the track, the corresponding coordinates are captured from the GPS by the controller. The location of the abnormality (LOA) is captured when the acceleration signal exceeds the set threshold value. When the train passes through any remote or hilly areas, the signal either becomes weak or it will transpire. Henceforth, it becomes very difficult to find the faulty location. The LOA is updated in the cloud server and the information is provided to other trains which pass through the fault location. It also provides information to other trains to enable the drivers to reduce their speed to avoid derailment.

1.1 WIRELESS SENSOR NETWORK

A **wireless sensor network** (WSN) is a computer network consisting of spatially distributed autonomous devices using sensors to cooperatively monitor physical or environmental conditions such as temperature, sound, vibration, pressure, motion or pollutants at different locations. The development of wireless sensor networks was originally motivated by military applications such as battlefield surveillance. However, wireless sensor networks are now used in many civilian application areas, including environment and habitat monitoring, healthcare applications, home automation, and traffic control.

In addition to one or more sensors, each node in a sensor network is typically equipped with a radio transceiver or other wireless communications device, a small microcontroller, and an energy source, usually a battery. The size a single sensor node can vary from shoebox-sized nodes down to devices the size of grain of dust. The cost of sensor nodes is similarly variable, ranging from hundreds of dollars to a few cents, depending on the size of the sensor network and the complexity required of individual sensor nodes. Size and cost constraints on sensor nodes result in corresponding constraints on resources such as energy memory computational speed and bandwidth. In computer science, wireless sensor networks are an active research area with numerous workshops and conferences arranged each year.

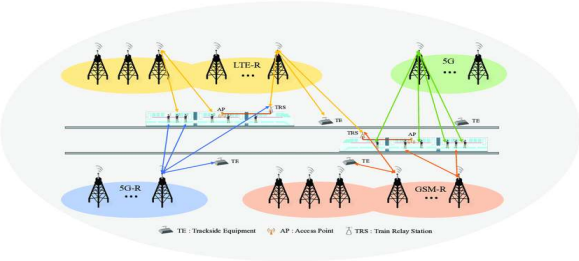


Figure:1.1 Wireless Network

1.2 Applications

The applications for WSNs are many and varied. They are used in commercial and industrial applications to monitor data that would be difficult or expensive to monitor using wired sensors. They could be deployed in wilderness areas, where they would remain for many years (monitoring some environmental variable) without the need to recharge/replace their power supplies. They could form a perimeter about a property and monitor the progression of intruders (passing information from one node to the next). There are a many uses for WSNs.

Typical applications of WSNs include monitoring, tracking, and controlling. Some of the specific applications are habitat monitoring, object tracking, nuclear reactor controlling, fire detection, traffic monitoring, etc. In a typical application, a WSN is scattered in a region where it is meant to collect data through its sensor nodes.

- Environmental monitoring
- Habitat monitoring
- Acoustic detection
- Seismic Detection
- Military surveillance
- Inventory tracking
- Medical monitoring
- Smart spaces
- Process Monitoring

Area monitoring is a typical application of WSNs. In area monitoring, the WSN is deployed over a region where some phenomenon is to be monitored. As an example, a large quantity of sensor nodes could be deployed over a battlefield to detect enemy intrusion instead of using landmines. When the sensors detect the event being monitored (heat, pressure, sound, light, electro-magnetic field, vibration, etc.),

the event needs to be reported to one of the base stations, which can take appropriate action (e.g., send a message on the internet or to a satellite). Depending on the exact application, different objective functions will require different data-propagation strategies, depending on things such as need for real-time response, redundancy of the data (which can be tackled via data aggregation techniques), need for security, etc.

Unique characteristics of a WSN are:

- Small-scale sensor nodes
- Limited power they can harvest or store
- Harsh environmental conditions
- Node failures
- Mobility of nodes
- Dynamic network topology
- Communication failures
- Heterogeneity of nodes
- Large scale of deployment
- Unattended operation

Sensor nodes can be imagined as small computers, extremely basic in terms of their interfaces and their components. They usually consist of a processing unit with limited computational power and limited memory, sensors (including specific conditioning circuitry), a communication device (usually radio transceivers or alternatively optical), and a power source usually in the form of a battery. Other possible inclusions are energy harvesting modules, secondary ASICs, and possibly secondary communication devices (e.g. RS232 or USB).

CHAPTER 2

LITERATURE SURVEY

2.1.Implementation of Railway Track Crack Detection and Protection

Authors: N.Karthick, R.Nagarajan, S.Suresh and R. Prabhu, International Journal of Engineering And Computer Science, Volume 6
Year: 2017

In this world people uses various types of transportation system to travel from one place to another place. Mostly they give importance to public transportation for safer journey. At the same time the transport departments check out the safety measures implemented in them. The proposed system is suitable for railways transportation to identify the cracks in the railway tracks earlier and prevent the accidents. In this paper to use crack detection sensor, this will be placed in the train engine. By this, if some crack is detected on the track the train starts to slow and stop at respective point automatically and exact place of crack would be given to control room. Secondly the next cause of accidents is prevented from two trains opposite in same track by using the same sensors fitted in the engine, if the sensor senses the same signal from opposite train, then it automatically applies the brake and stops the train at certain distance. The derailment causes several losses in railway accidents. The proposed system introduces Bluetooth based technology, to prevent the trains accident. The Bluetooth device is installed at each front end of the locomotive. If the train starts to derail, automatically signal is braked and an alert is given to engine driver and on the other emergency brake is applied automatically. The main aim of the work is to avoid the train accidents without manual power.

2.2. Railway Crack Detection System

Author: Akhil N., Dinu Mohan, Fayis P., SijaGopinath, International Research Journal of Engineering and Technology, Vol. 3
Year: 2016

In this paper, we have established into use and operation of the integration of ultrasonic crack detection method and complete station for eternal railway track geometry surveying system. This system comprises of GPS module, GSM modem, IR sensor, PIR sensor to bring into operation the crack detection, communication purpose and identification of any living being crossing the railway track. The GPS module and GSM modem contribute in identification and transmission of railway geometric parameter of crack detection to the nearby railway station. This paper also explains the summation of an ultrasonic-based non-destructive testing (NDT) and wireless sensor networks (WSNs) to keep in a continuous record the material without interruption in nobility during run-time. The PIR sensor is executed to keep away manual patrolling and finding of living beings across the tracks. This can operate during the night as well as the daytime. The summation of both the technologies WSN and NDT will form various advanced and trending applications to make wireless material scanning more cost-effective in real-time.

2.3. Railway Tracks Crack Detection Based on the GSM Technique

Author: A. S. Muley, S B. Patil, A.H.Shelar, IRJET
Year: 2017

The Indian Railways has one of the largest railway networks in the wor1d and it provides the most important mode of pub1ic transport in India which is most commonly used and cost-effective long-distance transport system of the country. The main problem about a railway analysis is detection of cracks on track. If these damages are not controlled at early stages, they might lead to a number of derailments resulting in a heavy loss of life and property. In this work we are introducing a project that aims in designing robust railway crack detection scheme (RRCDS) using IR Sensor. This avoids the train accidents by detecting the cracks on railway tracks. The Robotic model is designed with a camera which sends pictures and live videos. And also capable of alerting the authorities in the form of SMS messages along with location by using GPS and GSM modules. The system also includes distance measuring sensor which displays the track deviation distance between the two tracks. This will save several trains in India from unwanted damages from the rail track.

2.4. IR Sensor Based Crack Detection of Railway Track Using GSM & GPS System

Author: P Nikhar, R Pise, Avinash IJRASET

Year: 2017

In India railway is one of the most common means of transport, which is the fourth largest railway community in the world. Even though Indian railways has an outstanding boom, it remains plagued because of some of the major issues like problem in gate crossing, fire accidents and problem in the track which remains unmonitored causing derailment. The tracks contract and expand due to changes in season. Due to these cracks may develop on the track. This proposed system identifies the cracks and the obstacles on the track using sensors and inform the control room through an SMS using GSM and GPS module.

CHAPTER 3

EXISTING SYSTEM

INTRODUCTION

In the existing system for detecting cracks on railway tracks, several techniques are employed, including visual inspection, video transmission, and Magnetic field methods. These methods aim to identify potential flaws in the tracks, but they come with their own set of challenges. Physical checking, for instance, involves manual scanning of components, which is not only time-consuming but also prone to human error.

In many instances, particularly in India, continuous monitoring of tracks is conducted using cameras for streaming content. However, this approach often falls short in detecting small cracks and proves to be costly. Similarly, the eddy current method, where current passes through the track to identify flaws, often yields inaccurate results, further complicating the detection process.

One of the overarching issues with these techniques is their heavy reliance on processing power, coupled with extended periods of time required for analysis. Consequently, the speed of detection by these systems is significantly hampered, leading to inefficiencies and discomfort in the overall railway maintenance process. Manual surveying of railway tracks presents numerous challenges, particularly in tunnels where interruptions are frequent due to the presence of human beings, animals, and objects on the track. Operating in such environments requires meticulous attention to safety protocols and constant vigilance to prevent accidents or disruptions to train services.

The manual surveying process involves physically inspecting the tracks for defects, which can be time-consuming and labor-intensive. Additionally, the confined spaces and low visibility within tunnels further complicate the task, increasing the risk of oversight or error. Despite these challenges, ensuring the integrity of railway tracks through thorough manual surveying remains essential for maintaining the safety and reliability of rail transportation systems.

