SENSOR-BASED RAILWAY GATE OPERATION SYSTEM

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# ABSTRACT

### Introduction:-

Railway gate is very essential for security purposes. If there is any defect in the system it will damage one or more life. Every year thousands of accidents occur on railway crossings and thousands of people are dying.

### Importance of this project:-

The objective of this project is to provide an automatic railway gate at a level crossing replacing the gates operated by the gatekeeper. It deals with two things. Firstly, it deals with the reduction of time

**Implementation Mode**:- Hardware and software

### Expected Outcome:-

Hence, if the train is late due to certain reasons, then gate remain closed for a long-time causing traffic near the gates. Hence, the time for which it is closed is less compared to the manually operated gates and also reduces the human labour.

### Applications:-

1. Railways gate controlling, 2] Parking gate controlling, 3] Toll gates

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## ABBREVIATIONS

1. Ultra Sonic sensor - Infrared Sensor
2. ICSP- In-Circuit Serial Programming
3. LCD- Liquid Crystal Display
4. CRT- Cathode Ray Tube
5. LED- Light Emitting Diode
6. TFT- Thin Film Transistor
7. SMD- Surface Mount Design
8. IDE- Integrated Development Environment

# CHAPTER 1

## INTRODUCTION

#### PROJECT OVERVIEW:

In India, the major ways of transportation used are roads and railways, many a times the both are crossing over. And in some places there are gates provided for controlling the crossover of both and other major cases none is provided that lead to accidents.In a big populated country like India, accidents are a daily crisis that is being faced by the people.Most of these accidents are Road accidents few percentages of these accidents occurs the railway level crossings. To prevent these accidents on the railway level crossing the automated system is proposed.

The arrival and departure of trains is done by the sensors set. The automatic railway gate has two main advantages :

* + 1. The reduction of time for which the gate is Being kept closed.
    2. To provide safety for the roads users by reducing the accidents as there is no scope of human errors in this case The safety and efficiency of railway systems are crucial, especially at level crossings where roads intersect with railway tracks. Traditional railway gate operation systems often rely on manual control or basic automated systems that are prone to human error and technical failures.

A sensorbased railway gate operation system aims to enhance safety and operational efficiency by utilizing advanced sensors and automation technologies to control railway gates. This project involves designing and implementing a system that can automatically detect approaching trains and operate the gates to ensure safe and timely closure and reopening, reducing the risk of accidents.

#### OBJECTIVE

Develop an automated railway gate control system that uses sensors to detect approaching trains and control the opening and closing of gates at level crossings.

* Enhance safety for both railway and road users.
* Minimize human intervention and error in gate operation.

This project aims to develop a sensor-based railway gate operation system designed to enhance safety and efficiency at level crossings. Traditional manual and semi-automated systems are susceptible to human error and operational delays, posing significant risks. The proposed system employs advanced sensors, such as infrared and ultrasonic sensors, to detect approaching trains and automatically control the opening and closing of railway gates. An arduino sensor data to manage gate operations, ensuring timely closure and reopening. Additional features include communication modules for remote monitoring and emergency override mechanisms for added safety.

By automating gate control, the system aims to reduce accidents, improve operational efficiency, and minimize human intervention. The project addresses challenges related to sensor accuracy, Authorized licensed use limited to: DRDO- ADA. Downloaded on June 22,2023 at 07:50:25 UTC from IEEE Xplore. Restrictions apply. system reliability, integration with existing infrastructure, and cost. Ultimately, this sensor-based solution represents a significant step forward in modernizing railway safety protocols. The figure1 shows the sensor based monitoring of railway gate in traditional manner

#### BLOCK DIAGRAM DESCRIPTION:

* + 1. BLOCK DIAGRAM:

|  |
| --- |
| ULTRA SONIC 1 |
| ULTRA SONIC 2 |

**Fig 1.2 Block Diagram of Automatic Railway Gate Control System using Arduino Uno**

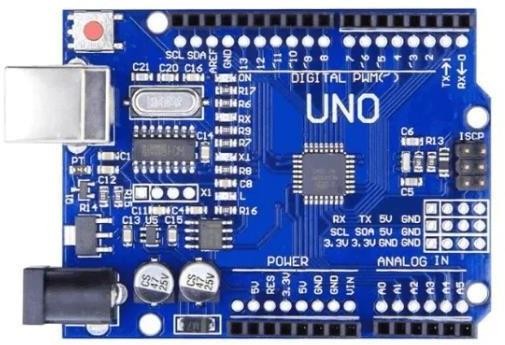
## BLOCK DIAGRAM DESCRIPTION:

## Power Supply:

Here we used +5V dc power supply. Power supply is a supply of electrical power. A device or system that supplies electrical or other types of energy to an output load or group of loads is called a power supply unit or PSU. The term is most commonly applied to electrical energy supplies, less often to mechanical ones, and rarely to others. Conversion of one form of electrical power to another desired form and voltage, typically involving converting AC line voltage to a well-regulated lower-voltage DC for electronic devices. Low voltage, low power DC power supply units are commonly integrated with the devices they supply, such as computers and household electronics.

##### Arduino Uno:

Arduino UNO is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

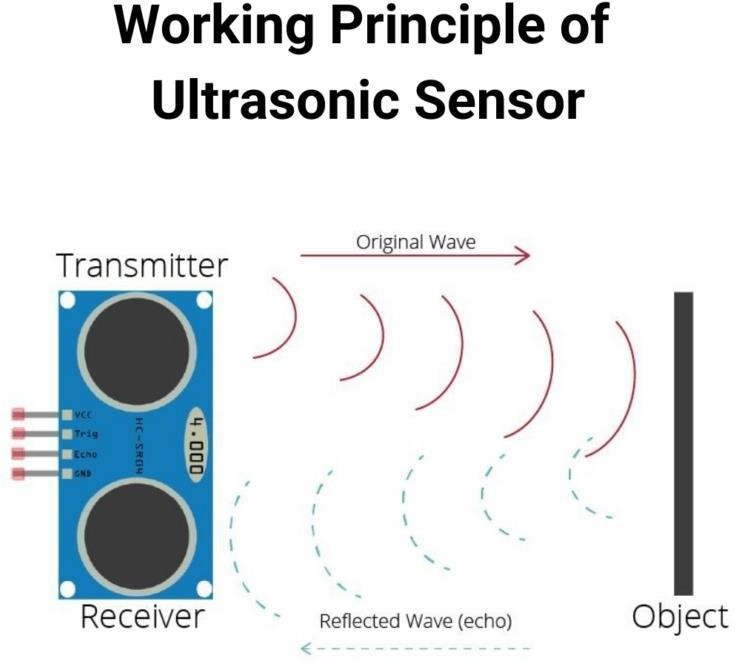


##### Fig 1.2 Arduino Uno

* + 1. **ULTRASONIC Sensor:**

An ultrasonic sensor is an instrument that measures the distance to an object using ultrasonic sound waves. An ultrasonic sensor uses a transducer to send and receive ultrasonic pulses that relay back information about an object's proximity. Ultrasonic sensors play a crucial role in ensuring the safety and efficiency of a sensor-based railway gate operation system. Here's a detailed explanation of how they function within this project.

Ultrasonic sensors operate on the principle of echolocation, similar to how bats navigate. They emit ultrasonic sound waves, which are sound waves with frequencies higher than the human audible range (typically above 20 kHz). These waves travel through the air and reflect back when they hit an object. The sensor measures the time it takes for the waves to return, and this time interval is used to calculate the distance to the object.

