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Smart Monitoring of the Train and Train Tracks to Prevent Railway Hazards

A Project By

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Date of Submission: September, 2024

“Smart Monitoring of the Train and Train Tracks to Prevent Railway Hazards”

A report submitted to the Department of Electrical and Electronic Engineering, Sonargaon University of Bangladesh in partial fulfillment of the requirements for the Award of Degree of Bachelor of Science in Electrical and Electronic Engineering.

Submitted by

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LETTER OF TRANSMITTAL

To

Rudaina Tasnuva

Lecturer

Department of Electrical and Electronic Engineering.

Sonargaon University of Dhaka, Bangladesh

Subject: Submission of Project Report

Dear Sir,

We are pleased to submit the project report on **Smart Monitoring of the Train and Train Tracks to Prevent Railway Hazards.** It was a great pleasure to work on such an important topic. This project has been done as per instruction of your supervision and according to the requirements of the Sonargaon University.

We expect that the project will be accepted by the concerned authority we will remain happy to further explanation that you may feel necessary in this regard.

Thank You

Sincerely yours,

Md Azhar Uddin

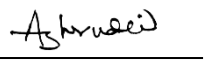
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DECLARATION

We do hereby solemnly declare that, the work presented here in this project report has been carried out by us and has not been previously submitted to any University/ Organization for award of any degree or certificate

We hereby ensure that the works that has been prevented here does not breach any existing copyright.

We further undertake to indemnify the university against any loss or damage arising from breach of the foregoing obligation.



Md Azhar Uddin
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Under Supervision of

Rudina Tasnuva
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ACKNOWLEDGEMENT

First, we started in the name of almighty Allah. This thesis is accomplished under the supervision of Rudaina Tasnuva, Lecturer, Department of Electrical and Electronic Engineering, Sonargaon University. It is a great pleasure to acknowledge our profound gratitude and respect to our supervisor for this consistent guidance, encouragement, helpful suggestion, constructive criticism and endless patience through the progress of this work. The successful completion of this thesis would not have been possible without his persistent motivation and continuous guidance.

The authors are also grateful to **Md. Rais Uddin Mollah**, Head of the Department of Electrical and Electronic Engineering for their co-operation and significant help for completing the thesis work successfully.

ABSTARCT

This project proposes a comprehensive smart monitoring system designed to enhance railway safety through the integration of electrical and mechanical components. Leveraging advanced technologies including sensors, microcontrollers, and display units, the system continuously monitors trains and tracks to detect and prevent hazards. The system incorporates various components such as electrical LED lights, LCD displays, buzzers, Switched Mode Power Supplies (SMPS), mechanical switches, Arduinos, and limitation switches. These components are strategically deployed on trains and along tracks to collect and analyze critical data in real-time. Electrical LED lights and LCD displays provide visual alerts and information to train operators and maintenance personnel regarding potential hazards or abnormal conditions detected by sensors. Buzzers serve as auditory alarms for immediate attention in critical situations. SMPS units ensure reliable power supply to the monitoring system, while mechanical switches and limitation switches are used for physical position detection and safety monitoring. The Arduino microcontroller acts as the central processing unit, collecting data from sensors, analyzing it using predefined algorithms, and triggering appropriate responses based on predefined thresholds or conditions. The system's architecture enables early detection of hazards such as track deformities, mechanical failures, or environmental risks, allowing for proactive intervention to mitigate risks and prevent accidents. This project aims to address limitations in traditional railway monitoring systems by integrating electrical and mechanical components with advanced sensor technologies. By providing real-time data insights and actionable alerts, the proposed system offers a proactive approach to railway safety, ultimately contributing to the creation of safer and more efficient railway networks.

Certification

I Certify that I have read this dissertation and that, in my opinion it is fully adequate, in scope and quality as a dissertation for the degree of BSC Engineering.

Rudina Tasnuva
Lecturer
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CHAPTER 1

INTRODUCTION

1.1 Introduction

In the last years, particular attention was focused on the monitoring of fast to very fast failures, which include landslides from rocky slopes (e.g. falls, topples and wedge sliding), but also sinkholes and debris flows channeled along high-inclination slopes. The relevance of such events is mainly related to the short time available for taking action in case of exposed infrastructures (highways, railways and so on), since no significant displacements are generally detected before failure. In this regard, the possible strategies to manage the natural risk are: i) monitoring precursors by using micro- or nano-seismometric devices as well as of acoustical emission records [1], [2]; ii) monitoring the site as well as the exposed infrastructures, by using optical devices (e.g. cameras, interferometers, videos) capable of detecting fast morphological changes or abnormal and unexpected objects hazardous for the infrastructure [3], [4], [5], [6] and [7]. The main purposes of monitoring are to investigate or detect the site at different evolutionary stages, corresponding to different distributions of the landslide hazard and to understand and control the parameters for forecasting the short-term evolution of gravitational instabilities. In case of railways, another important point is represented by detection of obstacles along the track that can be dangerous for train circulation. With respect to the previous works cited above, in this paper an approach based on smart cameras is presented for pervasive monitoring of railways. Each smart camera is a completely wireless and self-powered device that observes a portion of railway and its surrounding in order to detect obstacles, accumulation of debris and gravitational instabilities. To this end, smart cameras are equipped with specially-designed computer vision algorithms that are deployed on board the camera to analyze in real time the scene and provide an interpretation. With respect to other solutions, the proposed one is low cost, easy-to-install and scalable. Indeed, a special prototype of smart camera that is possible to produce at low cost is used. Being wireless and self-powered, the camera does not need major works to be wired and installed: it is sufficient to mount it on a pole. Finally, since the camera does not need to transmit images

routinely but just few bytes are necessary to describe the output of processing, many smart cameras can be installed to monitor a wide area, with no scalability concerns. The main contributions of the paper are the following. First, the specially designed smart camera prototype is introduced and described. The device has good features that make it useful for several applications in vision-based monitoring, especially when a self-powered solution must be adopted. Then, computer vision methods realized ad hoc for the smart camera prototype and the application to railway monitoring are introduced. Although being based on simple video analytics, the algorithms are optimized for deployment on an embedded device such as the proposed smart camera. Finally, the efficiency of the computer vision algorithms and the suitability of the smart camera approach are proved through real tests in a sample scenario that has been setup. The overall system was able to detect dangerous obstacles and to detected landslides and gravitational instabilities and showed to be reliable in continuous monitoring of infrastructures.

1.2 Motivation

The motivation behind the development of a smart monitoring system for trains and train tracks stems from the urgent need to enhance railway safety and efficiency. Railway transportation serves as a lifeline for economies around the world, facilitating the movement of goods and people over vast distances. However, it also presents inherent risks, including mechanical failures, track deformities, and environmental hazards, which can lead to accidents with devastating consequences. Traditional methods of monitoring railway infrastructure often rely on manual inspections and periodic maintenance schedules, which can be time-consuming, costly, and prone to human error. Furthermore, these approaches may not always detect potential hazards in real-time, increasing the risk of accidents and disruptions to railway operations.

1.3 Objective

The main objective of this project is to develop a accident detection and rescue system, Our objectives are pointed out below:

- To study of the **Smart Monitoring Of The Train And Train Tracks To Prevent Railway Hazards.**
- To design and construct of a **Smart Monitoring of Trains and Train Tracks for Railway Hazard Prevention** with line to distance maturement .
- To implement and study of take proper step to reduce the accident.
- To take necessary notes from the project for future improvements.

1.4 Structure of the Project

This Project is organized as follows:

Chapter 1 Introduction: The first chapter contains the statement of the introduction, our background study for the project, objectives of the study, methodology used in the project and the project outline.

Chapter 2 Literature Review: The chapter two contains our literature review part.

Chapter 3 Hardware and Software Analysis: Chapter three describes the theoretical model. Here we mainly discuss about Hardware and software development of our project etc.

Chapter 4 Methodology: Here we mainly discuss about proposed system architecture in details with having block diagram, circuit diagram, project working principle, complete project image of our project etc.

Chapter 5 Results and Discussion: Chapter five deals with the result, advantages, application and discussion about our project advantages and application.

Chapter 6 Conclusion: all about our project conclusion, limitations and future scope.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In this section topics related to **Smart Monitoring Of The Train And Train Tracks To Prevent Railway Hazard**s are included. These provide a sampling of problems appropriate for application of railway truck multiple safety system Based Accident Sensing System. The references are summarized below.