3.1 DISADVANTGES

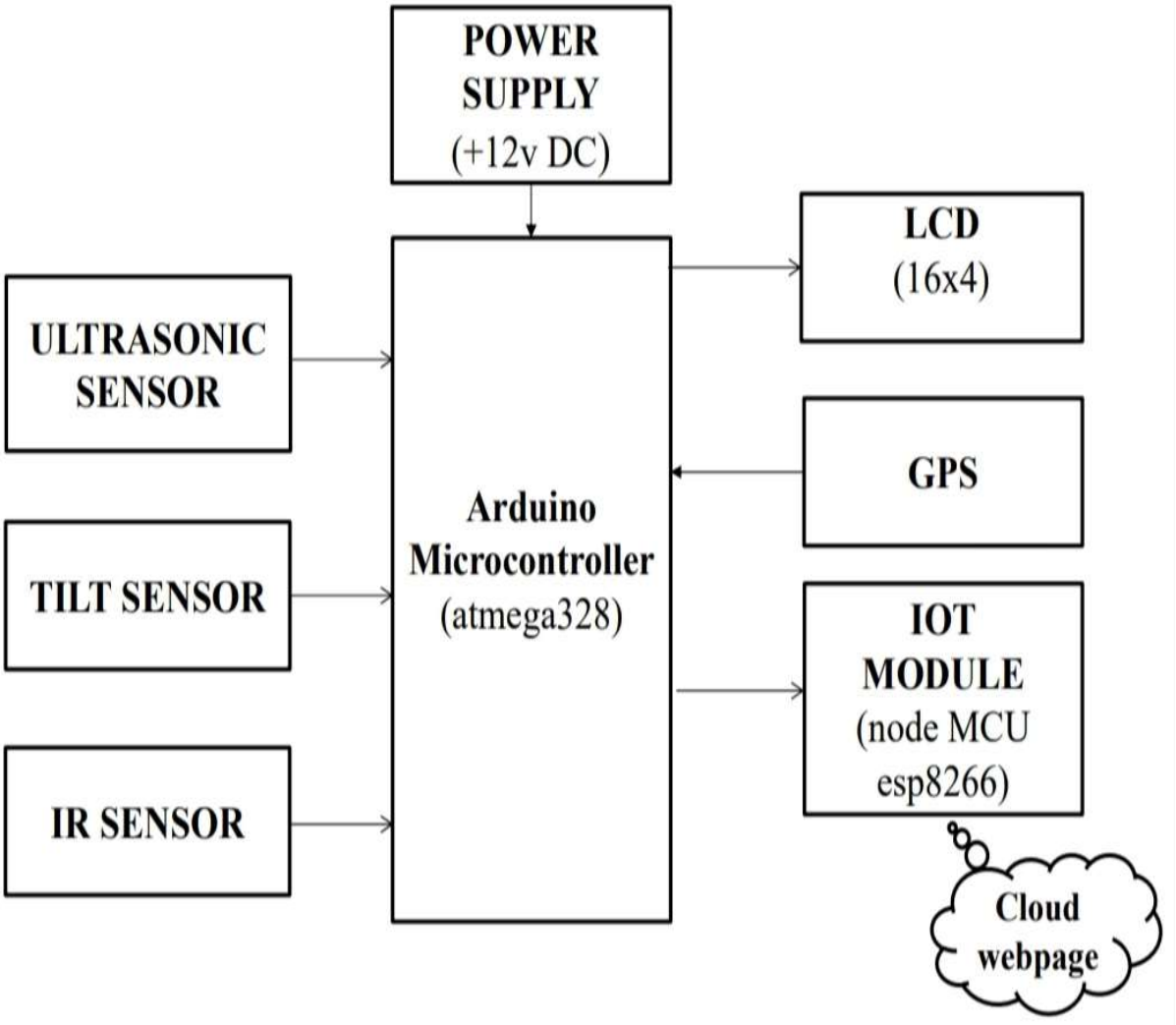
- The current system may suffer from delays in detecting track cracks or objects obstructing the railway, potentially leading to safety hazards and operational disruptions.
- Implementing and maintaining the IoT-based system with sensors and cameras along the railway track can incur significant upfront and ongoing costs, making it financially burdensome for some railway operators.
- Despite its capabilities, the system may have limitations in accurately identifying the severity and location of track damage or obstructions, leading to potential inefficiencies in response efforts.
- Meeting regulatory requirements for railway safety standards and data privacy adds another layer of complexity to the implementation and operation of the IoT-based monitoring system. Non-compliance could result in penalties or legal liabilities for railway operators.

CHAPTER 4

PROPOSED SYSTEM

The proposed system surpassed the existing system limitations used to identify defective railroad tracks. To use Arduino UNO board in this proposed system. Arduino is an integrated open-source development environment, which simplifies coding considerably. The system proposed is consisting of an ultrasonic sensor designed to detect cracks and IR and Ultrasonic sensors used to detect obstacles. This section discusses the IoT-RMS that helps to avoid train derailment. Different types of sensors such as speed and acceleration sensors are used locate anomalies. The sensors are mounted in the passenger or goods railcars and integrated with the IoT cloud for storage and processing. Accelerometers have been installed in the vertical and lateral direction of the axle-box. When any abnormality is detected, the controller sends details of the abnormality with location information to Open GPS (open-source GPS tracking system). The Arduino controller is primarily used for controlling the sensor outputs and is used for the transmission of information through IOT module, the purpose of which is to send the signal to the base station whenever a crack or obstacle is detected via an SMS. Using the GPS module, the exact latitude and longitudinal direction of the faulty track is obtained. In this device subtle cracks that are not visible to the naked eye can also be observed. The proposed system is therefore productive and minable. IoT based railway track monitoring systems present in the trains are connected to the cloud server. The controller of the track monitoring system performs various operations namely abnormal location identification, updating of the cloud server.

4.1 BLOCK DIAGRAM



4.2 ADVANTAGES

- By utilizing Arduino UNO board and a combination of ultrasonic, IR, speed, and acceleration sensors, the proposed system surpasses limitations of the existing system in detecting defective railroad tracks and obstacles on the railway.
- The system is equipped with an IoT module for transmitting real-time information to a base station via SMS whenever a crack or obstacle is detected, facilitating prompt response and intervention to ensure uninterrupted railway operations.
- Through the integration of GPS modules, the system can accurately determine the exact latitude and longitude of the faulty track, enabling swift and targeted maintenance efforts to address identified issues.
- With its advanced monitoring capabilities and real-time alert system, the proposed system enhances productivity by minimizing operational disruptions due to track defects or obstacles, while simultaneously improving safety for passengers and goods transported on the railway network.
- The inclusion of various sensors enables comprehensive monitoring of railway tracks, allowing for the detection of subtle cracks and obstacles that may not be visible to the naked eye, thereby enhancing safety and preventing potential accidents.

CHAPTER 5

HARDWARE DESCRIPTION

5.1 ARDUINO UNO

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 is used to write and upload the computer code to the physical board.

Arduino provides a standard form factor that breaks the functions of the micro-controller into a more accessible package

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 is used 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 LED on/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 micro-controller into a more accessible package.

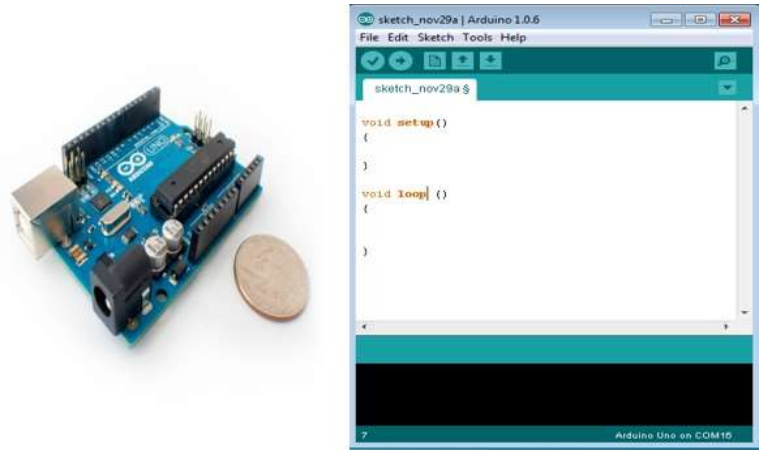


Figure 5.1. Arduino UNO

5.1.1 Board Type

Various kinds of Arduino boards are available depending on different microcontrollers used. However, all Arduino boards have one thing in common: they are programmed through the Arduino IDE. The differences are based on the number of inputs and outputs (the number of sensors, LEDs, and buttons you can use on a single board), speed, operating voltage, form factor etc. Some boards are designed to be embedded and have no programming interface (hardware), which you would need to buy separately. Some can run directly from a 3.7V battery, others need at least 5V. Here is a list of different Arduino boards available.

Types of Arduino boards,

1. Arduino UNO (ATMEGA328)
2. Arduino Leonardo (ATMEGA32U4)
3. Arduino mega (ATMEGA2560)

5.1.1.1 Arduino boards based on ATMEGA328 microcontroller

Board Name	Operating Volt	Clock Speed	Digital I/O	Analog Input	PWM	UART	Programming Interface
Arduino Uno R3	5V	16Mhz	14	6	6	1	USB via ATMega16U2
Arduino Uno R3 SMD	5V	16Mhz	14	6	6	1	USB via ATMega16U2
Red Board	5V	16Mhz	14	6	6	1	USB via FTDI
Arduino pro 3.3v/8Mhz	3.3V	8Mhz	14	6	6	1	FTDI-Compatible header
Arduino Mini-05	5V	16Mhz	14	8	6	1	FTDI-Compatible header
Arduino Pro mini 3.3v/8mhz	3.3V	8Mhz	14	8	6	1	FTDI-Compatible header
Arduino Pro mini 5v/16mhz	5V	16Mhz	14	8	6	1	FTDI-Compatible header
Arduino Ethernet	5V	16Mhz	14	6	6	1	FTDI-Compatible header
Lilypad Arduino 328 main Board	3.3V	8Mhz	14	6	6	1	FTDI-Compatible header
Lilypad Arduino simple board	3.3V	8Mhz	9	4	5	1	FTDI-Compatible header
Arduino FIO	3.3V	8Mhz	14	8	6	1	FTDI-Compatible header