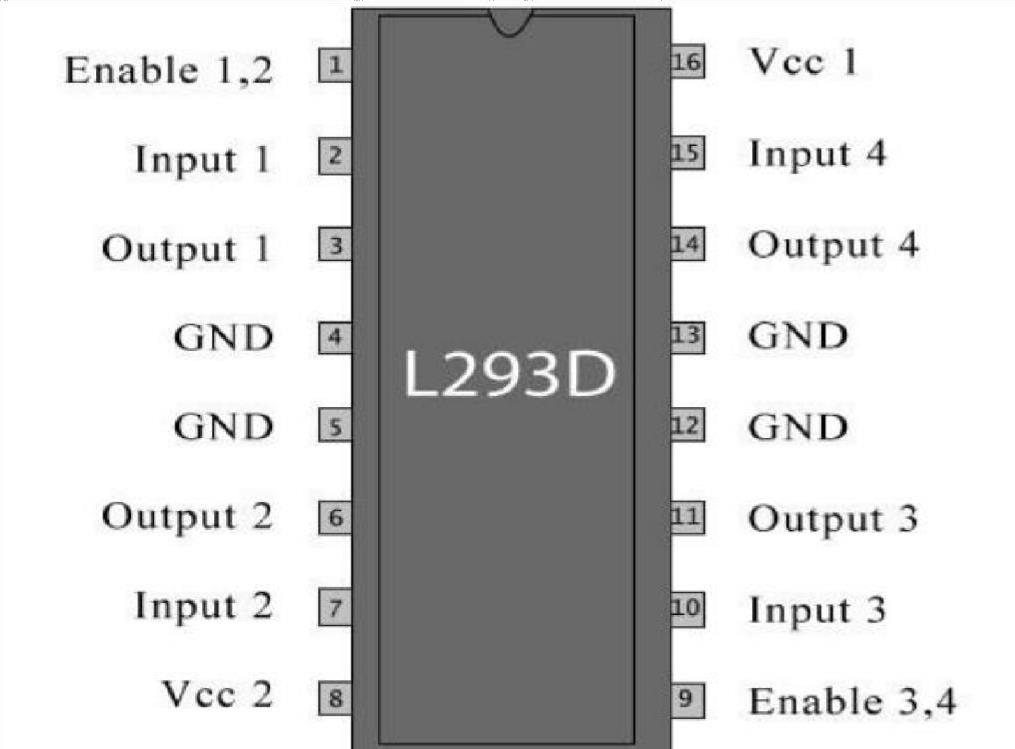


##### Fig1.3:Principle of Ultrasonic sensor

**1.3.4 Motor Driver:**

L293D is a dual H-bridge motor driver integrated circuit (IC). Motor drivers act as current amplifiers since they take a low-current control signal and provide a highercurrent signal. This higher current signal is used to drive the motors. L293D contains two inbuilt H-bridge driver circuits. In its common mode of operation, two DC motors can be driven simultaneously, both in forward and reverse direction.

The motor operations of two motors can be controlled by input logic at pins 2 & 7 and 10 & 15. Input logic 00 or 11 will stop the corresponding motor. Logic 01 and 10 will rotate it in clockwise and anticlockwise directions, respectively. 18 Enable pins 1 and 9 must be high for motors to start operating. When an enable input is high, the associated driver gets enabled. As a result, the outputs become active and work in phase with their inputs. Similarly, when the enable input is low, that driver is disabled, and their outputs are off and in the high-impedance state.



**Fig 1.4 Motor Driver Pin Description**

**Table 1.1 Motor Driver Pin Description**

|  |  |  |
| --- | --- | --- |
| PIN.NO | FUNCTION | NAME |
| 1 | Enable pin for Motor 1; active high | Enable 1,2 |
| 2 | Input 1 for Motor 1 | Input 1 |
| 3 | Output 1 for Motor 1 | Output 1 |
| 4 | Ground (0V) | Ground |
| 5 | Ground (0V) | Ground |
| 6 | Output 2 for Motor 1 | Output 2 |
| 7 | Input 2 for Motor 1 | Input 2 |
| 8 | Supply voltage for Motors; 9-12V (up to 36V) | VCC |
| 9 | Enable pin for Motor 2; active high | Enable 3,4 |
| 10 | Input 1 for Motor 1 | Input 3 |
| 11 | Output 1 for Motor 1 | Output 3 |
| 12 | Ground (0V) | Ground |
| 13 | Ground (0V) | Ground |
| 14 | Output 2 for Motor 1 | Output 4 |
| 15 | Input2 for Motor 1 | Input 4 |
| 16 | Supply voltage; 5V (up to 36V) | VCC |

* + 1. **Buzzer:**

A buzzer or beeper is an audio signalling device, which may be mechanical, electromechanical, or piezoelectric. Typical uses of buzzers and beepers include alarm devices, timers, train and confirmation of user input such as a mouse click or keystroke. A buzzer is a small yet efficient component to add sound features to our project/system.

It is very small and compact 2-pin structure hence can be easily used on breadboard, Perf Board and even on PCBs which makes this a widely used component in most electronic applications. There are two types of buzzers that are commonly available.



##### Fig 1.5 Buzzer

The one shown here is a simple buzzer which when powered will make a Continuous Beeeeeeppp.... sound, the other type is called a readymade buzzer which will look bulkier than this and will produce a Beep. Beep. Beep. Sound due to the internal oscillating circuit present inside it. But, the one shown here is most widely used because it can be customised with help of other circuits to fit easily in our application.

This buzzer can be used by simply powering it using a DC power supply ranging from 4V to 9V. A simple 9V battery can also be used, but it is recommended to use a regulated

+5V or +6V DC supply. The buzzer is normally associated with a switching circuit to turn ON or turn OFF the buzzer at required time and require interval.

**1.4 LITERATURE SURVEY**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **S.**  **no** | **Name of the author** | **Paper title** | **International journal/confe rence** | **Month/ Year** | **Description** | **Limitati on** |
| **1** | Abdullah Faizan | Review on Automatic Railway gate Control | International journal of research in advent technology | 2016 | To control the railway gate crossing with automation | System cannot work for very fast trains |
| **2** | Meheniger Alam | Hydroloic road system and railway gate control | Journal of Automation systems. | 2023 | The detection of arrival of train | Sensor do not work well in hill areas |
| **3** | A. Darwin Nesa Kumar | Automatic Railway gate control | AIP  Conference proceedings | 2024 | Automation of opening of gates | Gate delay and interval times |
| **4** | Kapu Ajay | Automatic Railway using IOT | Journal of Engineering Sciences | 2023 | Automation of gate operation done using sensors | Vechile detection |

# CHAPTER 2

### THEORETICAL ANALYSISs

##### Hardware Description:

##### Technical Description:

An Automatic Railway Gate Control System is a project that involves designing a system to automatically control the opening and closing of railway gates based on the arrival and departure of trains. This system ensures safety by preventing collisions between trains and vehicles or pedestrians at railway crossings.

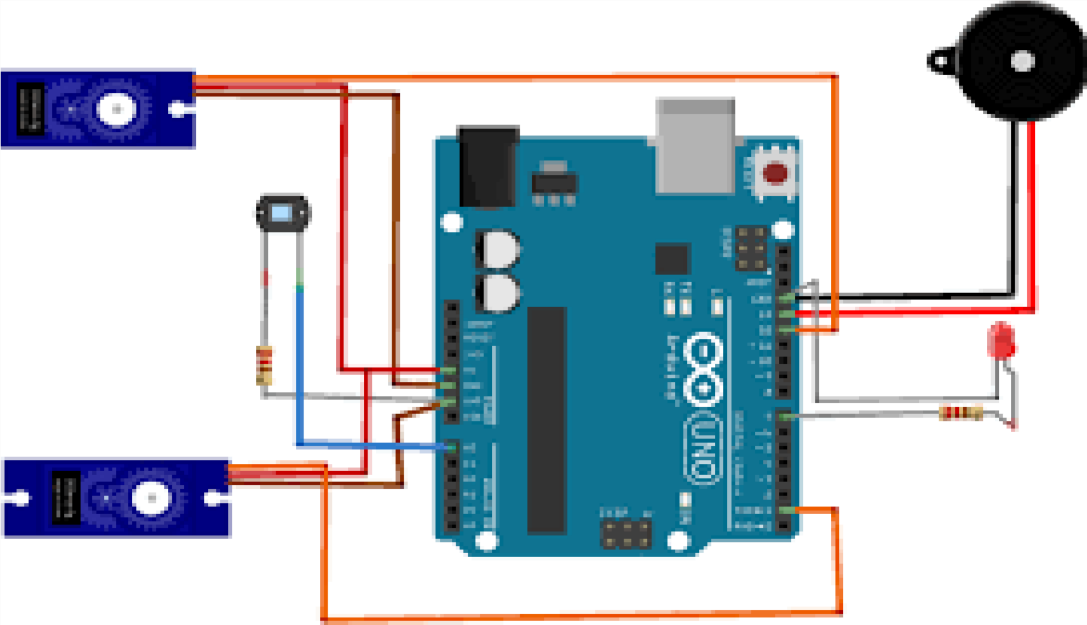
##### Working:

1. The main controlling device of the whole system is ARDUINO.
2. Ultra Sonic sensor, Buzzer, Servo Motor is interfacing to the Arduino microcontroller.
3. When the Ultra Sonic sensor detects the train, this data process to the Arduino then Arduino will open and close the gate along with buzzer automatically.
4. Servo motors works as a gates.
5. To achieve this task using Arduino UNO microcontroller loaded program written in embedded C language.