2.2 Literature Review

Between 1970 and 1980, there were 14 serious railway accidents with multiple fatalities in Sweden. Several accidents were caused by drivers passing signals at danger, and these might have been prevented by a train control system. These accidents caused a lot of media attention and debate in the beginning of the `80s, which led to the decision to install Automatic Train Control, ATC. After a head-on train collision in Lerum in November 1987, with 9 fatalities, the rules regulating maintenance work on signal equipment were changed. The accident was caused by a fault in the signal equipment: two cables had been switched incorrectly. The underlying cause was the time pressure on the maintenance workers, which led to the fault not being detected. Since that accident, more time has been given to the inspection of completed work. In general, this increases safety, but can also lead to longer delays. The decision to install ATC and the new rule regulating maintenance work can serve as examples of the way decisions on safety have been made in the railway sector. Actual accidents have stepped up the demand for higher safety and new safety rules have been formulated to prevent specific types of events occurring again. The decisions have been partly based on informal judgements and the process can be described as deterministic, because the risks have been judged solely on the basis of the possible consequences. The problem is that this approach can lead to a demand for huge investment to prevent events with very low probabilities. The same approach can also be found in

other countries. In 1987, there was a fire at King's Cross station on the London Underground, with 31 fatalities and many people seriously injured. In December 1988, two trains collided at Clapham Junction with 35 fatalities and many seriously injured. The investigations and judicial inquiries following these accidents resulted in several recommendations and new laws for increased safety. However, many of the recommended measures overlapped, were uneconomical or unnecessary in other ways. British Rail compiled a list of the cost per life saved for each of the 250 projects recommended following the accidents. The first 12 measures have very low costs, as low as £10,000 per life saved. At project 155, the costs have risen to about £1 million per life saved. After that, there is a fairly sharp rise in costs, so that, at project 210, the costs are approaching £10 billion per life saved.1 There are also other examples where the investment costs are low but the safety measures lead to other effects. In April 1990 there was a passenger train derailment in Sköldinge. The train was only allowed to travel at 40 km/h because of speed restrictions when passing points. This was given by the signals and the Automatic train control system (ATC). However, an ATC transponder2 was failing and when the driver received the information on the failure he immediately cancelled the braking induced by the ATC-system and increased speed to 126 km/h. When passing the point the train derailed. Two passengers were killed and several injured.The accident led to a change in the ATC-system. After receiving an erratic signal from the system, the driver now have to reduce speed below 80 km/h and maintain that speed until a correct signal is received from the ATC-system. This will eventually happen when the next transponder-group is passed. The distance between the transponder-groups varies from a few metres to several kilometres. This of course has effects on the traffic and it can lead to delays. The investment costs were small in comparison with the possible safety effects and the effects on the traffic. Priorities will always have to be established and the decision-makers will have to decide upon the resources available for safety and then choose between different safety projects. It is evident that society cannot afford every conceivable safety project. Still, society finds it hard to accept high risks from public transport, and there is a constant search for ever safer operations. This calls for a general approach for analysing railway safety. There is a need for procedures and models that combine safety issues and other effects, and that can deal with economic aspects as well as inputs that are more subjective. This thesis provides knowledge about methods for analysing railway safety.

2.3 Summary

The above has been discussed in detail in the past few literature's which has given us a lot of motivation to do this project.

CHAPTER 3

HARDWARE AND SOFTWARE ANALYSIS

3.1 Introduction

In this section, we will discuss elaborately about our hardware design of "**Smart Monitoring Of The Train And Train Tracks To Prevent Railway Hazards**" and the component description, features, working procedure and discription of our all equipment. The system hardware fabricates composed of micro-controller unit, display lcd, Buzzer,SMPS , Mechanical Switch or Limit Switch and Relay many more related components.

3.2 Hardware List

- ✓ LED Electric Light
- ✓ Display LCD
- ✓ Buzzer
- ✓ SMPS
- ✓ Limit Switch
- ✓ Arduino NANO
- ✓ Relay
- ✓ Flame Sensor
- ✓ Pump Motors

3.3 Arduino Nano

Arduino is open-source electronics prototyping platform based on flexible, easy-to-use hardware and software. It's intended for artists, designers, hobbyists, and anyone interested in creating interactive objects or environments. Arduino can sense the environment by receiving input from a variety of sensors and can affect its surroundings by controlling Lights, motors, and other actuators.

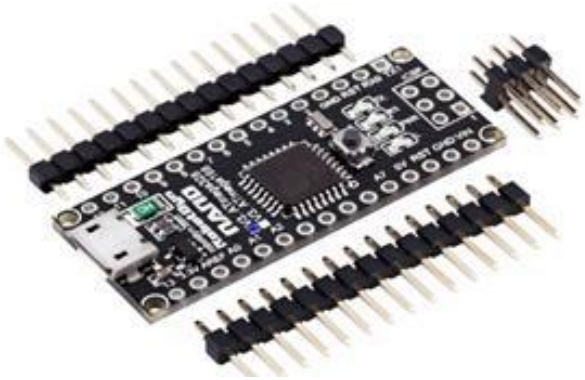


Figure 3.1: Arduino Nano

The micro-controller on the board is programmed using the Arduino programming language (based on Wiring) and the Arduino development environment (based on Processing). Arduino projects can be stand-alone or they can communicate with software on running on a computer (e.g. Flash, Processing, Maxims'). Arduino Nano is a surface mount breadboard embedded version with integrated USB. It is a small, complete, and breadboard friendly component. It has everything that Decimal/ Duemilanove has (electrically) with more analog input pins and onboard +5V AREF jumper. Physically, it is missing power jack. The Nano can automatically sense and switch to the higher potential source of power.

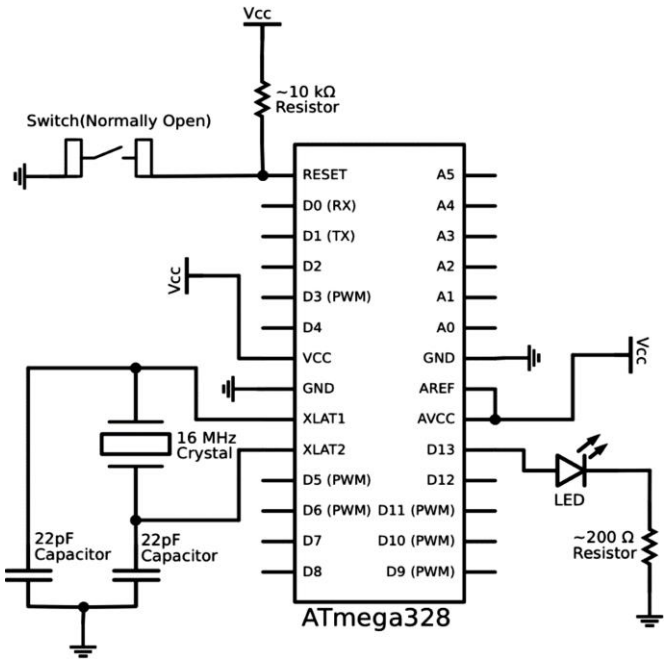


Figure 3.2: Arduino Nano Schematic Diagram

Nano's got the breadboard-ability of the Boarding and the Minibus with smaller footprint than either, so users have more breadboard space. It's got a pin layout that works well with

the Mini or the Basic Stamp (TX, RX, ATN, and GND on one top, power and ground on the other). This new version 3.0 comes with ATMEGA328 which offer more programming and data memory space. It has two layers. That make it easier to hack and more affordable. One of the best features of Arduino Nano is, it's easy to use, compact and also small.