Table No 5.1.1.2 ATMEGA328 microcontroller

5.1.1.2 Arduino boards based on ATMEGA32u4 microcontroller

Board Name	Operating Volt	Clock Speed	Digital I/O	Analog Input	PWM	UART	Programming Interface
Arduino Leonardo	5V	16Mhz	20	12	7	1	Native USB
Pro micro 5v/16Mhz	5V	16Mhz	14	6	6	1	Native USB
Pro micro 3.3v/8Mhz	5V	16Mhz	14	6	6	1	Native USB
LilyPad Arduino USB	3.3V	8Mhz	14	6	6	1	Native USB

Table No 5.1.1.2 ATMEGA32u4 microcontroller

5.1.1.3 Arduino boards based on ATMEGA2560 microcontroller

Board Name	Operating Volt	Clock Speed	Digital I/O	Analog Input	PWM	UART	Programming Interface
Arduino Mega 2560 R3	5V	16Mhz	54	16	14	4	USB Via ATMega16U2B
Mega Pro 3.3v	3.3V	8Mhz	54	16	14	4	FTDI-Compatible header
Mega Pro 5v	5V	16Mhz	54	16	14	4	FTDI-Compatible header
Mega Pro mini 3.3v	3.3V	8Mhz	54	16	14	4	FTDI-Compatible header

Table No 5.1.1.3 ATMEGA2560 microcontroller

5.1.2 Arduino - Board Description

In this chapter, we will learn about the different components on the Arduino board. We will study the Arduino UNO board because it is the most popular board in the Arduino board family. In addition, it is the best board to get started with electronics and coding. Some boards look a bit different from the one given below, but most Arduinos have majority of these components in common.

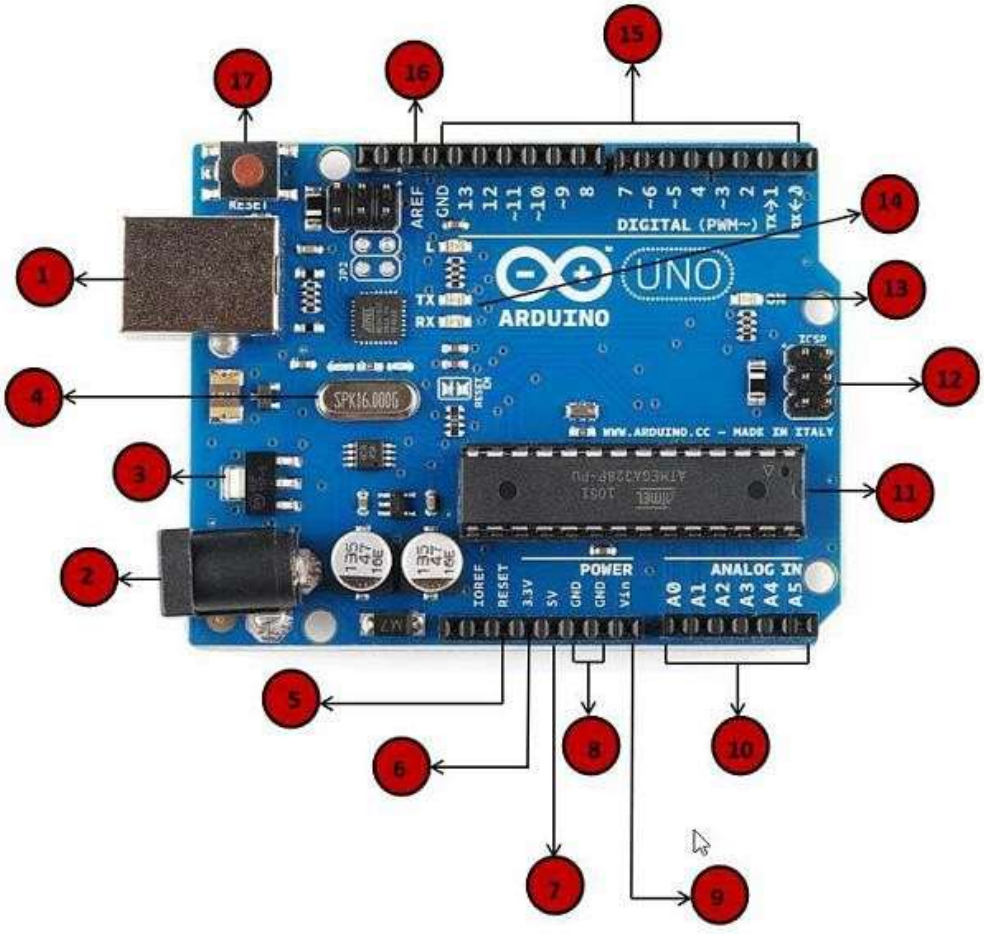


Figure 5.1.2 Arduino - Board Description

1	**Power USB** Arduino board can be powered by using the USB cable from your computer. All you need to do is connect the USB cable to the USB connection (1).
2	**Power (Barrel Jack)** Arduino boards can be powered directly from the AC mainspower supply by connecting it to the Barrel Jack (2).
3	**Voltage Regulator** The function of the voltage regulator is to control the voltage given to the Arduino board and stabilize the DC voltages used bythe processor and other elements.
4	**Crystal Oscillator** The crystal oscillator helps Arduino in dealing with time issues by using the crystal oscillator. The number printed on top of the Arduino crystal is 16.000H9H. It tells us that the frequency is 16,000,000 Hertz or 16 MHz
5,17	**Arduino Reset** You can reset your Arduino board, i.e., start your program from the beginning. You can reset the UNO board in two ways. First, by using the reset button (17) on the board. Second, you can connect an external reset button to the Arduino pin labelled RESET (5).
6-7	**Pins (3.3, 5, GND, Vin)** ➢ 3.3V (6) − Supply 3.3 output volt ➢ 5V (7) − Supply 5 output volt ➢ Most of the components used with Arduino board works fine

8-9	➢ **GND** (8) (Ground) − There are several GND pins on the Arduino, any of which can be used to ground your circuit. ➢ **Vin** (9) − This pin also can be used to power the Arduino board from an external power source, like AC mains powersupply.
10	**Analog pins** The Arduino UNO board has five analog input pins A0 through A5. These pins can read the signal from an analog sensor like thehumidity sensor or temperature sensor and convert it into a digitalvalue that can be read by the microprocessor.
11	**Main microcontroller** Each Arduino board has its own microcontroller. You can assume it as the brain of your board. The main IC (integrated circuit) on the Arduino is slightly different from board to board. The microcontrollers are usually of the ATMEL Company. Youmust know what IC your board has before loading up a new program from the Arduino IDE. This information is available onthe top of the IC. For more details about the IC construction andfunctions, you can refer to the data sheet.
12	**ICSP pin** Mostly, ICSP (12) is an AVR, a tiny programming header for the Arduino consisting of MOSI, MISO, SCK, RESET, VCC, and GND. It is often referred to as an SPI (Serial Peripheral Interface), which could be considered as an "expansion" of the output. Actually, you are slaving the output device to the masterof the SPI bus.

13	**Power LED indicator** This LED should light up when you plug your Arduino into a power source to indicate that your board is powered up correctly.If this light does not turn on, then there is something wrong withthe connection.
14	**TX and RX LEDs** On your board, you will find two labels: TX (transmit) and RX (receive). They appear in two places on the Arduino UNO board.First, at the digital pins 0 and 1, to indicate the pins responsible for serial communication. Second, the TX and RX led (13). The TX led flashes with different speed while sending the serial data.The speed of flashing depends on the baud rate used by the board.RX flashes during the receiving process.
15	**Digital I/O** The Arduino UNO board has 14 digital I/O pins (15) (of which 6provide PWM (Pulse Width Modulation) output. These pins canbe configured to work as input digital pins to read logic values (0or 1) or as digital output pins to drive different modules like LEDs, relays, etc. The pins labelled "~" can be used to generatePWM.
16	**AREF** AREF stands for Analog Reference. It is sometimes, used to set an external reference voltage (between 0 and 5 Volts) as the upperlimit for the analog input pins.

Table No 5.1.2 Arduino - Board Description

5.2 POWER SUPPLY

The Arduino Uno can be powered via the USB connection or with an external power supply. The power source is selected automatically. External (non-USB) power can come either from an AC-to-DC adapter (wall-wart) or battery. The adapter can be connected by plugging a 2.1mm center-positive plug into the board's power jack. Leads from a battery can be inserted in the Ground and Vin pin headers of the power connector.

The board can operate on an external supply of 6 to 20 volts. If supplied with less than 7V however, the 5V pin may supply less than five volts and the board may be unstable. If using more than 12V, the voltage regulator may over heat and damage the board. The recommended range is 7 to 12 volts. The power pins are as follows,

The ac voltage typically 220V rms, is connected to a transformer, which steps that ac voltage down to the level of the desired dc output. A diode rectifier then provides a full-wave rectified voltage that is initially filtered by a simple capacitor filter to produce a dc voltage. This resulting dc voltage usually has some ripple or ac voltage variation.

A regulator circuit removes the ripples and also remains the same dc value even if the input dc voltage varies, or the load connected to the output dc voltage changes. This voltage regulation is usually obtained using one of the popular voltage regulator IC units.

5.2.1 Working Principle

Transformer: The potential transformer will step down the power supply voltage (0-230V) to (0-6V) level. Then the secondary of the potential transformer will be connected to the precision rectifier, which is constructed with the help of op–amp. The advantages of using precision rectifier are it will give peak voltage output as DC; rest of the circuits will give only RMS output.

Bridge rectifier: When four diodes are connected as shown in figure, the circuit is called as bridge rectifier. The input to the circuit is applied to the diagonally opposite corners of the network, and the output is taken from the remaining two corners. Let us assume that the transformer is working properly and there is a positive potential, at point A and a negative potential at point B. the positive potential at point A will forward bias D3 and reverse bias D4.