##### Procedure:

* + - 1. Take all the components required.
      2. Connect two Ultra Sonic sensor to left and right sides of Arduino 5V pin.
      3. Connect Motor Driver to Arduino digital pin 4.
      4. Connect Buzzer to Arduino digital pin 9.
      5. Write Arduino code to read sensor data, control the gate mechanism, and implement safety features.
      6. Observe the closing and opening of gate with respect to train arrival.

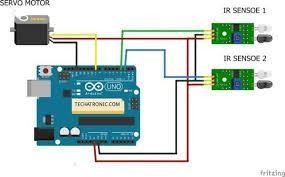
##### Schematic Diagram:

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**Fig 2.1 Schematic Diagram**

#### EXISTING SYSTEM

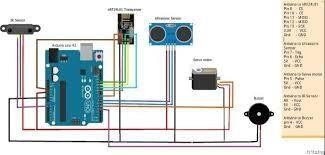
* The existing solution for an automatic railway gate system typically involves sensors placed near the railway tracks to detect the presence of an approaching train.
* When a train is detected, the gate is automatically closed to prevent vehicles or pedestrians from crossing the tracks. Once the train has passed, the gate is opened again**.**
* This system also utilizes commercial programming using IDE but proposed system is developed using python that can easily detect train arrival and accurately operates the gate **.**



**Fig2.2: Existing system**

#### PROPOSED SYSTEM

* In our system, we are placing ultrasonic sensors near the railway tracks. Ultrasonic sensors are used in this system, because it has a very high range
* At a certain distance before the level crossing and after the level crossing, these ultrasonic sensors are placed.



**Fig 2.3 Proposed system**

#### USE OF ULTRASONIC SENSOR

While ultra sonic sensors offer several advantages, they also have limitations that should be considered when choosing them for a sensor-based railway gate operation system: Ultra Sonic sensor may be affected by sunlight, especially in outdoor environments, leading to false readings or reduced accuracy. Extreme weather conditions such as fog, rain, or snow can interfere with Ultra Sonic sensor performance, affecting their reliability. Accumulation of dust, dirt, or debris on the sensor's surface can obstruct the infrared beam, leading to inaccurate readings or sensor failure. Ultra Sonic sensor typically have a limited detection range compared to other sensors like ultrasonic sensors.

This limitation may require more sensors to cover a larger area effectively, increasing system complexity and cost. Ultra Sonic sensor rely on detecting reflections from objects. They may struggle to detect non-reflective or transparent objects, leading to incomplete or inaccurate detection. Ultra Sonic sensor require a clear line of sight between the emitter and the receiver. Any obstruction between them, such as vegetation, structures, or vehicles, can hinder detection accuracy and reliability.

Objects casting shadows on the sensor or blocking the infrared beam can cause false readings or missed detections, particularly in complex or cluttered environments. Ultra Sonic sensor may experience interference from other infrared sources, such as heat sources or nearby electronic devices, leading to false readings.In systems with multiple Ultra Sonic sensor, crosstalk between sensors can occur, where signals from one sensor affect the readings of another, complicating data interpretation and potentially leading to errors. Extreme temperatures can affect the performance and reliability of Ultra Sonic sensor, potentially leading to drift in readings or sensor malfunction.

Evaluating these factors against the specific requirements and operating conditions of the railway gate operation system will help ensure an appropriate sensor selection that balances performance, reliability, and cost-effectiveness. Figure3 describes the ultrasonic arrangement. In our system, we are placing ultrasonic sensors near the railway tracks. Ultrasonic sensors are used in this system, because it has a very high range . At a certain distance before the level crossing and after the level crossing, these ultrasonic sensors are placed.

##### Reason to choose Ultrasonic Sensors in a Sensor-Based Railway Gate Operation System

Ultrasonic sensors are highly suitable for a sensor-based railway gate operation system due to their unique advantages and features. Here are the key reasons for choosing ultrasonic sensors for this application: Ultrasonic sensors operate without physical contact with the object being detected. This reduces wear and tear on the sensor and ensures a longer lifespan compared to contact based sensors. They can be placed at a distance from the railway track, minimizing the risk of damage from passing trains or other environmental factors.

Ultrasonic sensors provide accurate distance measurements, essential for determining the exact location and speed of an approaching train. They also offer reliable and consistent performance, ensuring precise detection and timing for gate operations. Ultrasonic sensors are relatively unaffected by environmental conditions such as fog, rain, dust, and varying light conditions. This makes them highly reliable for outdoor applications. They function effectively across a broad range of temperatures and weather conditions, ensuring year-round reliability.

Ultrasonic sensors can detect objects at long distances, which is crucial for early detection of approaching trains, allowing sufficient time for gate operations. They can cover wide areas and are capable of detecting large objects, such as trains, over significant distances. Ultrasonic sensors can be easily integrated into various system configurations and can be used alongside other types of sensors to enhance detection accuracy and reliability. They are versatile and can be used for different aspects of the railway gate operation system, such as train detection, speed measurement, and obstacle detection.

Ultrasonic sensors are designed to withstand harsh conditions, requiring minimal maintenance. This reduces operational costs and ensures long-term reliability. Many ultrasonic sensors have self-cleaning capabilities, preventing dust and debris from affecting their performance.. Multiple ultrasonic sensors can be used to provide redundancy, ensuring that the system remains02 operational even if one sensor fails. They enable real-time monitoring and quick response to changes, enhancing the safety and reliability of the gate operation system



##### Fig2.4 ULTRASONIC SENSOR

* + 1. **Advantages of Ultrasonic Sensors**
* Non-contact Measurement:

Ultrasonic sensors can measure distances without physical contact with the object, making them ideal for applications where contact is not feasible or could cause damage.

* Versatility:

They can detect a wide range of materials, including solids, liquids, and granular substances.

* Environmental Robustness:

Ultrasonic sensors are relatively unaffected by dust, smoke, and lighting conditions, ensuring reliable operation in various environments.

* High Precision:

They offer high accuracy in distance measurement, typically within a few millimetres

##### Application in Railway Gate Operation Systems In a sensor-based railway gate operations

Ultrasonic sensors can be used for detecting the presence and position of trains. Here’s how they would work in this context:

* + - 1. Installation:

Ultrasonic sensors are installed along the railway tracks at strategic points before and after the level crossing. Multiple sensors ensure continuous monitoring and redundancy.

* + - 1. Train Detection:

When a train approaches, the ultrasonic sensors emit sound waves. These waves reflect back from the train's surface and are detected by the sensors.

* + - 1. Distance Measurement:

The time interval between the emission and reception of the sound waves is measured. The control circuit calculates the distance to the train using the speed of sound.

* + - 1. Data Processing:

The measured distances are sent to a central microcontroller, which processes the data to determine the train's speed and proximity to the crossing.

* + - 1. Gate Control:

When the train is detected within a certain range, the microcontroller signals the gate actuators to close the gates. Once the train has passed, the gates are reopened based on signals from sensors placed after the crossing

# CHAPTER 3

## IMPLEMENTATION

##### The Design Methodology of the Proposed System

The proposed system consists of three main components. These are:

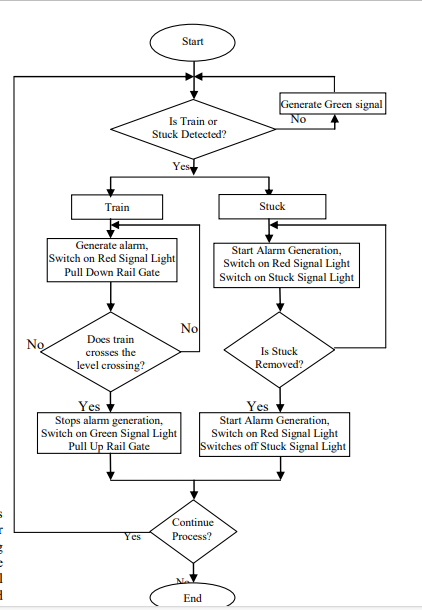
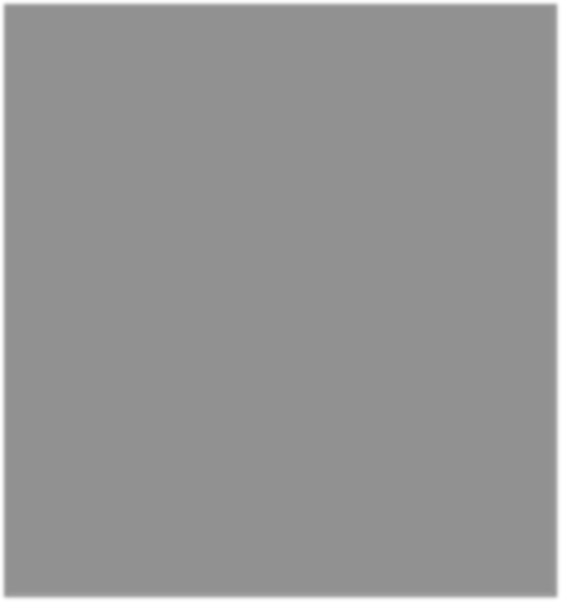
1. ultrasonic sensor
2. arduino uno &python
3. buzzer
4. LCD display

The ultrasonic sensors which are placed at both sides of the level crossing detect the train and another ultrasonic sensor which is placed at the level crossing detects the stuck of vehicle at level crossing. Once the ultrasonic sensors are triggered, the sensors will generate and transmit ultrasound in the forward direction. This ultrasound will be reflected back to the sensor if any object is present within 3 meter range.

The ultrasonic sensors are triggered at a regular time interval. If the both ultrasonic sensors of the any side of level crossing receive the reflected sound then the controller unit decides that a train is coming. If the ultrasonic sensor place at the middle of the level crossing receives the reflected sound continuously for a certain period then stuck is detected. If the train is detected, the controller measures the direction of the train, switches on the red lights, and generates alarm through alarm generator and pull down the gate immediately.

This situation remains unchanged until the train passes the both sensors of the other either side. After that the controller pulls up the gate, stops sound generation and switches on the green light immediately. When the stuck is detected, the controller switches on the stuck signal light of the both side of line crossing so that the train operator can take necessary steps to avoid devastating accident.

## FLOW DIAGRAM



##### The Train and Stuck detection

The scan angle of the proposed system is set to 0˚ because the sensors are placed parallel to the train. Ultrasonic signal transmitter and receiver are used for detecting the train and stuck on the level crossing in this system. Two ultrasonic sensors are located at the left and another two sensors are located at right side of the level crossing.

The pair of sensors are placed one Km apart from the level crossing and distance between two sensors of a pair is 10m. The transmitter emits the ultrasonic wave simultaneously and the receivers get the reflected wave. By analyzing the reflected wave the object can be detected. In the proposed system if two sensors of either side of the level crossing detects object at a time then it is assumed that a train is coming because 10m long object running through the rail line is generally the train. Obstacle is calculated using TOF (time of flight). In the proposed system The Ultra sonic sensors are place 1.5m apart from the rail line and it is considered that The maximum operating speed of train of Bangladesh is 100 km/h.

The time taken to travel 1km, the distance between the sensor meter is 36 seconds. If no obstacle is found then the sensors are triggered at the time interval of 1s seconds. If any obstacle is found by any sensor the system triggers the sensor repeatedly at 0.5s second interval.

##### Detection of Stuck on the level crossing

When there is a stuck on the level crossing the ultrasonic sensor which is place at the middle of the level crossing can detect the stuck. The scan angle of the sensor is set to 60˚. The sensor is triggered in every second. The received signal of the receiver is analyzed in every 10 seconds. If all transmitted signals are reflected and received by the receiver then the controller decides that there is a stuck on the level crossing.

##### Warning and signal generation

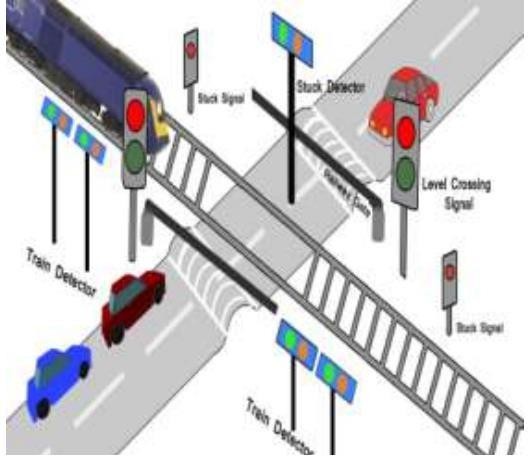
When a train is found, the controller starts generating alarm sound, switches off the green signal and switches on the red signal at both side of the road. Drivers stop their vehicles as soon as possible whenever they notice the red signal and alarm sound. When a stuck is detected on the level crossing the controller switches on the stuck signal lights so that the train operators can take decision to avoid collision.

##### Rail gate controlling

The Railway gate at the level crossing is operated according to the train coming towards the level crossing. The gate is always up position and when a train comes towards the level crossing the rail gate is pulled down. When the train passes the train a certain distance.

The level crossing then the gate is pulled up. In our proposed model we have used two servo motors. The motor is operated from 0o to 90o . Initially the gate is perpendicular to the ground and when the gate is pulled down then it becomes parallel to the ground. In our proposed system the gate is placed two meters apart from the both side of the level crossing. Gates, signal lights and alarm are synchronised by the control unit.

When the train comes towards the level crossing the controller switches on red signal lights, starts alarm generation and pull down the gate at a time. When the controller observes the train passed then the level crossing it immediately switches off the red signal, switches on green signal, stops alarm generation and pull up the gate at a time.



**Fig 3.1 abstract view of railway controlling**

# CHAPTER 4

## HARDWARE AND SOFTWARE REQUIRED

##### Modules:

##### Arduino Uno:

The Arduino Uno is a widely popular open-source microcontroller board that serves as a versatile platform for prototyping and implementing various electronic projects. The availability of both digital and analog pins makes the Arduino Uno adaptable to a wide array of projects. Powering the Arduino Uno is straightforward, as it can be connected to a computer via USB or supplied with power through an external source ranging from 7 to 12 volts. The inclusion of a USB interface simplifies the programming and communication processes, enabling seamless interaction with a computer for code development and transfer.

Programming the Arduino Uno is facilitated through the Arduino Integrated Development Environment (IDE), a user friendly platform that streamlines code creation and uploading to the board. This accessibility makes the Arduino Uno an excellent choice for beginners and experienced developers alike. One notable aspect of the Arduino Uno is its commitment to the open-source philosophy. The hardware design and software code are freely available, allowing users to modify and share their creations with the community. This collaborative and open nature has contributed to the widespread adoption and success of the Arduino platform in the maker and electronics communities.

In addition to its fundamental features, the Arduino Uno's pin configuration and capabilities play a pivotal role in its versatility. The digital pins can be configured for various tasks, including reading digital signals or generating PWM for applications like controlling motor speed or LED brightness. Simultaneously, the analog pins facilitate the connection of analog sensors, enabling the measurement of real-world phenomena such as temperature, light intensity, or sound levels.

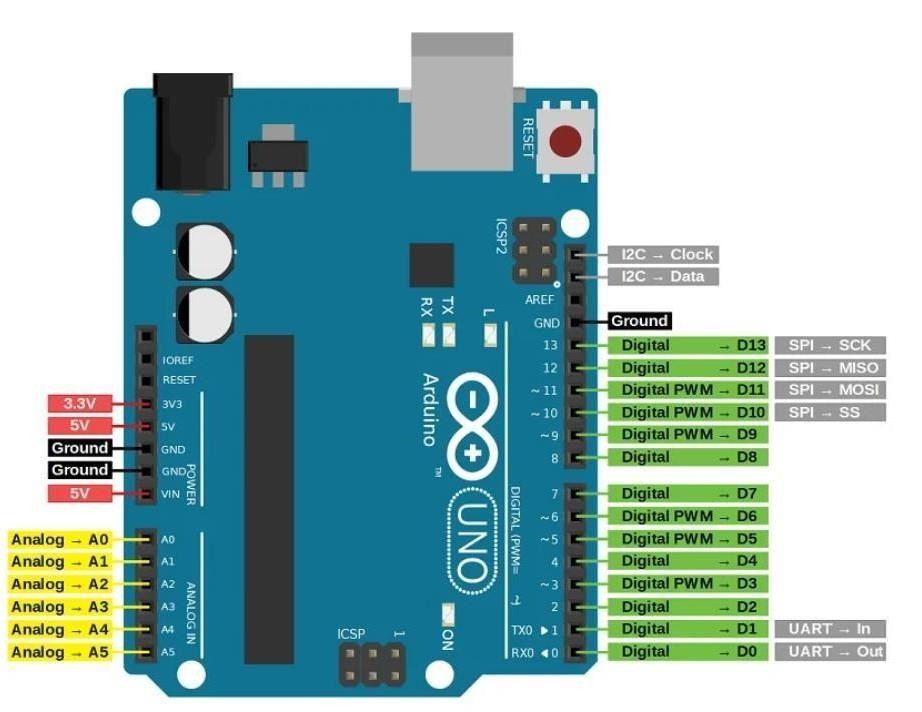
. The Arduino Uno's open-source nature fosters a vibrant community that continually contributes to its ecosystem. Users can access a vast repository of libraries and example codes, streamlining the development process.