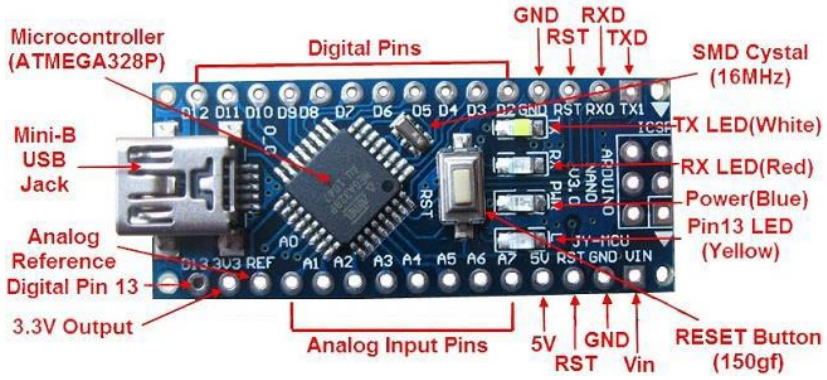


Figure 3.3: How Arduino Nano looks like

Specifications:

- Micro-controller: Atmel ATmega328
- Operating Voltage (logic level): 5 V
- Input Voltage (recommended): 7-12 V
- Input Voltage (limits): 6-20 V
- Digital I/O Pins: 14 (of which 6 provide PWM output)
- Analog Input Pins: 8
- DC Current per I/O Pin: 40 mA
- Flash Memory: 32 KB (of which 2KB used by boot loader)
- SRAM : 2 KB
- EEPROM: 1 KB
- Clock Speed: 16 MHz
- Dimensions: 0.70" x 1.70"

Features:

- Automatic reset during program download
- Power OK blue LED
- Green (TX), red (RX) and orange (L) LED
- Auto sensing/switching power input

- Small mini-B USB for programming and serial monitor
- ICSP header for direct program download
- Manual reset switch

Micro-controller IC ATmega328p

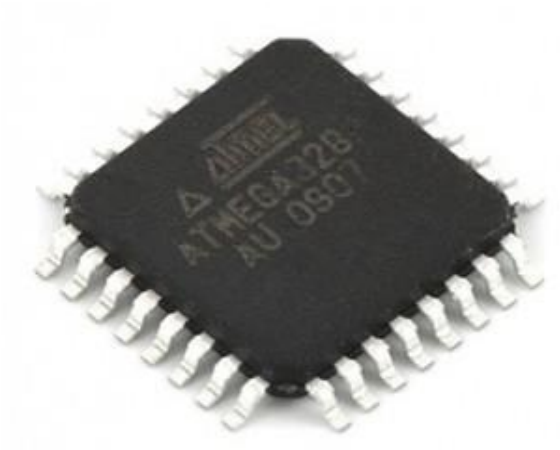


Figure 3.4: Micro-controller IC AT mega 328p

The high-performance Microchip Pico Power 8-bit AVR RISC-based micro-controller combines 32KB ISP flash memory with read-while-write capabilities, 1024B EEPROM, 2KB SRAM, 23 general purpose I/O lines, 32 general purpose working registers, three flexible timer/counters with compare modes, internal and external interrupts, serial programmable USART, a byte-oriented 2-wire serial interface, SPI serial port, a 6-channel 10-bit A/D converter (8-channels in TQFP and QFN/MLF packages), programmable watchdog timer with internal oscillator, and five software selectable power saving modes. The device operates between 1.8-5.5 volts. By executing powerful instructions in a single clock cycle, the device achieves throughput's approaching 1 MIPS per MHz, balancing power consumption and processing speed.

3.4 LCD Display

The LCD (liquid crystal display) screen is an electronic display module and looks for various applications. A 16x2 LCD display is a very basic module and it is very commonly used in various devices and circuits. These modules are preferred over seven sections and many other segments.



Figure 3.5: 16*2 LCD Display

The reasons for having LCD are economic; Easily programmable, special and even custom characters (different in seven sections), there are no restrictions on displaying animations. A 16x2 LCD means it can display 16 characters per line and contains 2 lines. Each character on this LCD is displayed in a 5x7 pixel matrix.

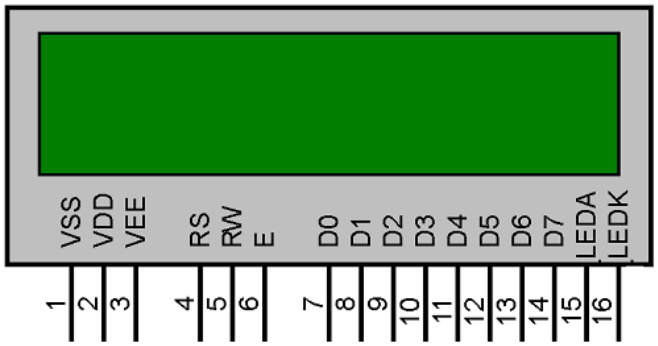


Figure 3.6: Pin out of 16*2 LCD Display

This LCD contains two articles called Command and Data. The command register stores the command instructions on the LCD. The command is a command given to the LCD to perform a predefined task such as starting it, clearing its screen, locating the cursor, controlling the display, etc.

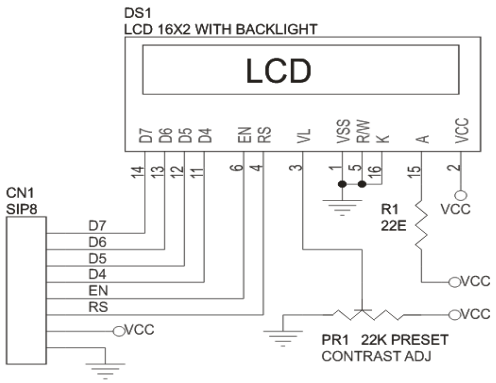


Figure 3.7 : 16*2 LCD Display interfacing with Arduino

Feature

The features of this LCD mainly include the following.

- The operating voltage of this LCD is 4.7V-5.3V
- It includes two rows where each row can produce 16-characters.
- The utilization of current is 1mA with no backlight
- Every character can be built with a 5×8 pixel box
- The alphanumeric LCDs alphabets & numbers
- Is display can work on two modes like 4-bit & 8-bit
- These are obtainable in Blue & Green Backlight
- It displays a few custom generated characters

3.5 Relay

A relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays. Relays are used where it is necessary to control a circuit by a separate low-power signal, or where several circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits as amplifiers: they repeated the signal coming in from one circuit and re-transmitted it on another circuit. Relays were used extensively in telephone exchanges and early computers to perform logical operations.

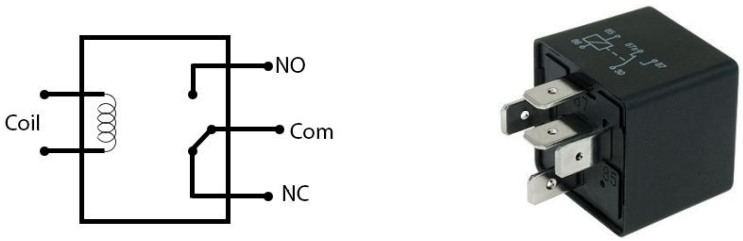


Figure 3.8: Relay

A type of relay that can handle the high power required to directly control an electric motor or other loads is called a contactor. Solid-state relays control power circuits with no moving parts, instead using a semiconductor device to perform switching. Relays with calibrated operating characteristics and sometimes multiple operating coils are used to

protect electrical circuits from overload or faults; in modern electric power systems these functions are performed by digital instruments still called "protective relays".

Magnetic latching relays require one pulse of coil power to move their contacts in one direction, and another, redirected pulse to move them back. Repeated pulses from the same input have no effect. Magnetic latching relays are useful in applications where interrupted power should not be able to transition the contacts. Magnetic latching relays can have either single or dual coils. On a single coil device, the relay will operate in one direction when power is applied with one polarity, and will reset when the polarity is reversed. On a dual coil device, when polarized voltage is applied to the reset coil the contacts will transition. AC controlled magnetic latch relays have single coils that employ steering diodes to differentiate between operate and reset commands. The relay module is the one in the figure below.

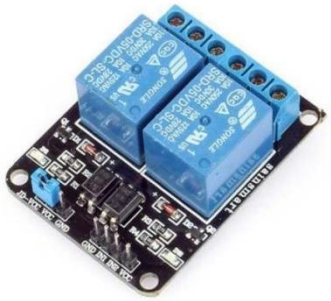


Figure 3.9: Relay Module.

This module has two channels (those blue cubes). There are other varieties with one, four and eight channels.

Main's voltage connections.

In relation to mains voltage, relays have 3 possible connections:

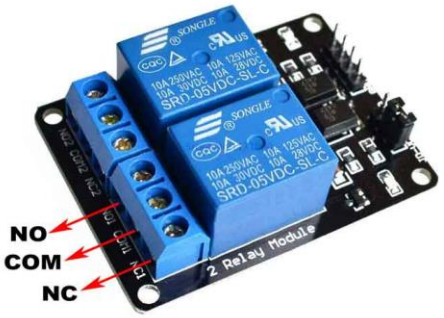


Figure 3.10: Main's voltage connections.