The negative potential at point B will forward bias D1 and reverse D2. At this time D3 and D1 are forward biased and will allow current flow to pass through them; D4 and D2 are reverse biased and will block current flow. The path for current flow is from point B through D1, up through RL, through D3, through the secondary of the transformer back to point B. this path is indicated by the solid arrows. Waveforms (1) and (2) can be observed across D1 and D3.

One-half cycle later the polarity across the secondary of the transformer reverse, forward biasing D2 and D4 and reverse biasing D1 and D3. Current flow will now be from point A through D4, up through RL, through D2, through the secondary of T1, and back to point A. This path is indicated by the broken arrows. Waveforms (3) and (4) can be observed across D2 and D4. The current flow through RL is always in the same direction. In flowing through RL this current develops a voltage corresponding to that shown waveform (5). Since current flows through the load (RL) during both half cycles of the applied voltage, this bridge rectifier is a full-wave rectifier.

One advantage of a bridge rectifier over a conventional full-wave rectifier is that with a given transformer the bridge rectifier produces a voltage output that is nearly twice that of the conventional full-wave circuit.

This may be shown by assigning values to some of the components shown in views A and B. assume that the same transformer is used in both circuits.

The peak voltage developed between points X and y is 1000 volts in both circuits. In the conventional full-wave circuit shown—in view A, the peak voltage from the center tap to either X or Y is 500 volts.

Since only one diode can conduct at any instant, the maximum voltage that can be rectified at any instant is 500 volts.

The maximum voltage that appears across the load resistor is nearly-but never exceeds-500 volts, as result of the small voltage drop across the diode. In the bridge rectifier shown in view B, the maximum voltage that can be rectified is the full secondary voltage, which is 1000 volts. Therefore, the peak output voltage across the load resistor is nearly 1000 volts. With both circuits using the same transformer, the bridge rectifier circuit produces a higher output voltage than the conventional full-wave rectifier circuit.

VIN - The input voltage to the Arduino board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin supplying voltage via the power jack, access it through this pin.

5V.- The regulated power supply used to power the microcontroller and other components on the board. This can come either from VIN via an on-board regulator, or be supplied by USB or another regulated 5V supply.

3.3V - A 3.3-volt supply generated by the on-board regulator. Maximum current draw is 50 mA.

GND. Ground pins

5.2.2 Arduino Uno SMD R3

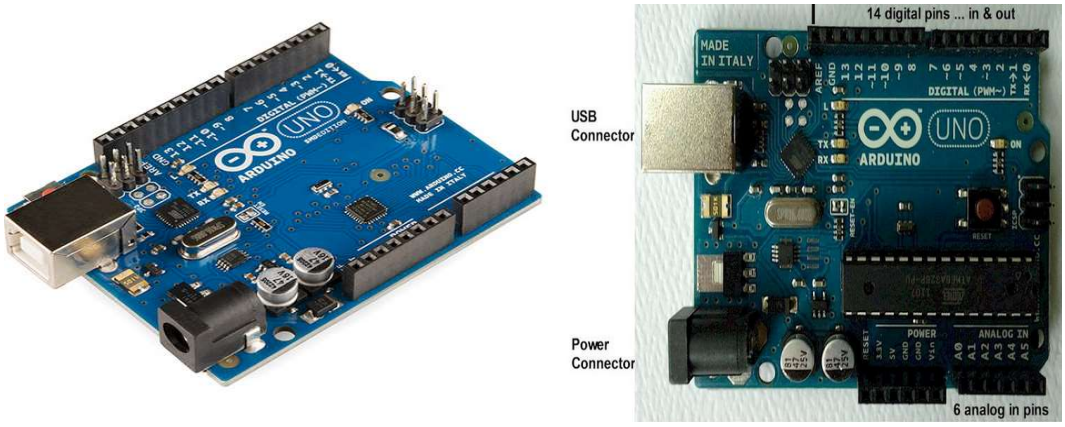


Figure 5.2.2 Arduino Uno SMD R3

Arduino is a computer hardware and software company, project, and user community that designs and manufactures microcontroller kits for building digital devices and interactive objects that can sense and control objects in the physical world. The project's products are distributed as open-source hardware and software, which are licensed under the GNU Lesser General Public License (LGPL) or the GNU General Public License (GPL), permitting the manufacture of Arduino boards and software distribution by anyone. Arduino boards are available commercially in preassembled form, or as do-it-yourself kits.

The project's board designs use a variety of microprocessors and controllers. These systems provide sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards ("shields") and other circuits. The boards feature serial communications interfaces, including Universal Serial Bus (USB) on some models, for loading programs from personal computers. The microcontrollers are mainly programmed using a dialect of features from the programming languages C and C++. In addition to using traditional compiler tool chains, the Arduino project provides an integrated development environment (IDE) based on the Processing language project.

The Arduino project started in 2005 as a program for students at the Interaction Design Institute Ivrea in Ivrea, Italy, aiming to provide a low-cost and easy way for novice and professionals to create devices that interact with their environment using sensors and actuators. Common examples of such devices intended for beginner hobbyist include simple robots, thermostats, and motion detectors.

5.3 Ultrasonic Sensor

Figure 5.3 Ultrasonic Sensor

Ultrasonic sensors (also known as transceivers when they both send and receive) work on a principle similar to radar or sonar which evaluate attributes of a target by interpreting the echoes from radio or sound waves respectively. Ultrasonic sensors generate high frequency sound waves and evaluate the echo which is received back by the sensor. Sensors calculate the time interval between sending the signal and receiving the echo to determine the distance to an object.

This technology can be used for measuring the wind speed and direction (anemometer), fullness of a tank and speed through air or water. For measuring speed or direction a device uses multiple detectors and calculates the speed from the relative distances to particulates in the air or water.

To measure the amount of liquid in a tank the sensor measures the distance to the surface of the fluid. Further applications include humidifiers, sonar, medical ultrasonography, burglar alarms and non-destructive testing.

Systems typically use a transducer which generates sound waves in the ultrasonic range above 18000 hertz by turning electrical energy into sound then upon receiving the echo turn the sound waves into electrical energy which can be measured and displayed.

The technology is limited by the shapes of surfaces and the density or consistency of the material. For example, foam on the surface of a fluid in a tank could distort a reading.

An ultrasonic transducer is a device that converts energy into ultrasound or sound waves above the normal range of human hearing. While technically a dog whistle is an ultrasonic transducer that converts mechanical energy in the form of air pressure into ultrasonic sound waves the term is more apt to be used to refer to piezoelectric transducers that convert electrical energy into sound. Piezoelectric crystals have the property of changing size when a voltage is applied thus applying an alternating current (AC) across them causes them to oscillate at very high frequencies, thus producing very high frequency sound waves.

ultrasonic sensor provides a very low-cost and easy method of distance measurement. This sensor is perfect for any number of applications that require you to perform measurements between moving or stationary objects. Naturally, robotics applications are very popular but you'll also find this product to be useful in security systems or as an infrared replacement if so desired. You will definitely appreciate the activity status LED and the economic use of just one I/O pin.

5.3.1 Features

- Provides precise, non-contact distance measurements within a 2 cm to 3 m range.
- Simple pulse in/pulse out communication.
- Burst indicator LED shows measurement in progress.

- 20 mA power consumption.
- Narrow acceptance angle.
- 3-pin header makes it easy to connect using a servo extension cable, no soldering required.

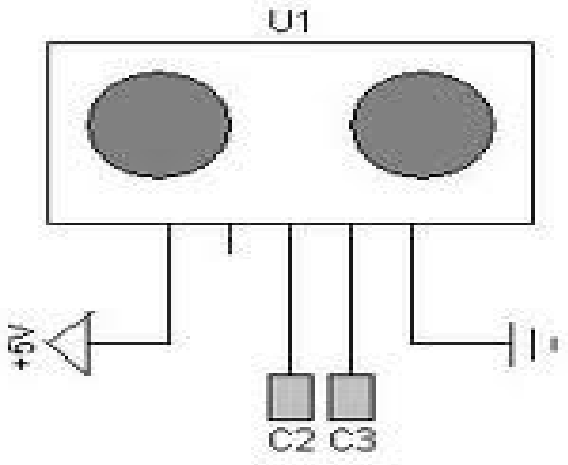


Figure 5.3.1 Ultrasonic Transducer Circuit Diagram

5.4 Infrared Sensor

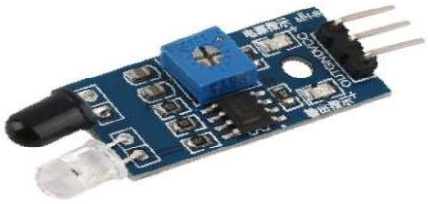


Figure 5.4 Infrared Sensor

An infrared sensor is an electronic device that emits and/or detects infrared radiation in order to sense some aspect of its surroundings. Infrared sensors can measure the heat of an object as well as detect motion. Many of these types of sensors only measure infrared radiation rather than emitting it and thus are known as passive infrared (PIR) sensors.

All objects emit some form of thermal radiation usually in the infrared spectrum. This radiation is invisible to our eyes, but can be detected by an infrared sensor that accepts and interprets it. In a typical infrared sensor like a motion detector, radiation enters the front and reaches the sensor itself at the canter of the device. This part may be composed of more than one individual sensor each of them being made from pyroelectric materials, whether natural or artificial. These are materials that generate an electrical voltage when heated or cooled.

These pyroelectric materials are integrated into a small circuit board. They are wired in such a way so that when the sensor detects an increase in the heat of a small part of its field of view, it will trigger the motion detector's alarm. It is very common for an infrared sensor to be integrated into motion detectors like those used as part of a residential or commercial security system.

Emissivity:

Emissivity is the measurement of energy-emitting characteristics of different materials or surfaces. An object's emitted or produced IR energy decreases or increases in proportion to its temperature. IR sensors use adjustable emissivity settings that enable them to obtain temperature measurements of different surface types.