The availability of shields add-on boards that seamlessly attach to the Arduino Uno further enhances its capabilities, allowing users to expand functionality without intricate wiring or soldering. In the educational realm, the Arduino Uno has become a cornerstone for introducing students to electronics and programming. Its approachable interface, extensive documentation, and wealth of online resources contribute to a supportive learning environment. Many universities, schools, and maker spaces incorporate the Arduino Uno into their curricula to provide hands-on experience with real-world applications of STEM concepts.

##### Features:

* + - * + The operating voltage is 5V
        + The recommended input voltage will range from 7v to 12V
        + The input voltage ranges from 6v to 20V
        + Digital input/output pins are 14
        + Analog input pins are 6
        + DC Current for each input/output pin is 40 mA
        + DC Current for 3.3V Pin is 50 mA
        + Flash Memory is 32 KB
        + SRAM is 2 KB
        + EEPROM is 1 KB
        + CLK Speed is 16 MHz

##### Pin Description:

****

**Fig 4.1 Arduino Pin Description**

**Vin:** This is the input voltage pin of the Arduino board used to provide input supply from an external power source.

**5V:** This pin of the Arduino board is used as a regulated power supply voltage and it is used to give supply to the board as well as on board components.

**3.3V:** This pin of the board is used to provide a supply of 3.3V which is generated from a voltage regulator on the board

**GND:** This pin of the board is used to ground the Arduino board.

**Reset:** This pin of the board is used to reset the microcontroller. It is used to Resets the microcontroller.

**Analog Pins:** The pins A0 to A5 are used as an analog input and it is in the range of 0-5V.

**Digital Pins:** The pins 0 to 13 are used as a digital input or output for the Arduino board.

**Serial Pins:** These pins are also known as a UART pin. It is used for communication between the Arduino board and a computer or other devices. The transmitter pin number 1 and receiver pin number 0 is used to transmit and receive the data resp.

**External Interrupt Pins:** This pin of the Arduino board is used to produce the External interrupt and it is done by pin numbers 2 and 3.

**PWM Pins:** This pins of the board is used to convert the digital signal into an analog by varying the width of the Pulse. The pin numbers 3,5,6,9,10 and 11 are used as a PWM pin.

**SPI Pins:** This is the Serial Peripheral Interface pin, it is used to maintain SPI communication with the help of the SPI library. SPI pins include:

1. SS: Pin number 10 is used as a Slave Select
2. MOSI: Pin number 11 is used as a Master Out Slave In
3. MISO: Pin number 12 is used as a Master In Slave Out
4. SCK: Pin number 13 is used as a Serial Clock

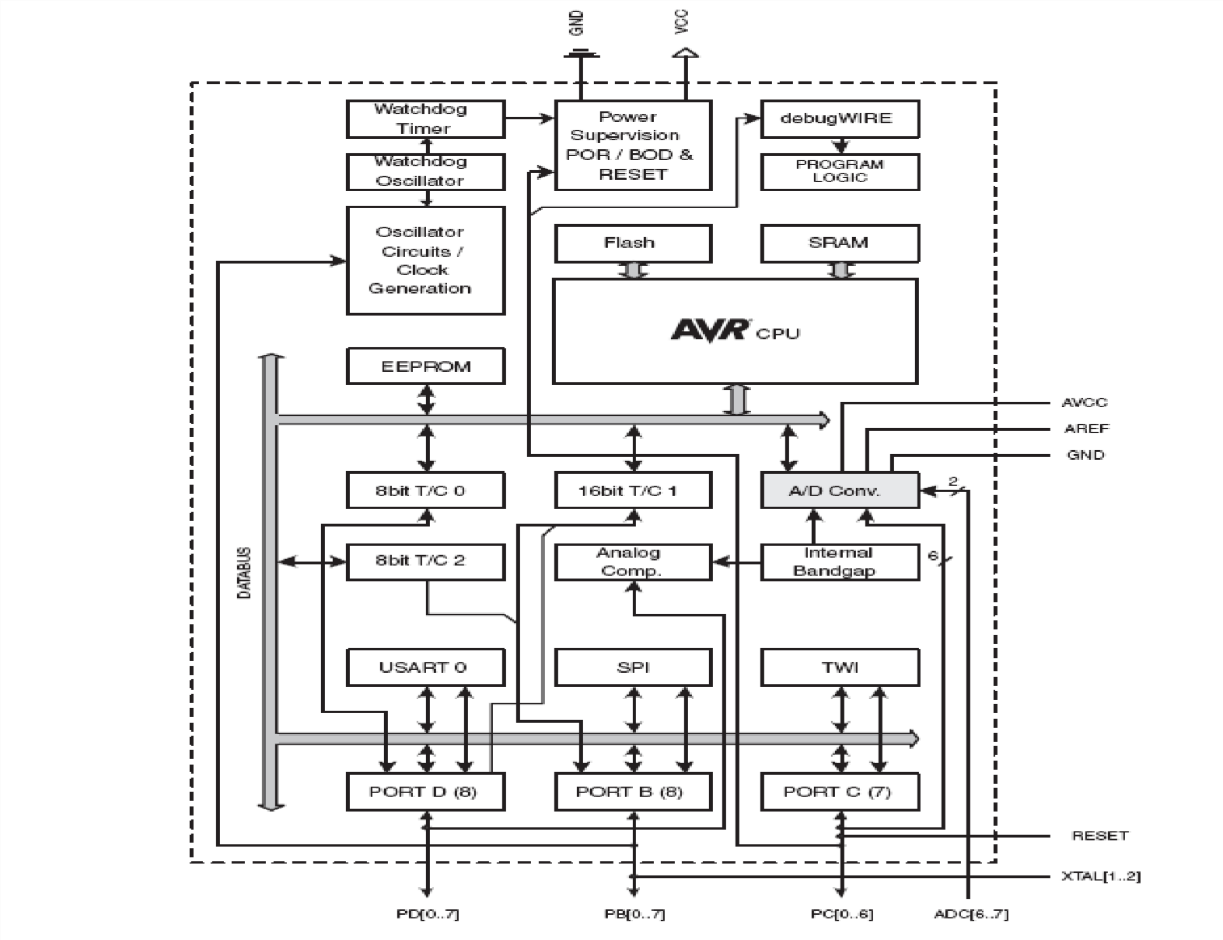
**LED Pin:** The board has an inbuilt LED using digital pin-13. The LED glows only when the digital pin becomes high.

**AREF Pin:** This is an analog reference pin of the Arduino board. It is used to provide a reference voltage from an external power supply.

##### ATmega:

The ATmega48PA/88PA/168PA/328P is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega48PA/88PA/168PA/328P achieves throughputs approaching 1 MIPS per MHz allowing the system designed to optimize power consumption versus processing speed.

### Block Diagram

****

##### Fig4.2 Block diagram of ATmega

The AVR core combines a rich instruction set with 32 general purpose working registers. All the 32 registers are directly connected to the Arithmetic Logic Unit (ALU), allowing two independent registers to be accessed in one single instruction executed in one clock cycle. The resulting architecture is more code efficient while achieving throughputs up to ten times faster than conventional CISC microcontrollers.

The ATmega48PA/88PA/168PA/328P provides the following features: 4K/8K bytes of In-System Programmable Flash with Read-While-Write capabilities, 256/512/512/1K bytes EEPROM, 512/1K/1K/2K bytes SRAM, 23 general purpose I/O lines, 32 general purpose working registers, three flexible Timer/Counters with compare modes, internal and external interrupts, a serial programmable USART, a byte-oriented 2-wire Serial Interface, an SPI serial port, a 6-channel 10-bit ADC (8 channels in TQFP and QFN/MLF packages), a programmable Watchdog Timer with internal Oscillator, and five software selectable power saving modes.