COM: common pin

NO (Normally Open): there is no contact between the common pin and the normally open pin. So, when you trigger the relay, it connects to the COM pin and supply is provided to a load

NC (Normally Closed): there is contact between the common pin and the normally closed pin. There is always connection between the COM and NC pins, even when the relay is turned off. When you trigger the relay, the circuit is opened and there is no supply provided to a load.

Pin wiring

The connections between the relay module and the Arduino are really simple:

GND: goes to ground

IN: controls the first relay (it will be connected to an Arduino digital pin)

IN2: controls the second relay (it should be connected to an Arduino digital pin if you are using this second relay. Otherwise, you don't need to connect it)

VCC: goes to 5V

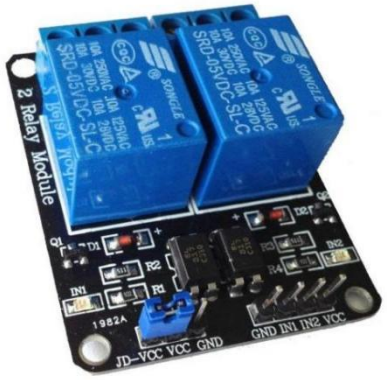


Figure 3.11: Voltage Connections

3.6 Switch Mode Power Supply (SMPS)

A switched-mode power supply (switching-mode power supply, switch-mode power supply, switched power supply, SMPS, or switcher) is an electronic power supply that incorporates a switching regulator to convert electrical power efficiently. Like other power supplies, an SMPS transfers power from a DC or AC source (often mains power) to DC loads, such as a personal computer, while converting voltage and current characteristics. Unlike a linear power supply, the pass transistor of a switching-mode supply continually switches between low-dissipation, full-on and full-off states, and spends very little time in the high dissipation transitions, which minimizes wasted energy. A hypothetical ideal switched-mode power supply dissipates no power. Voltage regulation is achieved by varying the ratio of on-to-off time (also known as duty cycles). In contrast, a linear power supply regulates the output voltage by continually dissipating power in the pass transistor. This higher power conversion efficiency is an important advantage of a switched-mode power supply. Switched-mode power supplies may also be substantially smaller and lighter than a linear supply due to the smaller transformer size and weight.



Figure 3.12: SMPS

Switching regulators are used as replacements for linear regulators when higher efficiency, smaller size or lighter weight are required. They are, however, more complicated; their switching currents can cause electrical noise problems if not carefully suppressed, and simple designs may have a poor power factor. Switched-mode power supplies are classified according to the type of input and output voltages. The four major categories are:

- AC to DC
- DC to DC
- DC to AC
- AC to AC

A basic isolated AC to DC switched-mode power supply consists of:

- Input rectifier and filter
- Inverter consisting of switching devices such as MOSFETs
- Transformer
- Output rectifier and filter
- Feedback and control circuit

The input DC supply from a rectifier or battery is fed to the inverter where it is turned on and off at high frequencies of between 20 KHz and 200 KHz by the switching MOSFET or power transistors. The high-frequency voltage pulses from the inverter are fed to the transformer primary winding, and the secondary AC

output is rectified and smoothed to produce the required DC voltages. A feedback circuit monitors the output voltage and instructs the control circuit to adjust the duty cycle to maintain the output at the desired level.

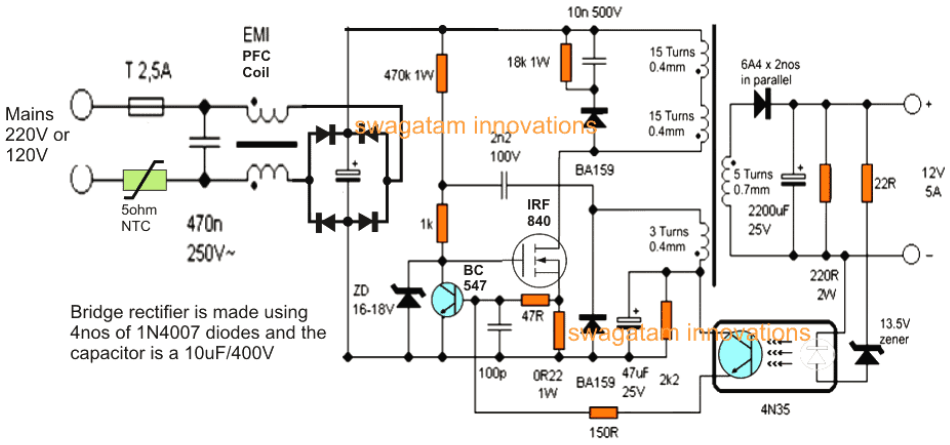


Figure 3.13: SMPS Circuit

Basic working concept of an SMPS

A switching regulator does the regulation in the SMPS. A series switching element turns the current supply to a smoothing capacitor on and off. The voltage on the capacitor controls the time the series element is turned. The continuous switching of the capacitor maintains the voltage at the required level.

Design basics

AC power first passes through fuses and a line filter. Then it is rectified by a full-wave bridge rectifier. The rectified voltage is next applied to the power factor correction (PFC) pre-regulator followed by the downstream DC-DC converter(s). Most computers and small appliances use the International Electrotechnical Commission (IEC) style input connector. As for output connectors and pin outs, except for some industries, such as PC and compact PCI, in general, they are not standardized and are left up to the manufacturer.

There are different circuit configurations known as topologies, each having unique characteristics, advantages and modes of operation, which determines how the input power is transferred to the output. Most of the commonly used topologies such as flyback, push-pull, half bridge and full bridge, consist of a transformer to provide isolation, voltage

scaling, and multiple output voltages. The non-isolated configurations do not have a transformer and the power conversion is provided by the inductive energy transfer.

Advantages of switched-mode power supplies:

- Higher efficiency of 68% to 90%
- Regulated and reliable outputs regardless of variations in input supply voltage
- Small size and lighter
- Flexible technology
- High power density
- Disadvantages:
- Generates electromagnetic interference
- Complex circuit design
- Expensive compared to linear supplies

Switched-mode power supplies are used to power a wide variety of equipment such as computers, sensitive electronics, battery-operated devices and other equipment requiring high efficiency. Linear voltage IC regulators have been the basis of power supply designs for many years as they are very good at supplying a continuous fixed voltage output. Linear voltage regulators are generally much more efficient and easier to use than equivalent voltage regulator circuits made from discrete components such a zener diode and a resistor, or transistors and even op-amps.The most popular linear and fixed output voltage regulator types are by far the 78… positive output voltage series, and the 79… negative output voltage series. These two types of complementary voltage regulators produce a precise and stable voltage output ranging from about 5 volts up to about 24 volts for use in many electronic circuits.There is a wide range of these three-terminal fixed voltage regulators available each with its own built-in voltage regulation and current limiting circuits. This allows us to create a whole host of different power supply rails and outputs, either single or dual supply, suitable for most electronic circuits and applications. There are even variable voltage linear regulators available as well providing an output voltage which is continually variable from just above zero to a few volts below its maximum voltage output.