Detection:

Detection An object's emitted energy reaches the IR sensor via the device's optic system, which in turn focuses the energy onto its photosensitive detectors. The detectors convert the IR energy into an electrical signal, which then is converted into a temperature value based on the object's emissivity. This value may be displayed on the IR sensor or converted as digital input and sent to a computer terminal for display.

5.5 TILT Sensor

Figure 5.5 TILT Sensor

A tilt sensor often referred to as an inclinometer is a device designed to detect and measure the tilt or inclination of an object relative to the Earth's gravity. Utilizing various technologies such as mercury switches, electrolytic, capacitive or MEMS sensors, tilt sensors provide precise angle measurements that are vital in numerous applications.

From adjusting screen orientation in smartphones to ensuring stability in vehicles through systems like electronic stability control tilt sensors play crucial roles in modern electronics and automotive industries.

Additionally, they find extensive use in construction, aerospace, industrial machinery, and other fields where monitoring tilt angles is essential for safety, control, and efficiency. By accurately detecting and measuring tilt these sensors contribute significantly to the reliability and performance of diverse systems and equipment.

Emissivity:

Emissivity is a property of a material that describes its ability to emit thermal radiation. It is a measure of how efficiently an object emits infrared radiation compared to a perfect black body radiator at the same temperature. Emissivity values range from 0 to 1, with a value of 1 indicating a perfect emitter (a black body) and lower values indicating less efficient emitters.

Detection:

Detection is a critical process in various domains, involving the identification of specific targets or phenomena within a given context. It employs sensors, instruments or observation techniques to recognize the presence, location, quantity or attributes of the target. From security and surveillance systems to environmental monitoring tools detection serves diverse purposes. In medical diagnostics, it aids in disease identification while in industrial processes, it ensures quality control. Scientific research heavily relies on detection to observe natural phenomena and particles advancing our knowledge. Additionally, detection plays a crucial role in emergency response by providing early warnings and facilitating effective disaster management.

5.6 Node MCU

The Node MCU (**N**ode **M**icro**c**ontroller **U**nit) is an open-source software and hardware development environment built around an inexpensive System-on-a-Chip (SoC) called the ESP8266. The ESP8266, designed and manufactured by Express if Systems, contains the crucial elements of a computer CPU, RAM, networking (Wi-fi), and even a modern operating system and SDK. That makes it an excellent choice for the Internet of Things (IoT) projects of all kinds.

However, as a chip the ESP8266 is also hard to access and use. You must solder wires, with the appropriate analog voltage, to its pins for the simplest tasks such as powering it on or sending a keystroke to the computer on the chip. You also have to program it in low-level machine instructions that can be interpreted by the chip hardware. This level of integration is not a problem using the ESP8266 as an embedded controller chip in mass-produced electronics. It is a huge burden for hobbyists, hackers or students who want to experiment with it in their own IoT projects.

But, what about Arduino? The Arduino project created an open-source hardware design and software SDK for their versatile IoT controller. Similar to NodeMCU, the Arduino hardware is a microcontroller board with a USB connector, LED lights and standard data pins. It also defines standard interfaces to interact with sensors or other boards. But unlike NodeMCU, the Arduino board can have different types of CPU chips (typically an ARM or Intel x86 chip). with memory chips and a variety of programming environments. There is an Arduino reference design for the ESP8266 chip as well. However, the flexibility of Arduino also means significant variations across different vendors. For example, most Arduino boards do not have Wi-fi capabilities and some even have a serial data port instead of a USB port.

5.6.1 USB to Serial Converter - CP2102 or CH340G

Incorporated into each NodeMCU is a USB to Serial Converter. The official design is based on the CP2102 chipset and offers the best compatibility. Genuine boards use the CP2102 chipset including the officially licensed Amica NodeMCU modules. The other common USB to Serial Converter used is the CH340G which is common.

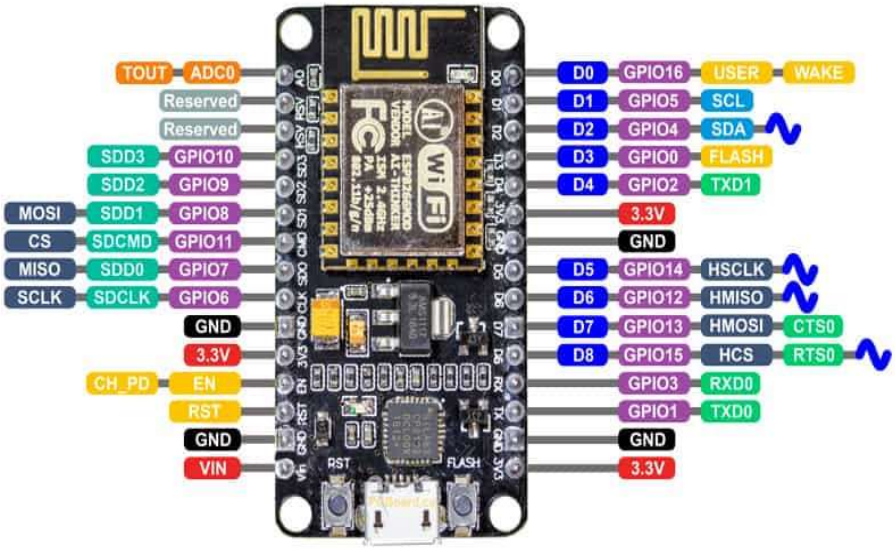


Figure 5.6.1 Node MCU

POWER PINS There are four power pins. **VIN** pin and three **3.3V** pins.

- **VIN** can be used to directly supply the NodeMCU/ESP8266 and its peripherals. Power delivered on **VIN** is regulated through the onboard regulator on the NodeMCU module you can also supply 5V regulated to the **VIN** pin
- **3.3V** pins are the output of the onboard voltage regulator and can be used to supply power to external components.

GND PINS are ground pins of NodeMCU/ESP8266.

12C Pins are used to connect I2C sensors and peripherals. 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 NodeMCU/ESP8266 has 17 GPIO pins which can be assigned to 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. When configured as an input, it can also be set to edge-trigger or level-trigger to generate CPU interrupts.

ADC Channel the Node MCU is embedded with a 10-bit precision SAR ADC. The two functions can be implemented using ADC. Testing power supply voltage of VDD3P3 pin and testing input voltage of TOUT pin. However, they cannot be implemented at the same time.

UART Pins NodeMCU/ESP8266 has 2 UART interfaces (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.

However, UART1 (TXD1 pin) features only data transmit signal so, it is usually used for printing log.

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

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

SDIO Pins NodeMCU/ESP8266 features Secure Digital Input/Output Interface (SDIO) which is used to directly interface SD cards. 4-bit 25 MHz SDIO v1.1 and 4-bit 50 MHz SDIO v2.0 are supported.

PWM PINS The board has 4 channels of Pulse Width Modulation (PWM). The PWM output can be implemented programmatically and used for driving digital motors and LEDs. PWM frequency range is adjustable from 1000µs to 10000µs (100 Hz and 1 kHz).

CONTROL PINS are used to control the NodeMCU/ESP8266. These pins include Chip Enable pin (EN), Reset pin (RST) and WAKE pin.

- **EN:** The ESP8266 chip is enabled when EN pin is pulled HIGH. When pulled LOW the chip works at minimum power.
- **RST:** RST pin is used to reset the ESP8266 chip.
- **WAKE:** Wake pin is used to wake the chip from deep-sleep.

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- **WAKE:** Wake pin is used to wake the chip from deep-sleep.

Depending on the Operating System you are using with the NodeMCU, the appropriate driver must be installed. Generally, Windows 10 immediately recognizes the CP2102 chipset while the CH340G may require separate installation. Drivers for the CP2102 are available for download from the Silicon Labs support site. Drivers constantly evolve and ensuring and installing the most recent version in your development environment minimum issues. Drivers are available for Windows, Mac, Linux, and Android. We also have a local copy of the CP2102 drivers (v10.1.8) available locally for download. You always best to visit the original manufacturer to ensure you are receiving the most recent versions of the drive.

Figure 5.6.2 WCH CH340G chipset

WCH maintain and update the drivers for the CH340G on a regular basis. Versions of the driver are also available for Windows, Mac, Linux, and Android. Visit their Driver Download page. We also have a local copy of the CH340G drivers (version 3.5) available locally for download. You are always best to visit the original manufacturer to ensure you are receiving the most recent versions of the driver.

5.7 GPS

Figure 5.7 Global Positioning System (GPS)

The Global Positioning System (GPS) is a space-based satellite navigation system that provides location and time information in all weather conditions, anywhere on or near the Earth where there is an unobstructed line of sight to four or more GPS satellites. The system provides critical capabilities to military, civil and commercial users around the world. It is maintained by the United States government and is freely accessible to anyone with a GPS receiver.

The GPS project was developed in 1973 to overcome the limitations of previous navigation systems, integrating ideas from several predecessors, including a number of classified engineering design studies from the 1960s. GPS was created and realized by the U.S. Department of Defence (DoD) and was originally run with 24 satellites. It became fully operational in 1994. Roger L. Easton is generally credited as its inventor.

Advances in technology and new demands on the existing system have now led to efforts to modernize the GPS system and implement the next generation of GPS III satellites and Next Generation Operational Control System (OCX). Announcements from the Vice President and the White House in 1998 initiated these changes. In 2000, U.S. Congress authorized the modernization effort, referred to as GPS III.

In addition to GPS, other systems are in use or under development. The Russian Global Navigation Satellite System (GLONASS) was developed contemporaneously with GPS, but suffered from incomplete coverage of the globe until the mid-2000s. There are also the planned European Union Galileo positioning system, Chinese Compass navigation system and Indian Regional Navigational Satellite System.