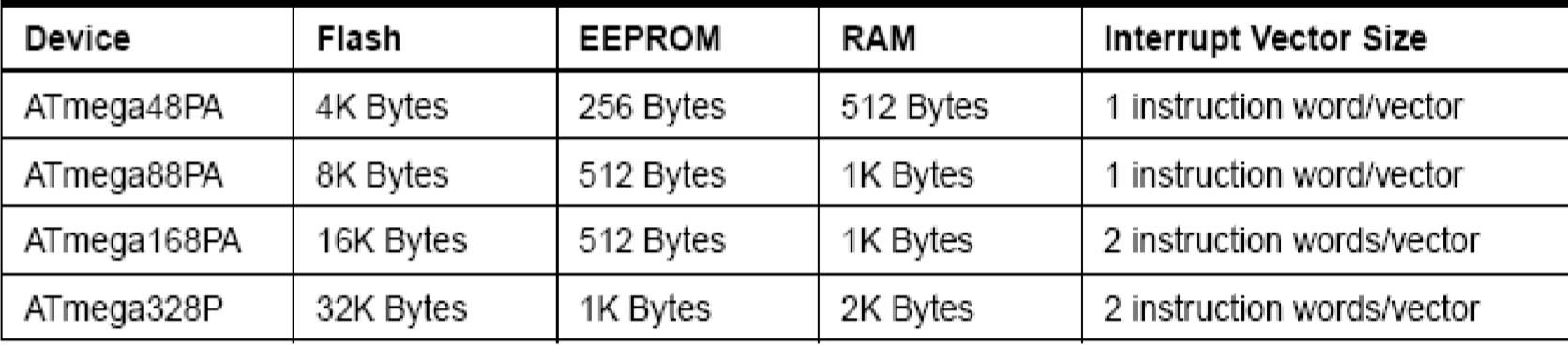
In Power-save mode, the asynchronous timer continues to run, allowing the user to maintain a timer base while the rest of the device is sleeping. The ADC Noise Reduction mode stops the CPU and all I/O modules except asynchronous timer and ADC, to minimize switching noise during ADC conversions. In Standby mode, the crystal/resonator Oscillator is running while the rest of the device is sleeping. This allows very fast start-up combined with low power consumption.

The device is manufactured using Atmel’s high density non-volatile memory technology. The On-chip ISP Flash allows the program memory to be reprogrammed InSystem through an SPI serial interface, by a conventional non-volatile memory programmer, or by an On-chip Boot program running on the AVR core. The Boot program can use any interface to download the application program in the Application Flash memory. Software in the Boot Flash section will continue to run while the Application Flash section is updated, providing true Read-While-Write operation. By combining an 8-bit RISC CPU with In System Self-Programmable Flash on a monolithic chip.

ATmega48PA/88PA/168PA/328P is a powerful microcontroller that provides a highly flexible and cost effective solution to many embedded control applications.

The ATmega48PA/88PA/168PA/328P AVR is supported with a full suite of program and system development tools including: C Compilers, Macro Assemblers, Program Debugger/Simulators, In-Circuit Emulators, and Evaluation kits.

##### TABLE 4.1 Comparison between ATmega48PA, ATmega88PA, ATmega168PA, ATmega328P

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The ATmega48PA, ATmega88PA, ATmega168PA and ATmega328P differ only in memory sizes, boot loader support, and interrupt vector sizes. Table 2-1 summarizes the different memory and interrupts vector sizes for the three devices.

ATmega88PA, ATmega168PA and ATmega328P support a real Read-While-Write Self Programming mechanism. There is a separate Boot Loader Section, and the SPM instruction can only execute from there. In ATmega48PA, there is no Read-While-Write support and no separate Boot Loader Section. The SPM instruction can execute from the entire Flash.

### ALU – Arithmetic Logic Unit

The high-performance AVR ALU operates in direct connection with all the 32 general purpose working registers. Within a single clock cycle, arithmetic operations between general purpose registers or between a register and an immediate are executed. The ALU operations are divided into three main categories – arithmetic, logical, and bit functions. Some implementations of the architecture also provide a powerful multiplier supporting both signed/unsigned multiplication and fractional format. See the “Instruction Set” section for a detailed description.

#### ULTRASONIC SENSOR:

Similar to any other sensor, the Arduino Ultrasonic Sensor is used to sense the object and predict the distance of the object in appropriate units which is inches.

Therefore, we can define the Arduino Ultrasonic Sensor as a device that uses the ultrasonic sensing technique to estimate the distance of an object.

Arduino is used for creating this sensor since it needs to be programmed to detect the reflected rays from objects and display the distance in the desired format.

##### Specifications:

Before getting started with the sensor, we need to mention some specifications of the sensor that can ensure proper working conditions for the sensor.

* The Arduino board needs a minimum **power supply of 5V** which is required to turn the Arduino on. This must be Direct Voltage.
* The Arduino board needs a **Quiescent Current which is at most 2mA** and a **working current of 15mA**. Higher current values can burn the Arduino components.
* It is preferred that the object must be placed at the center line of the sensor but it can also be present at a certain angle from the center. This is known as effectual angle which should be less than **15°.**
* The distance at which an object must be placed so that it can be detected by a sensor is around **2cm – 400 cm**. The accuracy of detection decreases with an increase in distance.

##### Pin Description:

|  |  |  |
| --- | --- | --- |
| **Pin Number** | **Pin Name** | **Description** |
| 1 | Vcc | The Vcc pin powers the sensor, typically with +5V |
| 2 | Trigger | Trigger pin is an Input pin. This pin has to be kept high for 10us to initialize measurement by sending US wave. |
| 3 | Echo | Echo pin is an Output pin. This pin goes high for a period of time which will be equal to the time taken for the US wave to return back to the sensor. |
| 4 | Ground | This pin is connected to the Ground of the system. |

**Table 4.2: pin description of Ultrasonic sensor**

##### Software Description

* + 1. **How Arduino IDE works**:

When a user writes code and compiles, the IDE will generate a Hex file for the code**. (Hex file are Hexadecimal files which are understood by Arduino)** and then sent to the board using a USB cable. Every Arduino board is integrated with a microcontroller, the microcontroller will receive the hex file and runs as per the code written.

##### Functions of Arduino IDE:

Arduino IDE consists of different sections

1. WindowBar
2. MenuBar
3. ShortcutButtons
4. Text Editor
5. Output Panel



##### Fig 4.10 (a) Arduino IDE Window

**Window Bar:**

The window bar consists the name of File and the Arduino IDE software version **Menu Bar:**

The menu bar consists of

1. File
   * New

It creates a new File. (Ctrl+N)

* + Open

It is used to open the file which was saved before. (Ctrl+O)

* + Open Recent

It shows the shortlist of Recently opened programs.

* + Sketchbook

Shows the current sketches which you have used for your project

* + Examples

Examples of a few basic problems for reference.

* + Close

Closes the main screen window. (Ctrl+W)

* + Save

It is used to save the current sketch. (Ctrl+S)

* + Save as…

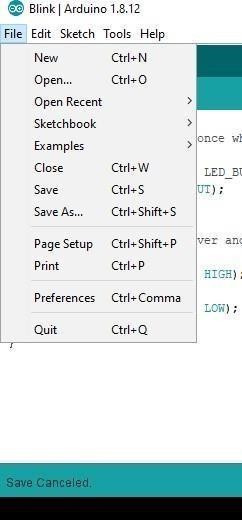
Allows saving the current sketch with a different name. (Ctrl+Shift+S)

* + Page Setup

Page settings for modifying the page(Text). (Ctrl+Shift+P)

* + Print

Used to print the current program. (Ctrl+P)



##### Fig 4.11 (b) File

* + Preferences

Settings of the IDE software can be changed here. (Ctrl+,)

* + Quit

Closes all IDE windows. (Ctrl+Q)

##### Edit

* + Undo/Redo

Goes back of one or more steps you did while editing.

* + Cut

Cuts the selected text from the editor.

* + Copy

Copies the selected text from the editor

* + Copy for Forum

It copies and changes the style of code suitable for the forum.

* + Copy as HTML

It copies and changes the style of code suitable for the Html.