Switch Mode Power Supply

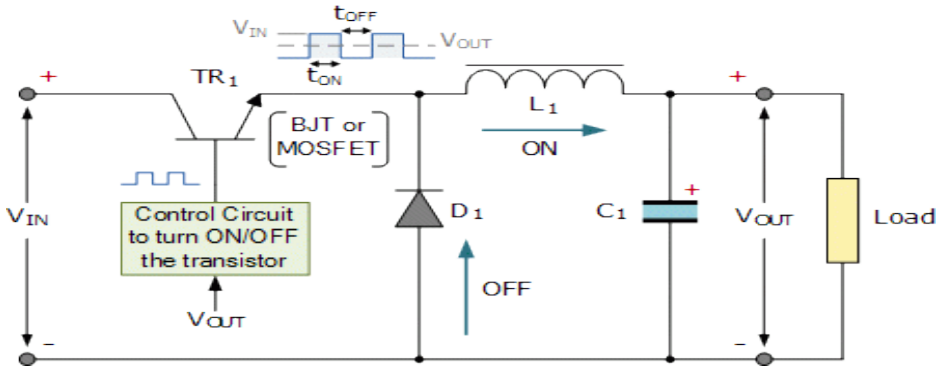


Figure 3.14: SMPS Circuit Connection

Most d.c. power supplies comprise of a large and heavy step-down mains transformer, diode rectification, either full-wave or half-wave, a filter circuit to remove any ripple content from the rectified d.c. producing a suitably smooth d.c. voltage, and some form of voltage regulator or stabiliser circuit, either linear or switching to ensure the correct regulation of the power supplies output voltage under varying load conditions. Then a typical d.c. power supply would look something like this:

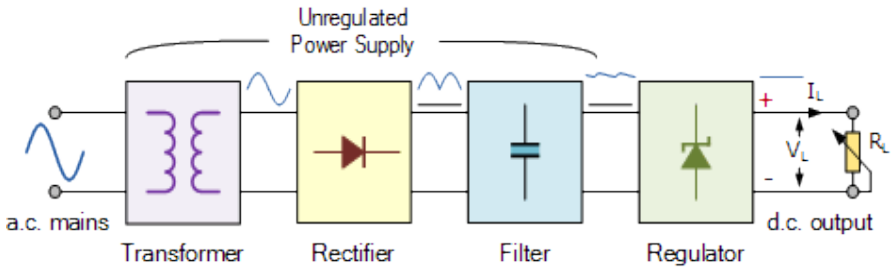


Figure 3.15: DC Power supply way

These typical power supply designs contain a large mains transformer (which also provides isolation between the input and output) and a dissipative series regulator circuit. The regulator circuit could consist of a single zener diode or a three-terminal linear series regulator to produce the required output voltage. The advantage of a linear regulator is that the power supply circuit only needs an input capacitor, output capacitor and some feedback resistors to set the output voltage.

3.7 LED Electric Light

LED rail signals replace incandescent units to better meet the critical 24/7 reliability needs of railway and transit operators. Benefits of advanced LED technology in these 365-day-a-year devices include recurring energy savings and lower maintenance.



Figure 3.16: LED Electric Light

In recent years, LED technology (Light Emitting Diode) has spread rapidly finding applications of inquestionable interest in the railway signalling industry. The strength of these devices is based on their potential to be brighter, more efficient and more reliable than the incandescent lamps.

Their high switching speed and manufacturing technology compatible with that of silicon chips make them ideal for realization of devices extremely versatile in their use. LED signals are characterized by technological innovation that can bring significant economic and operational benefits in the management of railway signals, creating interesting economic opportunities for operators.

3.8 Buzzer

Piezo elements are actually one of the coolest crystals you'll play with. Flex them, they generate a voltage (pretty high, actually). Pass power through them, and they'll flex. Do it fast enough, and they'll start to make a sound! So besides making annoying little beep noises, you could use it as a sensor to detect a knock or other similar vibration.

Specifications

- Operating Voltage: 1.0 ~ 20.0V
- Rated Voltage: 3.0V
- Diameter: Ø12.5mm
- Total Height: 6.3mm
- Capacitance: 15,000pF
- Current Consumption: ≤2mA
- Resonance Frequency: 4,000Hz
- Sound Pressure Level at 10cm: ≥75db
- Self Drive: No



Figure 3.17: Buzzer

3.9 Limit Switch

A limit switch is a type of electromechanical device commonly used in industrial and automation applications to detect the presence or absence of an object, or to determine the position of a moving part. It consists of a mechanical lever or button that makes contact



Figure 3.18: Limit Switch

with an actuator, and when activated, it generates an electrical signal.When the object or moving part comes into contact with the actuator, it applies force to the actuator, causing it to move. This movement triggers the mechanism inside the limit switch, either opening or closing the contacts depending on the switch's configuration. This change in the contact state generates an electrical signal that can be used to control other devices or machinery in the system.

3.10 Flame Sensor

The flame sensor can detect flame and infrared light sources with wavelengths ranging from 760 nm to 1100 nm. It uses the LM393 comparator chip, which gives a clean, stable digital output signal and driving ability of 15 mA. This flame detector that can be used in fire alarms and other fire detecting devices.

Specifications

- LM393 comparator chip
- Detection Range: 760 nm to 1100 nm
- Operating Voltage: 3.3 V to 5 V
- Maximum Output Current: 15 mA
- Digital Outputs: 0 and 1
- Detection Angle: about 60 degrees

- Adjustable sensitivity via potentiometer
- LED lights indicators: power (red) and
- digital switching output (green)
- Fixed bolt holes for easy installation
- PCB Size: 32 x 14 mm

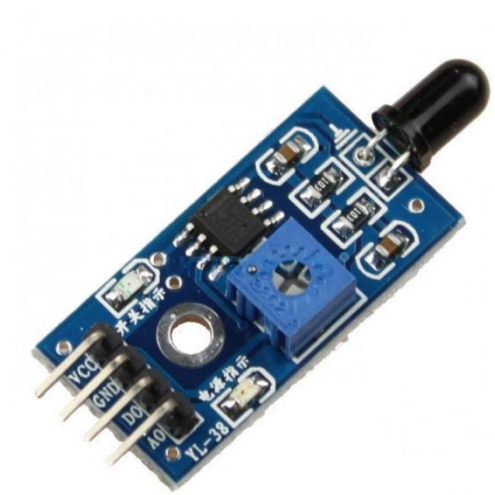


Figure 3.19: Flame Sensor

3.11 Pump Motor

This is a low cost, small size Submersible Pump Motor which can be operated from a 2.5 ~ 6V power supply. It can take up to 120 liters per hour with very low current consumption of 220mA. Just connect tube pipe to the motor outlet, submerge it in water and power it. Make sure that the water level is always higher than the motor. Dry run may damage the motor due to heating and it will also produce noise.



Figure 3.20: Pump Motor

Feature:

- Operating Current : 130 ~ 220mA
- Flow Rate : 80 ~ 120 L/H
- Maximum Lift : 40 ~ 110 mm
- Continuous Working Life : 500 hours
- Driving Mode : DC, Magnetic Driving
- Material : Engineering Plastic
- Outlet Outside Diameter : 7.5 mm
- Outlet Inside Diameter : 5 mm

3.12 Resistor

A resistor is a passive two-terminal electrical component that implements electrical resistance as a circuit element. Resistors act to reduce current flow, and, at the sometime, act to lower voltage levels within circuits. Resistors may have fixed resistances or variable resistances, such as those founding thermostats, visitors, trimmers, photo resistors, hamsters and potentiometers. The current through a resistor is in direct proportion to the voltage across the resistor's terminals. This relationship is represented by Ohm's law.



Figure 3.21: Resistor

Theory of operation

The behavior of an ideal resistor is dictated by the relationship specified by Ohm ‘slaw:

$$V = I.R$$

Ohm's law states that the voltage (V) across a resistor is proportional to the current (I), where the constant of proportionality is the resistance (R).

Equivalently, Ohm's law can be stated:

$$I = V/R$$

This formulation states that the current (I) is proportional to the voltage (V) and inversely proportional to the resistance (R). This is directly used in practical computations. For example, if a 300-ohm resistor is attached across the terminals of a12 volt battery, then a current of12 / 300 = 0.04 amperes flows through that resistor.

3.13 Arduino Software

An intelligent micro-controller unit called the Arduino Uno can be programmed with the Arduino software. There is no need to install any software other than the Arduino first. From the Tools Board menu (according to your on-board micro-controller) select "Arduino Unio A" using the hardware programmer.

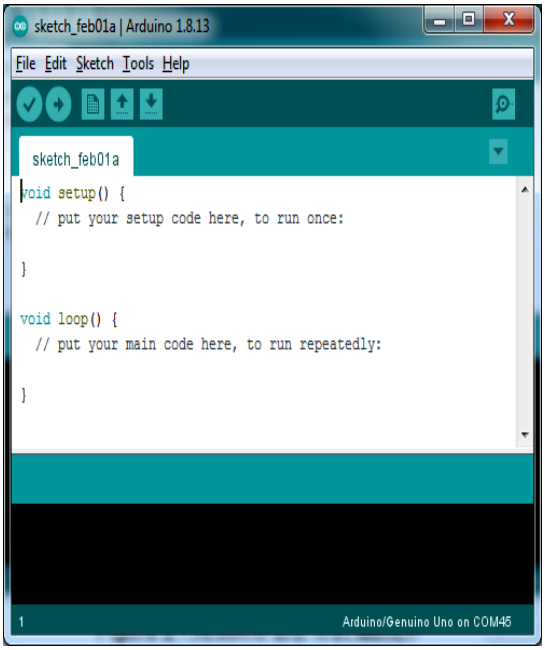


Figure 3.22: Arduino Software Interface IDE

The communication uses the native STK 500 protocol (reference C header file). We can bypass the boot loader and program the micro-controller under the ICSP (In Circuit Serial Programming) heading. Atmeg16U2 firmware source code (or 8U2 on The Rev1 and Rev2) Atmega 16U2/8U2 boards are loaded with a DFU boot loader, which can be enabled at: On the Rev 1: board, attach a solder jumper to the back of the board. Rev 2 or later: There is a resistor that pulls the 8U2/16U2 HWB wires to ground, making it easy to put in DFU mode. The Arduino Uno is the latest smart micro-controller unit and has Several advantages for communicating with other Arduino computers or other micro-controllers.