5.7.1 BASIC OF GPS

A GPS receiver calculates its position by precisely timing the signals sent by GPS satellites high above the Earth. Each satellite continually transmits messages that include

- the time the message was transmitted
- satellite position at time of message transmission

The receiver uses the messages it receives to determine the transit time of each message and computes the distance to each satellite using the speed of light. Each of these distances and satellites' locations define a sphere. The receiver is on the surface of each of these spheres when the distances and the satellites' locations are correct.

These distances and satellites' locations are used to compute the location of the receiver using the navigation equations.

This location is then displayed, perhaps with a moving map display or latitude and longitude elevation information may be included. Many GPS units show derived information such as direction and speed, calculated from position changes.

In typical GPS operation, four or more satellites must be visible to obtain an accurate result. Four sphere surfaces typically do not intersect. Because of this we can say with confidence that when we solve the navigation equations to find an

intersection, this solution gives us the position of the receiver along with accurate time thereby eliminating the need for a very large, expensive and power hungry clock. The very accurately computed time is used only for display or not at all in many GPS applications, which use only the location. A number of applications for GPS do make use of this cheap and highly accurate timing. These include time transfer, traffic signal timing and synchronization of cell phone base stations.

Although four satellites are required for normal operation fewer apply in special cases. If one variable is already known a receiver can determine its position using only three satellites. For example, a ship or aircraft may have known elevation. Some GPS receivers may use additional clues or assumptions such as reusing the last known altitude, dead reckoning, inertial navigation or including information from the vehicle computer to give a (possibly degraded) position when fewer than four satellites are visible.

5.8 LCD display

Figure 5.8 LCD Display

A liquid-crystal display (LCD) is a flat-panel display or other electronically-modulated optical device that uses the light-modulating properties of liquid crystals. Liquid crystals do not emit light directly instead using a backlight or reflector to produce images in color or monochrome. LCDs are available to display arbitrary images (as in a general-purpose computer display) or fixed images with low information content, which can be displayed or hidden such as preset words, digits and 7-segment displays as in a digital clock.

They use the same basic technology except that arbitrary images are made up of a large number of small pixels, while other displays have larger elements. LCDs are used in a wide range of applications including LCD televisions, computer monitors, instrument panels, aircraft cockpit displays and indoor and outdoor signage. Small LCD screens are common in portable consumer devices such as digital cameras, watches, calculators, mobile and telephones, including smartphones. LCD screens are also used on consumer electronics products such as DVD players, video game devices and clocks. LCD screens have replaced heavy bulky cathode ray tube (CRT) displays in nearly all applications. LCD screens are available in a wider range of screen sizes than CRT and plasma displays with LCD screens available in sizes ranging from tiny digital watches to huge big-screen television sets.

Since LCD screens do not use phosphors, they do not suffer image burn-in when a static image is displayed on a screen for a long time (e.g., the table frame for an aircraft schedule on an indoor sign). However, susceptible to image persistence. The LCD screen is more energy-efficient and can be disposed of more safely than a CRT can. Its low electrical power consumption enables it to be used in battery-powered electronic equipment more efficiently than CRTs can be. By 2008, annual sales of televisions with LCD screens exceeded sales of CRT units worldwide and the CRT became obsolete for most purposes.

PC REQUIREMENT

CPU Processor	:	Intel Pentium
Hard Disk	:	40 GB
RAM	:	256 MB
Monitor	:	15VGA Color
Mouse	:	Ball/Optical
Keyboard	:	102 Keys

CHAPTER 6

SOFTWARE REQUIREMENT

Operating System	:	Windows 10
Front End	:	PHP, Proteus, Keil C
Back End	:	My-SQL, Embedded C

6.1 FRONT-END SOFTWARE

6.1.1 PHP (Personal Home Page)

PHP Hypertext Preprocessor (the name is a recursive acronym) is a widely used, general-purpose scripting language that was originally designed for web development to produce dynamic web pages. For this purpose, PHP code is embedded into the HTML source document and interpreted by a web server with a PHP processor module which generates the web page document. As a general-purpose programming language, PHP code is processed by an interpreter application in command-line mode performing desired operating system operations and producing program output on its standard output channel. It may also function as a graphical application. PHP is available as a processor for most modern web servers and as standalone interpreter on most operating systems and computing platforms.

PHP was originally created by Rasmus Lerdorf in 1995 and has been in continuous development ever since. The main implementation of PHP is now produced by The PHP Group and serves as the de facto standard for PHP as there is no formal specification. PHP is free software released under the PHP License which is incompatible with the GNU General Public License (GPL) because restrictions exist regarding the use of the term PHP.

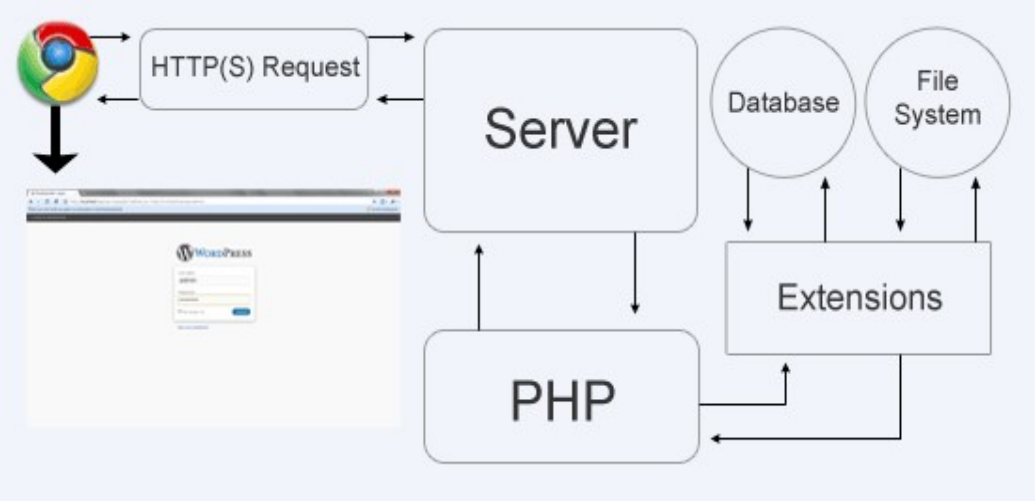


Figure 6.1.1 PROCESS OF PHP

Hypertext refers to files linked together using hyperlinks, such as HTML (Hypertext Markup Language) files. Preprocessing is executing instructions that modify the output. Below is a demonstration of the difference between HTML and PHP files.

Benefit of PHP

Because the server does processing, the output of PHP files changes when its input changes. For example, most of the pages on the Horticulture site have only two PHP commands,

1. Include the header file that defines the links on the left, the banner and the quick links at the top.
2. Include the footer file that displays the mission statement and Horticulture contact information.

Because including the files is performed every time the PHP file is accessed when the header/footer files change the new content will be immediately updated. In other words, if you add a new link every page that includes the header will immediately display the new link.

6.1.2 PROTEUS

Proteus is a widely used software tool primarily for electronic design automation (EDA) and simulation of electronic circuits. It offers a comprehensive suite of tools for designing, testing, and simulating circuits before they are physically implemented.

Proteus stands as an indispensable tool in the realm of electronic design automation, offering a comprehensive suite of features tailored to circuit design and simulation. With its intuitive interface and vast component library users can swiftly craft intricate schematics, paving the way for accurate simulations of electronic circuits. Its simulation engine capable of handling mixed-mode circuits and microcontroller-based systems empowers designers to predict and analyze circuit behavior with precision. Beyond simulation Proteus seamlessly integrates PCB design capabilities facilitating the transition from schematic to board layout. Whether in educational settings or professional environments Proteus serves as a reliable companion for engineers, educators, and enthusiasts.

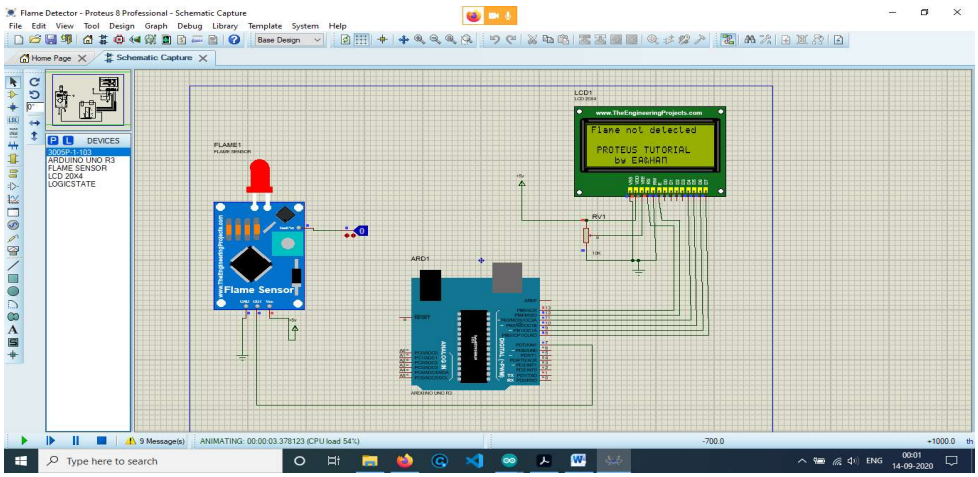


Figure 6.1.2 PROTEUS SOFTWARE

6.1.3 Keil C

Keil C commonly referred to as Keil µ Vision is a widely utilized integrated development environment (IDE) specifically designed for programming microcontrollers particularly those based on ARM architecture. Keil C provides a comprehensive toolset for embedded software development, offering a user-friendly interface coupled with powerful features tailored to the needs of embedded systems designers. At its core Keil C leverages the C programming language enabling developers to write efficient and portable code for microcontroller applications. With its seamless integration of the Keil Compiler developers can compile, debug and optimize their code within a unified environment. Moreover, Keil C supports a wide range of microcontroller families providing extensive device support and peripheral libraries to streamline development across various platforms. Its robust debugging capabilities, including real-time emulation and hardware simulation, empower developers to identify and resolve issues efficiently. Overall Keil C stands as a cornerstone in the embedded systems development landscape, offering a reliable and feature-rich solution for building firmware for microcontroller-based applications.