* + Paste

It pastes the text from the copied text.

* + Select All

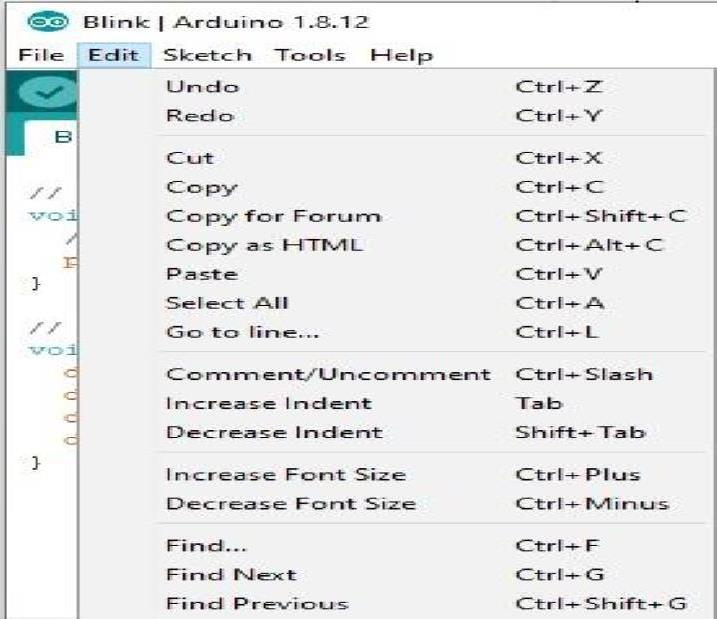
Select’s all the content from the editor.

* + Comment/Uncomment

It is used to comment and uncomment selected lines of code.

* + Increase/Decrease Indent

Adds or removes a space at the beginning of each selected line



##### Figure 4.12 (c) Edit section

1. **Sketch**
   * Verify/Compile

Checks or verifies your program if any error is there, and displays in the output panel.

* + Upload

It compiles and also uploads the code to the Arduino board.

* + Upload Using Programmer

Uploads code using Programmer which is available in Tools Tab.

* + Show Sketch Folder

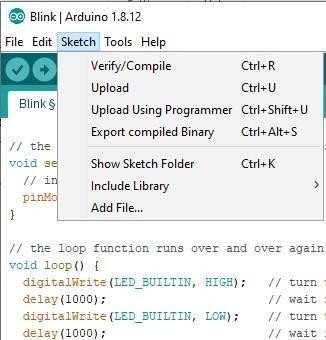
Opens the current sketch folder.

* + Include Library

Adds a library to your sketch by inserting #include statements at the start of your code

* + Add File…

Adds a file to the sketch and the new file appears in a new tab in window.

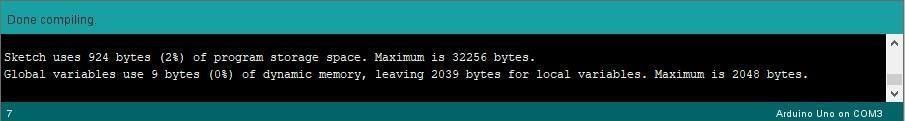


##### Figure 4.13 (d) Sketch Section

1. **Help Output Panel:**

This output panel is used to give comments about the code.

* + If the code is successfully compiled or any error occurs.
  + If the code has been successfully uploaded to the board. How much space the board has occupied



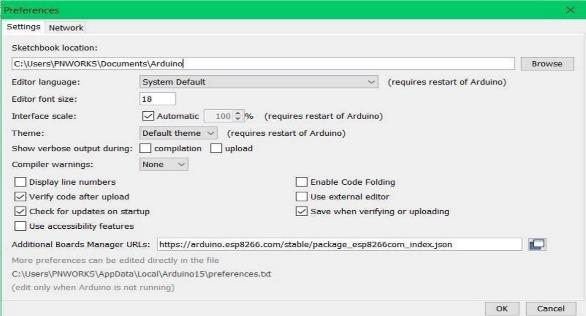
##### Fig 4.14 Output Panel

**4.2.3 Installation of ARDUINO board to Arduino IDE:**

Step 1. Start Arduino and open the Preferences window.

Step 2. Enter

https://arduino.ARDUINO.com/stable/package\_ARDUINOcom\_index.json into the Additional Board Manager URLs field.



**Figure 4.15 Arduino IDE Preferences Window**

**PYTHON IMPLEMENTATION:**

### ****Steps to Implement the Python Code****

1. **Arduino will read** the distance from two ultrasonic sensors (trigPin1, echoPin1 and trigPin2, echoPin2).
2. **Arduino sends the distance data** to the computer via **Serial Communication** (USB).
3. **Python reads the data** and checks if the train is detected within the detectionRange.
4. If a train is detected, Python sends a command to **close the gates**; otherwise, it **opens the gates**.

### ****How It Works:****

1. **Train Approaching:**
   * Python requests distance data from **Arduino**.
   * If any sensor detects an object within **10 cm**, the Python script **sends "CLOSE"** to Arduino.
   * **Arduino closes the gates** and activates the **buzzer**.
2. **Train Departs:**
   * When no object is within **10 cm**, Python sends **"OPEN"** to Arduino.
   * **Gates open**, and the **buzzer stops**.