The ATMA 328 provides URT TTL with Communication Protocol (5V), available in digital PIN 0 - (RX) for data retrieved with PIN No. 1 (TX) for data transmission. The system port communicates via USB Atimega 16U2 in the port and comes out as a low-end

port with computer software. '16U2 firmware uses standard USB CMM driver and no external drivers required. Anyway, Windows needs an .inf file.The Arduino file system contains a serial viewer that allows sending easy text data to and from Arduino boards. The RX and TX connectors will flash on the board when transferring data via USB-to-serial connector and USB connection to the computer (but not for serial communication on pins 0 and 1).
The software system library allows seamless communication within any digital PIN. The Atmeg 328 supports I2C information communication (TWI) and SPI. The Arduino software includes a wire library to support the use of the I2C car. Arduino programs are written in C or C ++ and the program code written for Arduino is called Sketch. Arduino IDE uses GNU and AVR LBC toolkit to compile programs, as well as upload programs using Android. For example, software for Arduino can be developed using the Arduino platform using Atmel micro-controllers, around the development of Atmel, AVR Studio or even the new Atmel Studio.

3.14 Easy EDA Software

Easy EDA is a web-based EDA tool suite that enables hardware engineers to design, simulate, share - publicly and privately - and discuss schematics, simulations and printed circuit boards. Other features include the creation of a bill of materials, Gerber files and pick and place files and documentary outputs in PDF, PNG and SVG formats. Easy EDA allows the creation and editing of schematic diagrams, SPICE simulation of mixed analogue and digital circuits and the creation and editing of printed circuit board layouts and, optionally, the manufacture of printed circuit boards.

Subscription-free membership is offered for public plus a limited number of private projects. The number of private projects can be increased by contributing high quality public projects, schematic symbols, and PCB footprints and/or by paying a monthly subscription.Registered users can download Gerber files from the tool free of charge; but for a fee, Easy EDA offers a PCB fabrication service. This service is also able to accept Gerber file inputs from third party tools.

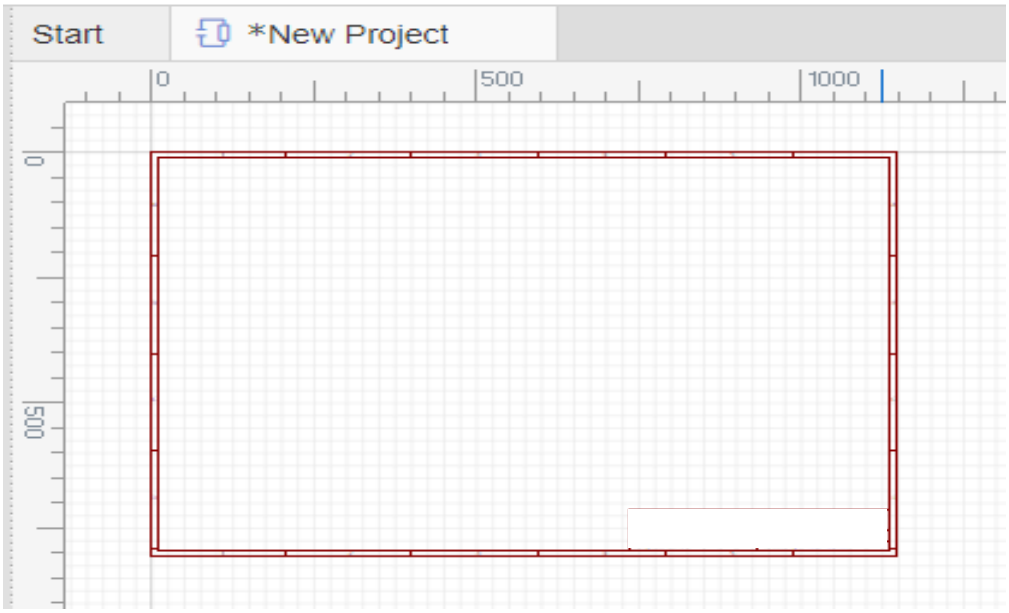


Figure 3.23: Easy EDA Software Interface

CHAPTER 4

METHODOLOGY

4.1 Our methodologies for the project

Our methodologies for the project:

- Creating an idea for **Smart Monitoring Of The Train And Train Tracks To Prevent Railway Hazards**. And designing a block diagram & circuit diagram to know which components we need to construct it.
- Collecting all the components of our system.
- Setting up all the components in a PCB board & then soldering. Lastly, assembling all the blocks in a board and to run the system & for checking purposes.