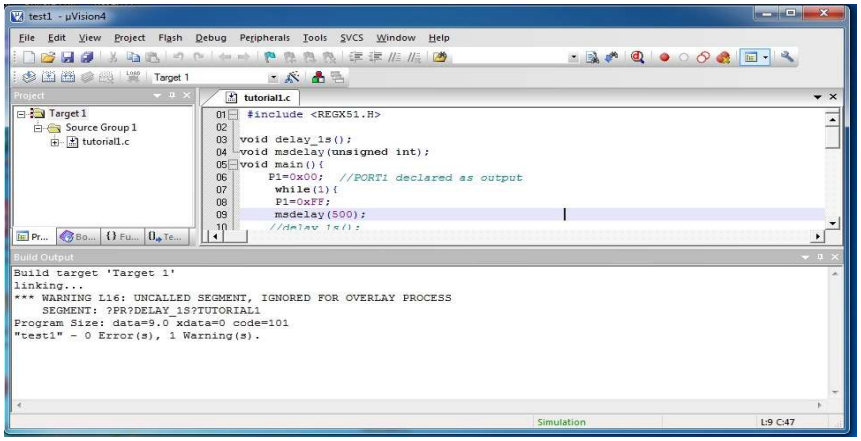


Figure 6.1.3 Keil C

6.2 BACK-END SOFTWARES

6.2.1 MYSQL

Introduction

The MySQL database has become the world's most popular open-source database because of its consistent fast performance, high reliability and ease of use. It's used on every continent Yes, even Antarctica by individual Web developers as well as many of the world's largest and fastest-growing organizations to save time and money powering their high-volume Web sites, business-critical systems and packaged software including industry leaders such as Yahoo!, Alcatel-Lucent, Google, Nokia, YouTube and Zappos.com.

Not only is MySQL the world's most popular open-source database, it's also become the database of choice for a new generation of applications built on the LAMP stack (Linux, Apache, MySQL, PHP / Perl / Python.) MySQL runs on more than 20 platforms including Linux, Windows, Mac OS, Solaris, HP-UX, IBM AIX, giving you the kind of flexibility that puts you in control.

Whether you're new to database technology or an experienced developer or DBA, MySQL offers a comprehensive range of certified software, support, training and consulting to make you successful.

MySQL can be built and installed manually from source code, but this can be tedious so it is more commonly installed from a binary package unless special customizations are required. On most Linux distributions the package management system can download and install MySQL with minimal effort, though further configuration is often required to adjust security and optimization settings.

Though MySQL began as a low-end alternative to more powerful proprietary databases, it has gradually evolved to support higher-scale needs as well. It is still most commonly used in small to medium scale single-server deployments, either as a component in a LAMP based web application or as a standalone database server.

Much of MySQL's appeal originates in its relative simplicity and ease of use, which is enabled by an ecosystem of open-source tools such as phpMyAdmin. In the medium range, MySQL can be scaled by deploying it on more powerful hardware such as a multi-processor server with gigabytes of memory.

There are however limits to how far performance can scale on a single server, so on larger scales, multi-server MySQL deployments are required to provide improved performance and reliability. A typical high-end configuration can include a powerful master database which handles data write operations and is replicated to multiple slaves that handle all read operations. The master server synchronizes continually with its slaves so in the event of failure a slave can be promoted to become the new master minimizing downtime. Further improvements in performance can be achieved by caching the results from database queries in memory using mem ached or breaking down a database into smaller chunks called shards which can be spread across a number of distributed server clusters.

6.2.2 EMBEDDED PROGRAMMING

Embedded systems programming is different from developing applications on a desktop computer. Key characteristics of an embedded system when compared to PCs are as follows. Embedded devices have resource constraints (limited ROM, limited RAM, limited stack space, less processing power) Components used in embedded system and PCs are different embedded systems typically uses smaller, less power consuming components. Embedded systems are more tied to the hardware. Two salient features of Embedded Programming are code speed and code size. Code speed is governed by the processing power, timing constraints, where as code size is governed by available program memory and use of programming language. Goal of embedded system programming is to get maximum features in minimum space and minimum time.

Embedded systems are programmed using different type of languages

- Machine Code
- Low level language, i.e., assembly
- High level language like C, C++, Java, Ada, etc.
- Application-level language like Visual Basic, scripts, Access, etc.

Difference between C and embedded C

Through C and embedded C appear different and They are used in different contexts, they have more similarities than the differences. Most of the constructs are same the difference lies in their applications.

C is used for desktop computers, while embedded C is for microcontroller-based applications. Accordingly, C has the luxury to use resources of a desktop PC like memory, OS, etc. While programming on desktop systems, we need not bother about memory. However, embedded C has to use with the limited resources (RAM, ROM, I/O's) on an embedded processor. Thus, program code must fit into the available program memory. If code exceeds the limit, the system is likely to crash.

Embedded systems often do not have a console, which is available in case of desktop applications. So, what basically is different while programming with embedded C is the mindset for embedded application. we need to optimally use the resources make the program code efficient and satisfy real time constraints, if any. All this is done using the basic constructs, syntaxes and function libraries of 'C'.

CHAPTER 7

RESULT AND DISCUSSION

7.1 Overview of project has been shown

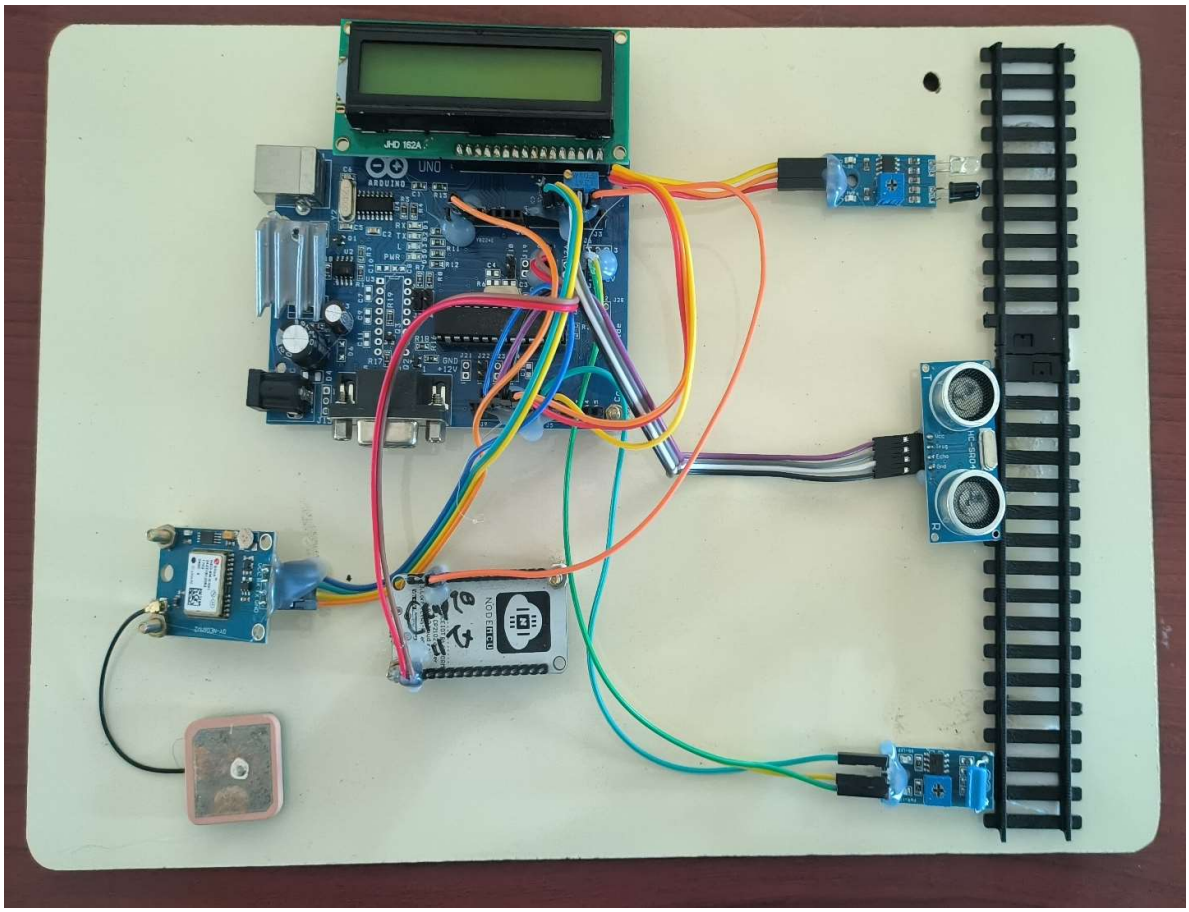


Figure 7.1 Overview of project hardware kit

7.2 SOURCE CODE

```
#include <Wire.h>;
#include <LiquidCrystal.h>
#include <TinyGPS++.h>
//library for gps module
#include <SoftwareSerial.h>
String msg="";
int GPSBaud = 9600;
SoftwareSerial gps_serial(4,5);
  //RX, TXinyGPSPlus gps;
  //create object for gps device double Lat;
  //variable for lattitude double Lot;
  //variable for longitude double Alt;
 //variable for altitude
const int rs = 13, en = 12, d4 = 11, d5 = 10, d6 = 9, d7 = 8;
Liquid Crystal lcd (rs, en, d4, d5, d6, d7);
int i=0;
int l=0;
int k=0;
//const int trigPin = A0;
//const int echoPin = A1;
const int trigPin1 = 2;
const int echoPin1 = 3;

#define SOUND_VELOCITY 0.034
#define CM_TO_INCH 0.393701
```

```
  long duration1;
  float distanceCm1;
  void setup ()

  {
  // gsm.begin(9600);
 //assign gsm buadrate gps_serial.begin(9600);
//assign gps buadrate Serial.begin(9600);
pinMode(trigPin1, OUTPUT);
  // Sets the trig Pin as an Output
  pinMode(echoPin1, INPUT);
  }
  void loop()
{
  Locationdata();
  delay(100);
  digitalWrite(trigPin1, LOW);
  delayMicroseconds(2);
  digitalWrite(trigPin1, HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin1, LOW);
  duration1 = pulseIn(echoPin1, HIGH);
  distanceCm1 = duration1 * SOUND_VELOCITY/2;
  int fl3=distanceCm1;
  lcd.begin(16, 2);
  lcd.print("RAIL TRACK  ");
    lcd.setCursor(0, 1) ;
```

```
  lcd.print("MONITOR SYSTEM");
  lcd.print("          ");
  delay(100);
  lcd.begin(16, 2);
  lcd.print("DISTANCE: ");
  lcd.setCursor(0, 1) ;
 lcd.print(fl3);
  delay(100);
if(fl3<10 && k==0)
{
  k++;
    sms();
}
if(fl3>5)
{
k=0;
}
//    Serial.println(analogRead(A0));
//    Serial.println(analogRead(A1));
if(analogRead(A0)>=100)
{
  sms1();
  }
if(analogRead(A1)<=50)
```