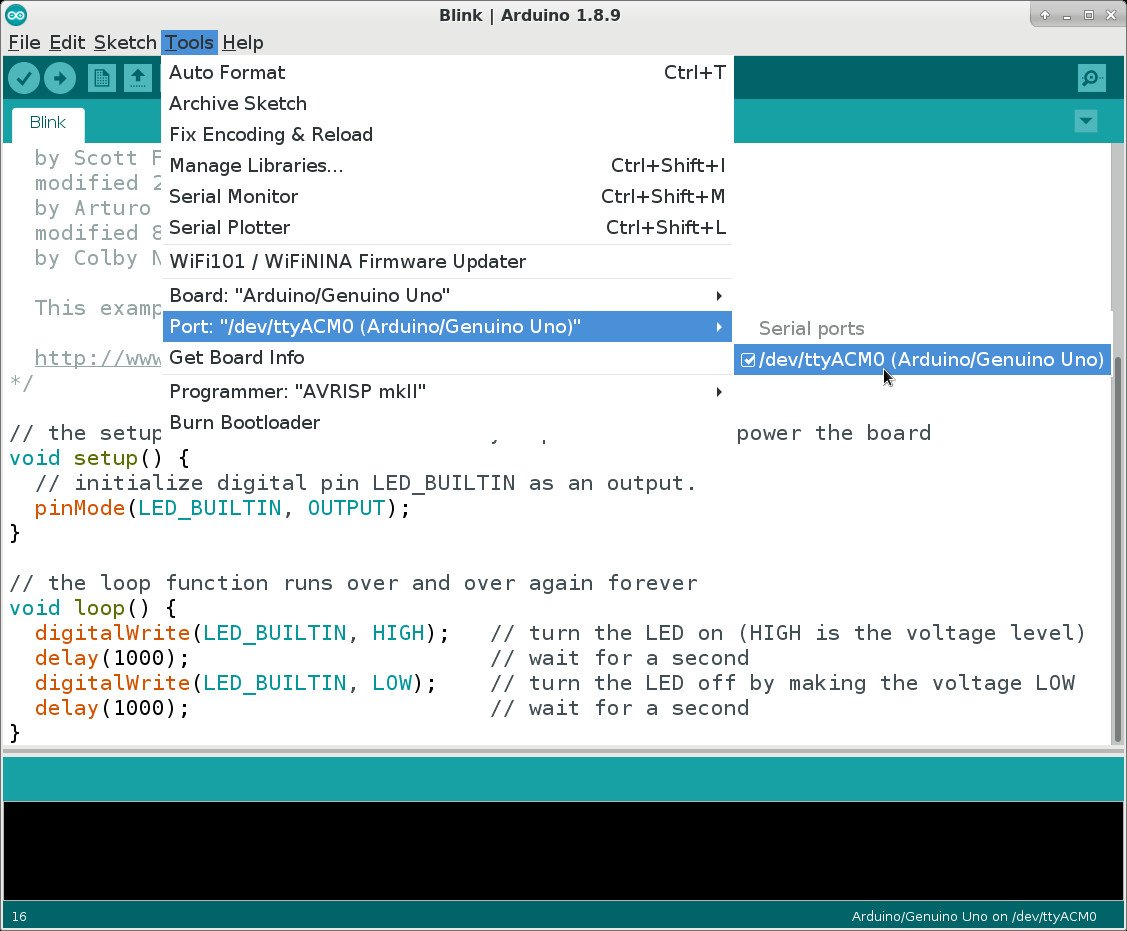
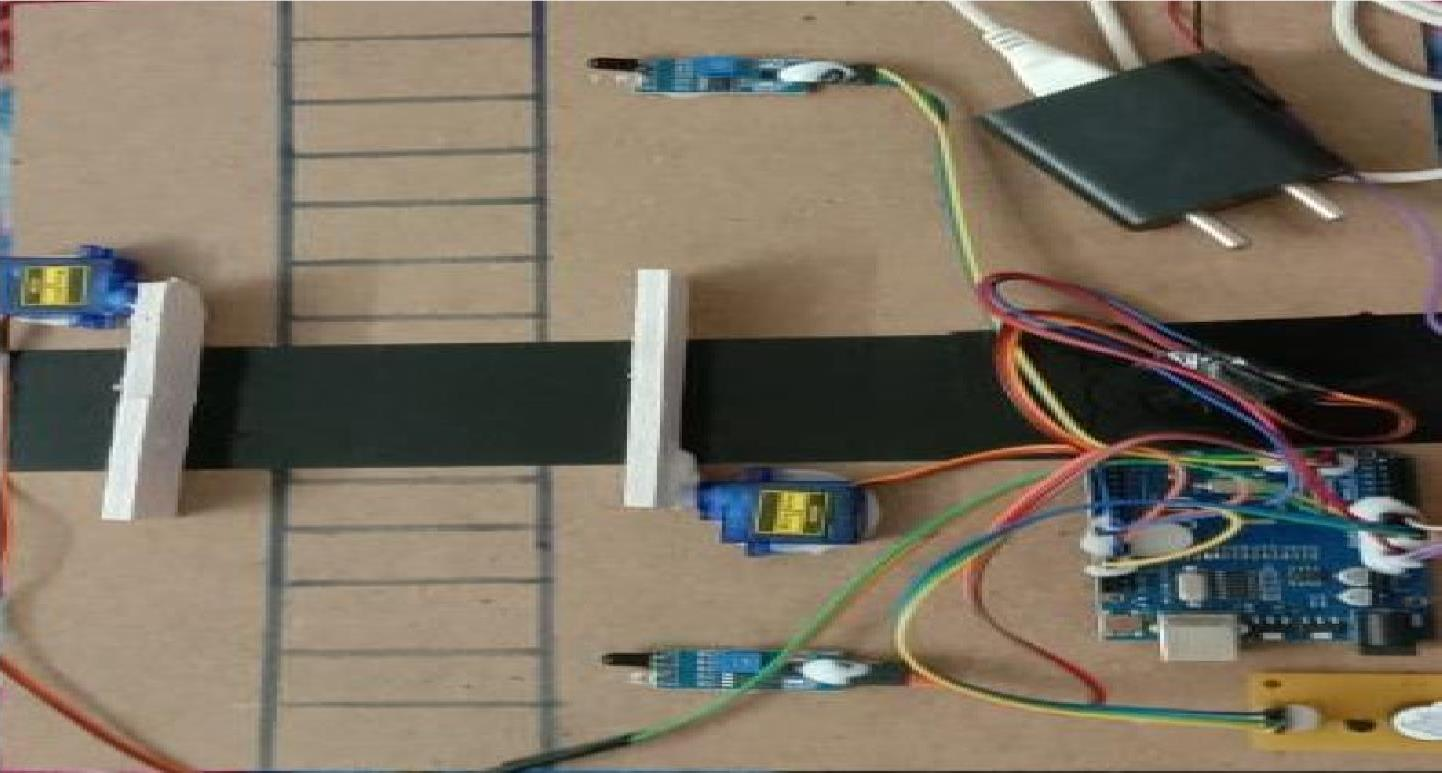


Fig 4.16: implementation of code through python

# CHAPTER 5

## RESULTS & DICUSSION

#### HARDWARE OUTPUT

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**Fig 5.1 Experimental Result**

## RESULT AND ANALYSIS

The project “Automatic railway gate controlling system using Arduino UNO and servo motor” was designed an automatic railway gate control system using Ultra Sonic Sensor and Arduino. The main controlling device of the whole system is Arduino. Ultra Sonic sensor, Buzzer, Servo Motor is interfacing to the Arduino microcontroller. When the Ultra Sonic sensor detects the train, this data process to the Arduino then Arduino will open and close the gate along with buzzer automatically. Servo motors works as a gate. To achieve this task using Arduino UNO microcontroller loaded program written in embedded C language.

To measure the performance of the proposed system we conduct several experiments. We design different cases like stuck on level crossing, train is apart from the train detector sensor with no stuck, train crossing the train detector sensor, train crossing the level crossing, and train passed a certain distance from the level crossing. Based on these cases the Almost in every case we get the desired result. The performance of the system does not depend on the speed of the train, temperature and weather. The accuracy of the proposed is very laudable. So our proposed system is very trustworthy

### Advantages:

* + - Avoid Manpower
    - Reduce operation cost
    - Performance is high
    - Accuracy is high
    - Automatic operation
    - Low power consumption

### Disadvantages:

* + - As the ultra sonic obstacle sensor can sensor all objects come in front of it, it might send false signal even if there is any object other than a train.
    - So in real-life, we recommend to use the frequency of the railway lines when a train appears as the signal to control the gate.

### Applications:

* + - Railways gate controlling
    - Parking gate controlling
    - Toll gates
    - Industries
    - Schools and college junctions

# CHAPTER 6

## CONCLUSION

#### CONCLUSION

To save the human life and vehicles from miserable train accidents is a challenge of the era of modern science and technology. The working model was fabricated within the laboratory premises. The results exhibit that it is one of the expedient approach for secure railway system. The ultrasonic sensors detect the train and stuck on the level crossing very quickly and communicate with the control unit.

The control unit takes proper steps which lead the train and vehicles movements either to move forward or to stop to avoid collision. Consequently, this is able to play a great contribution to the railway gate automation with reliability and lower cost. In future this developed working model will be equipped with GPS to navigate the position of the train and the track to avoid collision between two trains.

By implementing our system, train collisions can be predicted beforehand and necessary precautions could be taken in order to avoid any accidents. Derailments caused by excessive speeds could also be prevented as speeds of trains are always monitored.Automatic train detection and obstacle detection at level crossings would play a major role and guarantee a comprehensive amount of safety in the level crossings.

#### FUTURE SCOPE

The accidents due to railway level crossing and the obstacle can be avoided in real time by implementing this system and the whole process is completely automatic. In future the features like wireless system can be implemented in the real time operation. Integrating multiple sensor types, such as ultrasonic, infrared, UV, LiDAR, and radar sensors, can provide redundant and complementary detection capabilities, improving accuracy and reliability.

Leveraging high-speed 5G networks and edge computing capabilities can enable faster data processing, reduced latency, and enhanced responsiveness for critical operations. user- centric design. By embracing emerging technologies and collaborative approaches, railway gate operation systems can evolve to meet evolving transportation needs while prioritizing safety, efficiency, and accessibility for all users

* + - By Using this project we can control Railway gate system.
    - We can give voice communication to road users.
    - LED displays at railway crossing gates can also be achieved.
    - We can add railway track power generation to this project.

## REFERENCES:

The sites which were used while doing this project:

1. [www.wikipedia.com](http://www.wikipedia.com/)
2. [www.allaboutcircuits.com](http://www.allaboutcircuits.com/)
3. [www.microchip.com](http://www.microchip.com/) [4.w](http://www.howstuffworks.com/)ww[.howstuffworks.com](http://www.howstuffworks.com/)
4. [https://doi//10.1109/TENCON.2017.8227947](https://doi/10.1109/TENCON.2017.8227947)
5. <https://www.reference.com/science/function-connecting-wires-c7b22ee3838e0a17>
6. <https://www.tutorialspoint.com/arduino/arduino_board_description.htm>

Books referred:

* 1. Raj Kamal –Microcontrollers Architecture, Programming, Interfacing and System Design.
  2. Mazidi and Mazidi –Embedded Systems.
  3. PCB Design Tutorial –David. L. Jones.
  4. PIC Microcontroller Manual – Microchip.
  5. Pyroelectric Sensor Module- Murata.
  6. Embedded C –Michael. J. Pont.