4.2 Working Step Chart

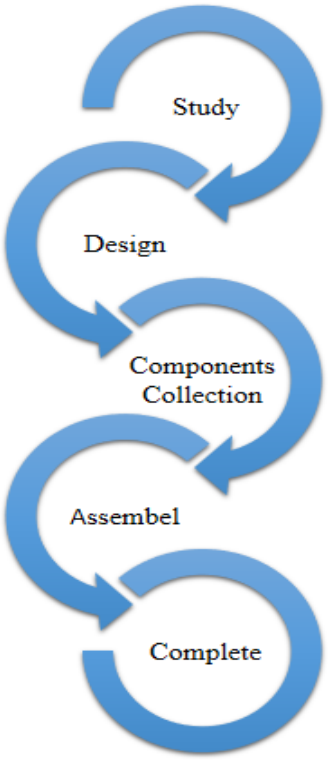


Figure 4.1: Working Step Chart

4.3 Block Diagram

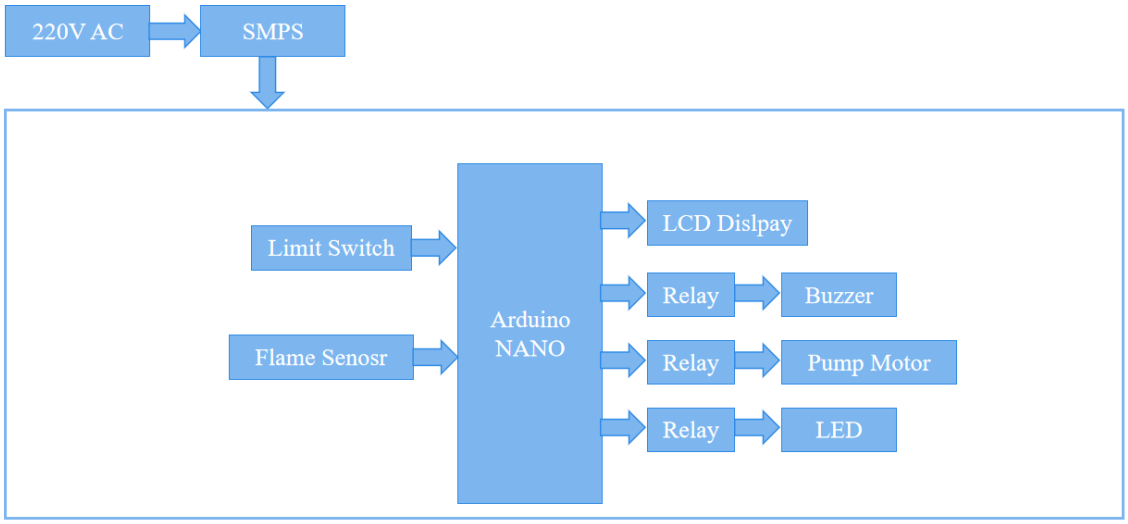


Figure 4.2: Block Diagram of Our System

4.4 Schematic Diagram

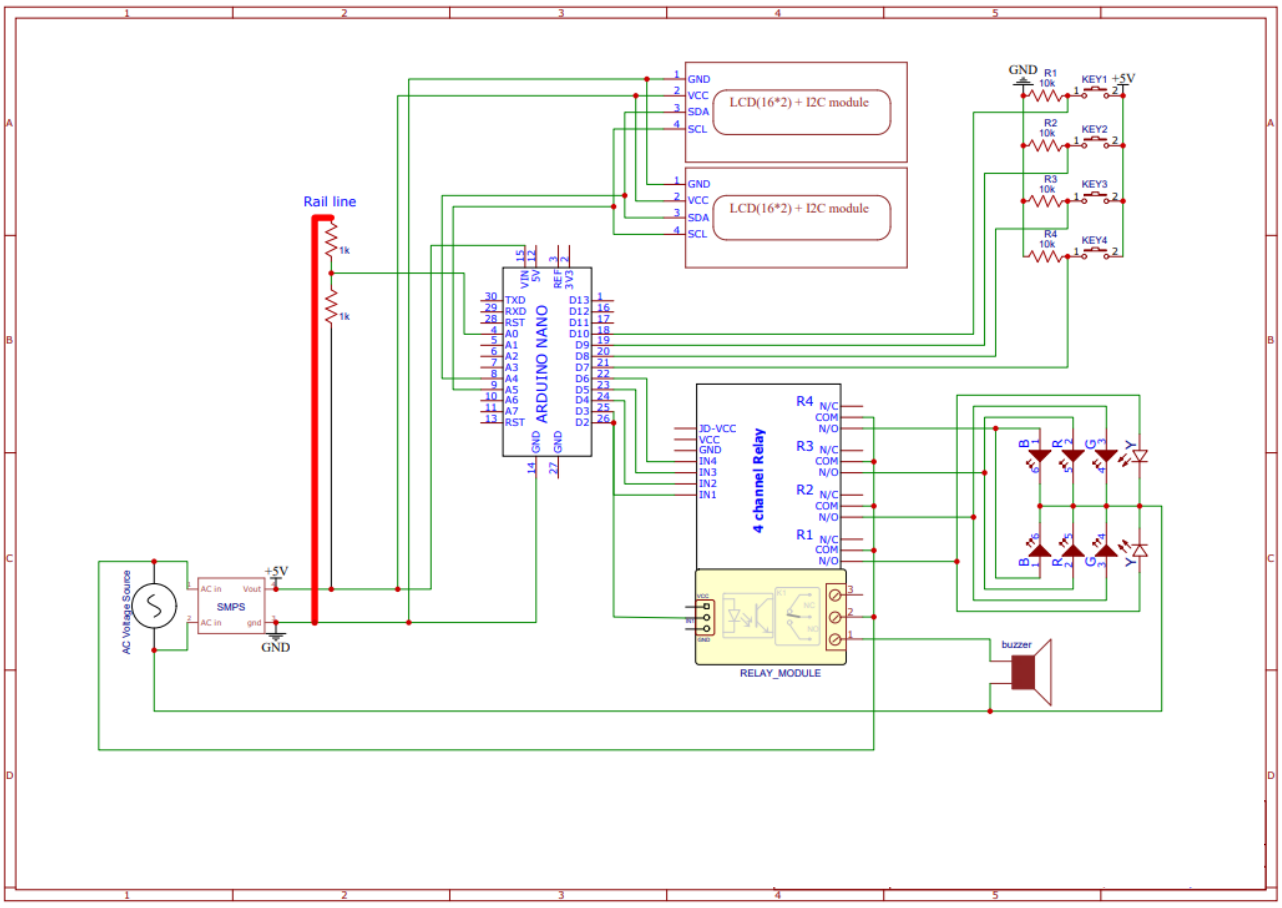


Figure 4.3: Schematic Diagram of the Project

4.5 Working Principle

"Smart Monitoring of Trains and Train Tracks for Railway Hazard Prevention" project involves integrating various electronic components to continuously monitor critical parameters of trains and tracks.The schematic diagram here is representing the electrical circuit and the components of the project. Here we have used standardized symbols and lines.The Arduino Nano serves as the central processing unit of the system. It collects data from sensors, processes it, and controls the operation of output devices based on predefined algorithms.Sensors .These sensors are installed on trains and along tracks to detect anomalies such as excessive vibrations, abnormal temperatures, or track irregularities.Electrical .LED lights are used as visual indicators to provide warnings or status notifications. They can be activated to indicate different levels of urgency or specific types of hazards detected by the sensors.An LCD display provides a user-friendly interface for displaying detailed information about detected hazards, train status, or system diagnostics. It offers real-time updates and enables operators to make informed decisions. The buzzer emits an audible alarm to alert train operators and maintenance personnel in case of critical hazards or emergencies. The sound can attract immediate attention and prompt appropriate responses.SMPS (Switched-Mode Power Supply) The SMPS provides a stable power supply to the system, ensuring consistent operation of all electronic components. It converts input voltage to the required levels for powering the Arduino Nano, sensors, and output devices. Relays are used to control high-power or high-voltage devices, such as signaling systems or emergency brakes. They enable the Arduino Nano to trigger emergency protocols or activate safety mechanisms when hazardous conditions are detected.Limitation switches are used as safety mechanisms to detect the position or movement of mechanical components, such as doors or switches. They provide feedback to the Arduino Nano, ensuring that safety protocols are followed correctly.This is a device that detects by ‘fire sensor’ and warns people about a potential fire through visual and auditory signals . It can be automated and connected to a central monitoring system.In the context of fire safety, a water spray system use the device is ‘DC mini Pump’ could be a fire suppression system that uses water to control or extinguish fires. This system can be designed for specific areas or equipment.This could include a communication system to alert by use sound “Buzzer’’ relevant personnel or occupants about a fire.

4.6 Our Final System View

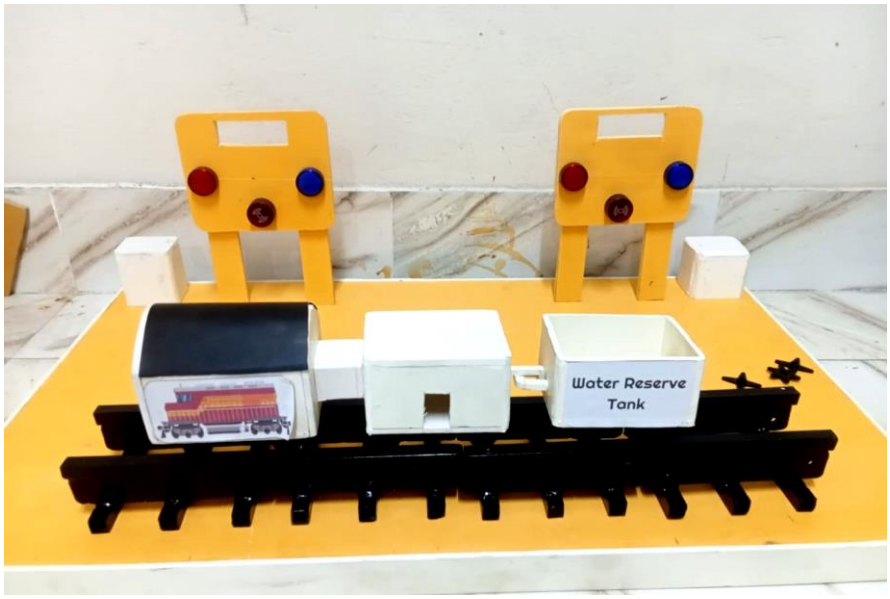


Figure 4.4: Our Final System Overview

CHAPTER 5
RESULT AND DISCUSSION

5.1 Result

This chapter contains the results obtained and discussion about the full project. Our project is railway truck cutting catch system. In our project making we used PVC boards for total hardware making. After finally completing this project, we ran it & we observed the output of this project. We can see that it is working well as expected. After making our project we observe it very careful. It works as we desire. Our project give output perfectly and all equipment are work perfectly. We check how much it works and we get perfect output from this project.