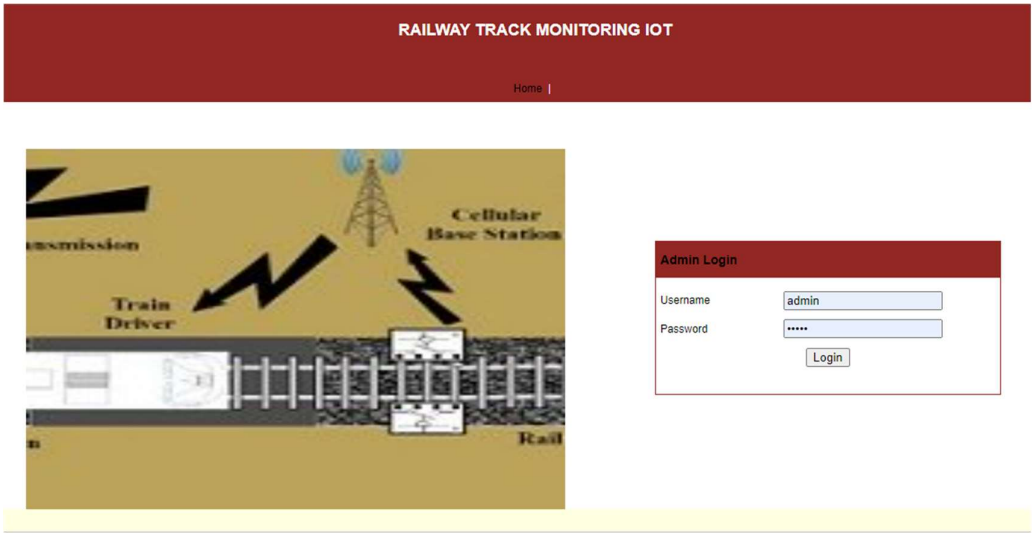
```
{
  sms2();
  }
{
 delay(10);
}
void sms()
{
    lcd.begin(16, 2);
  lcd.print("OBSTACLE DETECT");
  lcd.setCursor(0, 1) ;
  lcd.print("SMS SEND ");
  lcd.print("          ");
  delay(100);
  //String msg = "I am in trouble!
Lat:"+String(Lat)+",Lot:"+String(Lot)+"Alt:"+String(Alt);
  String msg = "OBSTACLE DETECTION: http://www.google.com/maps/place/"
+ String(Lat) + "," + String(Lot);
  Serial.print(msg);
 delay(5000);
}
void sms1()
{
        lcd.begin(16, 2);
  lcd.print("TRACK VIBRATION");
  lcd.setCursor(0, 1) ;
```

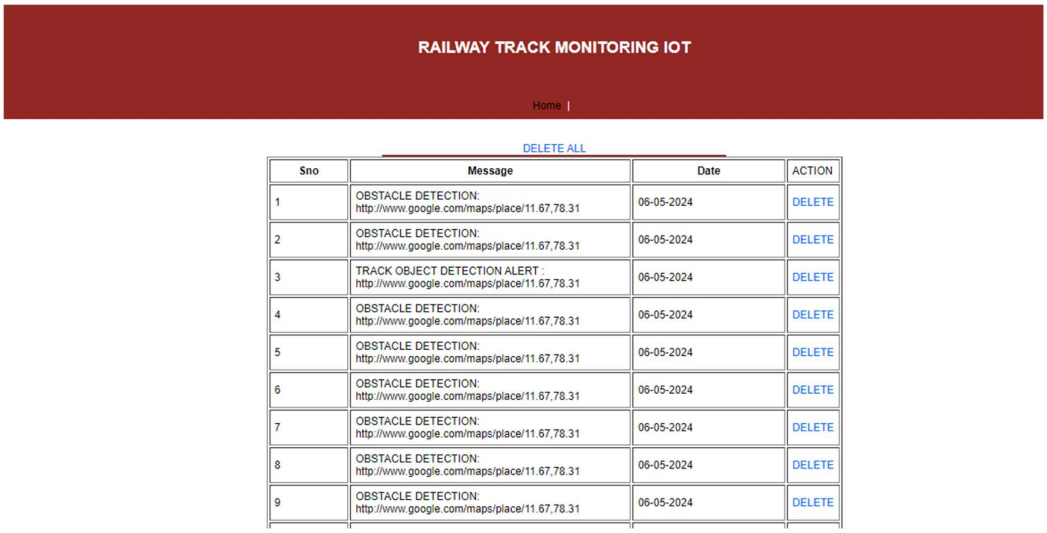
```
  lcd.print("ALERT SMS SEND ");
lcd.print("          ");
  delay(100);
//String msg = "I am in trouble!
Lat:"+String(Lat)+",Lot:"+String(Lot)+"Alt:"+String(Alt);
  String msg = "TRACK HEAVY VIBRATION ALERT :
http://www.google.com/maps/place/" + String(Lat) + "," + String(Lot);
  Serial.print(msg);
 delay(5000);
}
void sms2()
{
  lcd.begin(16, 2);
  lcd.print("OBJECT DETECTION");
  lcd.setCursor(0, 1) ;
  lcd.print("ALERT SMS SEND ");
  lcd.print("          ");
  delay(100);
  //String msg = "I am in trouble!
Lat:"+String(Lat)+",Lot:"+String(Lot)+"Alt:"+String(Alt);
  String msg = "TRACK OBJECT DETECTION ALERT :
http://www.google.com/maps/place/" + String(Lat) + "," + String(Lot);
  Serial.print(msg);
  delay(5000);
}
void Locationdata()
{
```

```
  while (gps_serial.available() > 0)
 {
 //check if serial data is available
    if (gps.encode(gps_serial.read()))
 {
            //encode Serial data
     if(gps.location.isValid())
 {
                  //if data is valid get location
       Lat = gps.location.lat();                  //update lattitude
       Lot = gps.location.lng();                   //update longiitude
       Alt = gps.altitude.meters();                //update altitude
     // Serial.println(Lat);
     //Serial.println(Lot);
      }
      Else
{
     //if data is not available
       Serial.println("Please connect gps");
       lcd.begin(16, 2);
  lcd.print("plz connect gps");

  delay(100);
      }
    }
  }
}
```

7.3 software output





Sno	Message	Date	ACTION
1	OBSTACLE DETECTION: http://www.google.com/maps/place/11.67,78.31	06-05-2024	DELETE
2	OBSTACLE DETECTION: http://www.google.com/maps/place/11.67,78.31	06-05-2024	DELETE
3	TRACK OBJECT DETECTION ALERT : http://www.google.com/maps/place/11.67,78.31	06-05-2024	DELETE
4	OBSTACLE DETECTION: http://www.google.com/maps/place/11.67,78.31	06-05-2024	DELETE
5	OBSTACLE DETECTION: http://www.google.com/maps/place/11.67,78.31	06-05-2024	DELETE
6	OBSTACLE DETECTION: http://www.google.com/maps/place/11.67,78.31	06-05-2024	DELETE
7	OBSTACLE DETECTION: http://www.google.com/maps/place/11.67,78.31	06-05-2024	DELETE
8	OBSTACLE DETECTION: http://www.google.com/maps/place/11.67,78.31	06-05-2024	DELETE
9	OBSTACLE DETECTION: http://www.google.com/maps/place/11.67,78.31	06-05-2024	DELETE

Figure 7.3 software output

CHAPTER 8

CONCLUSION

The approach taken is capable, if there are any of detecting flaws and obstacles on the surface. The method proposed has lots of advantages over conventional detection approaches that include minimal cost, reduced energy consumption, efficient detection system without human involvement and shorter analytical times. With this prototype, train collisions and derailments can be easily prevented to save many lives. It is also very beneficial for railroad operations testing units. we can also notice the position failure and the system used in this and also the location data is sent to the default mobile number. So that this enables us in rail line preservation and control as well. When we use the detector model for monitoring and we can claim that it is a fusion energy vehicle. The result shows that this exciting new technology will keep increasing the efficiency of the safety features for rail infrastructure. We can prevent accidents of up to 70% by enforcing these functionalities in the real-time implementation. Areas where manual testing is not feasible with this vehicle such as in shallow coalmines, mountainous areas and thick and deep forests regions can be easily carried out. When this vehicle is used for railway inspections and breakage detection, automatic SMS will be sent to a predetermined mobile number if cracks or abnormalities are identified by the device sensors. This will lead without errors to the management and control of the state of the railway tracks and thus to the preservation of the tracks in good condition.

CHAPTER 9

REFERENCE

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