- Finally, we have completed our project successfully & check our project its run accurately according to our objective.
- At first, we start our system.
- If the car has an accident, it will track the location of the car via telephone and send a text to the rescue team's phone.
- This will make it easier to get an accident vehicle out, and rescue teams will be able to get there quickly..
- Then the system will be able to work properly.
- Then Train when start to the line detected the limit switch .
- Then cross gate will be down the supported them to the line and truck cutt the train before the cross line and sound to the buzzer on brip sound .
- When any time fire any train part that’s time water pump automatic spay on the fire .
- Anybody Cut at a line that’s time going to the bif the sound to the driver and to the plate form contractor alart

5.2 Discussion

While working on our project, we did face some difficulties as it is a very complex system but the end results, we came up with were quite satisfactory. We have put the whole system through several tasks to validate our work and also have taken necessary

notes for future improvements. Some future recommendations that we have involves improvement in system design and wiring, adding features for more efficient.

5.3 Advantage

There are many advantages of our project because of its accuracy. Some of the advantages are pointed out below:

- Accident location detected automatically.
- Automatic text sends to rescue team.
- Reduce the searching time to find accident car.
- This project is easy to use.
- Cost effective.
- User-friendly.
- Automatic and requires less human interaction.
- Can be operated virtually from anywhere in the world.
- The whole system consumes very little energy.

5.4 Application

Some of the application areas of the project have been pointed out below:

- It can be used in any kind of vehicle.
- Vehicle Safety and Accident Detection
- Location Tracking and Recovery
- Emergency Response System
- Smart Transportation Systems
- Driver Assistance and Safety Features

5.5 Limitations

Though this project has many advantages but it has some limitations as well and they are listed below:

- Here we used Chinese products, for the prototype so there's some processing delay present in the circuit.
- In limit switch line to cross must be have some money to send to bip
- This project can now be only used for small scale purposes.

CHAPTER 6
CONCLUSION

6.1 Conclusion

In conclusion, ensuring railway safety requires a multifaceted approach that integrates regulatory compliance, stakeholder engagement, risk assessment, technological advancements, human factors analysis, emergency preparedness, and continuous improvement initiatives. By following the methodology outlined above, railway operators, infrastructure managers, regulatory authorities, and other stakeholders can effectively manage risks, enhance safety performance, and mitigate the likelihood and severity of railway accidents and incidents. Through regulatory analysis, stakeholders can establish a solid foundation for compliance with safety standards and guidelines, providing a framework for safety management practices. Stakeholder engagement facilitates collaboration and consensus-building among diverse parties, ensuring that safety initiatives reflect the needs and perspectives of all involved.Risk assessment serves as a proactive tool for identifying and prioritizing safety hazards, enabling targeted interventions to reduce risk exposure. Safety performance indicators provide measurable metrics to track progress and evaluate the effectiveness of safety initiatives over time.The integration of advanced technologies such as train control systems, track inspection technologies, and communication networks enhances safety capabilities and enables timely response to safety-critical events. Human factors analysis underscores the importance of addressing human error and organizational factors in ensuring railway safety.Emergency preparedness and response planning enable stakeholders to effectively manage emergencies and minimize their impact on passengers, railway personnel, and the surrounding communities. Continuous improvement fosters a culture of learning and adaptation, driving ongoing enhancements to safety policies, procedures, and technologies.

6.2 Future Scope

We are thinking about adding many features to our project in the future to get more desirable outcomes. Some of the steps that we are thinking about taking are given below:

- In future development this project can be develop by more sensor & alarm system.
- In future we will add a huge battery source.

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APPENDIX

Programming Code:

```
#include <LiquidCrystal_I2C.h>   // scl=d1& sda=d2
LiquidCrystal_I2C lcd(0x27, 16, 2);  // I2C address 0x3F, 16 columns and 2 rows



int track1 = 7;
int track2 = 8;
int track3 = 9;
int track4 = 10;
int t1;
int t2;
int t3;
int t4;

int r = 2;
int y = 3;
int g = 4;
int b = 5;
int s = 6;

int line_volt = 11;
int lv;

void setup() {
  // put your setup code here, to run once:
Serial.begin(9600);
pinMode(track1,INPUT);
pinMode(track2,INPUT);
pinMode(track3,INPUT);
pinMode(track4,INPUT);
pinMode(line_volt,INPUT);

pinMode(r,OUTPUT);
pinMode(y,OUTPUT);
pinMode(g,OUTPUT);
pinMode(b,OUTPUT);
pinMode(s,OUTPUT);

 lcd.init();      // initialize the lcd
 lcd.backlight(); // open the backlight
}

void loop() {
  // put your main code here, to run repeatedly:
  t1 = digitalRead(track1);
```

```
  t2 = digitalRead(track2);
  t3 = digitalRead(track3);
  t4 = digitalRead(track4);
  Serial.print(t1);
  Serial.print(t2);
  Serial.print(t3);
  Serial.println(t4);
if(t1 == 0 && t2 == 0 && t3 == 0 && t4 == 0){
  digitalWrite(r,LOW);
  digitalWrite(y,LOW);
  digitalWrite(g,LOW);
  digitalWrite(b,LOW);
  digitalWrite(s,LOW);
  lcd.setCursor(0,0);
  lcd,print("All OK");

  }
if(t1 == 1 && t2 == 0 && t3 == 0 && t4 == 0){
  digitalWrite(r,HIGH);
  digitalWrite(y,LOW);
  digitalWrite(g,LOW);
  digitalWrite(b,LOW);
  digitalWrite(s,HIGH);
  lcd.setCursor(0,0);
  lcd,print("Track-1 Fault");

  }
if(t1 == 0 && t2 == 1 && t3 == 0 && t4 == 0){
  digitalWrite(r,LOW);
  digitalWrite(y,HIGH);
  digitalWrite(g,LOW);
  digitalWrite(b,LOW);
  digitalWrite(s,HIGH);
   lcd.setCursor(0,0);
  lcd,print("Track-2 Fault");
  }
 if(t1 == 0 && t2 == 0 && t3 == 1 && t4 == 0){
  digitalWrite(r,LOW);
  digitalWrite(y,LOW);
  digitalWrite(g,HIGH);
  digitalWrite(b,LOW);
  digitalWrite(s,HIGH);
   lcd.setCursor(0,0);
  lcd,print("Track-3 Fault");
  }
if(t1 == 0 && t2 == 0 && t3 == 0 && t4 == 1){
  digitalWrite(r,LOW);
  digitalWrite(y,LOW);
  digitalWrite(g,LOW);
  digitalWrite(b,HIGH);
```

```
  digitalWrite(s,HIGH);
   lcd.setCursor(0,0);
  lcd,print("Track-4 Fault");
  }
////////////////////////////////////////////////////////////////////////////////////////
if(t1 == 1 && t2 == 1 && t3 == 0 && t4 == 0){
  digitalWrite(r,HIGH);
  digitalWrite(y,HIGH);
  digitalWrite(g,LOW);
  digitalWrite(b,LOW);
  digitalWrite(s,HIGH);
   lcd.setCursor(0,0);
  lcd,print("Track-1&2 Fault");
  }
if(t1 == 0 && t2 == 1 && t3 == 1 && t4 == 0){
  digitalWrite(r,LOW);
  digitalWrite(y,HIGH);
  digitalWrite(g,HIGH);
  digitalWrite(b,LOW);
  digitalWrite(s,HIGH);
   lcd.setCursor(0,0);
  lcd,print("Track-2&3 Fault");
  }
 if(t1 == 0 && t2 == 0 && t3 == 1 && t4 == 1){
  digitalWrite(r,LOW);
  digitalWrite(y,LOW);
  digitalWrite(g,HIGH);
  digitalWrite(b,HIGH);
  digitalWrite(s,HIGH);
   lcd.setCursor(0,0);
  lcd,print("Track-3&4 Fault");
  }
////////////////////////////////////////////////////////////////////////////////////////
if(t1 == 1 && t2 == 1 && t3 == 1 && t4 == 0){
  digitalWrite(r,HIGH);
  digitalWrite(y,HIGH);
  digitalWrite(g,HIGH);
  digitalWrite(b,LOW);
  digitalWrite(s,HIGH);
  lcd.setCursor(0,0);
  lcd,print("Track-1,2&3 Fault");
  }
 if(t1 == 0 && t2 == 1 && t3 == 1 && t4 == 1){
  digitalWrite(r,LOW);
  digitalWrite(y,HIGH);
  digitalWrite(g,HIGH);
  digitalWrite(b,HIGH);
  digitalWrite(s,HIGH);
  lcd,print("Track-2,3&4 Fault");
```