Khulna University of Engineering & Technology

PROJECT: SAFE RAILWAY

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Objectives:

- To enhance railway safety.
- To enhance the platform safety in a station.
- To implement digitalized railway crossing and warning system to prevent accident.

Introduction:

The digital railway accident prevention management system using Arduino Uno is an innovative solution designed to enhance safety and prevent accidents in railway operations. By leveraging the capabilities of Arduino Uno, a popular microcontroller board, this system integrates various sensors, communication modules, and control mechanisms to create a robust and efficient safety system.

Railway accidents can have devastating consequences, including loss of lives, injuries, and damage to infrastructure. Therefore, there is a growing need for advanced technologies that can proactively detect and mitigate potential risks. The digital railway accident prevention management system aims to address these concerns by providing real-time monitoring, intelligent decision-making, and effective response mechanisms.

The system incorporates several key components to achieve its objectives. Arduino Uno serves as the main controller, offering a cost-effective and versatile platform for integration and control. The microcontroller can interface with a wide range of sensors, actuators, and communication modules, allowing for flexible and expandable system architecture.

Sensors play a vital role in the system by detecting various parameters and environmental conditions. Sensors are used to implement platform safety in a station, level-crossing system and also warning system.

The collected data from sensors is processed by the Arduino Uno, which employs algorithms and decision-making logic to assess potential risks and trigger appropriate actions. These actions may include activating warning signals or notifying relevant authorities and emergency services.

Components:

Arduino Uno:

Arduino Uno is a popular open-source microcontroller board that provides a simple and affordable platform for creating interactive electronic projects. It is designed to be user-friendly, making it accessible to both beginners and experienced makers.

The heart of Arduino Uno is the ATmega328P microcontroller, which is an 8-bit AVR microcontroller from Atmel. It operates at a clock speed of 16 MHz and has 32KB of Flash memory for storing the program code.

It features a total of 14 digital input/output pins, labeled from 0 to 13. These pins can be used for reading digital inputs or controlling digital outputs, such as LEDs, motors, and sensors. Out of these pins, 6 can be used for Pulse Width Modulation (PWM) output.

It has 6 analog input pins, labeled A0 to A5. These pins can be used to measure analog voltages from sensors and other devices. The analog-to-digital converter (ADC) on the board allows for 10-bit resolution analog readings.

It can be powered using a USB connection from a computer, an external power supply, or a 9V battery. It has a voltage regulator that allows it to accept input voltages ranging from 7 to 20 volts.

It has a built-in USB interface, which allows it to be easily connected to a computer for programming and serial communication. It also has a dedicated UART (Universal Asynchronous Receiver-Transmitter) for serial communication with other devices.

Breadboard:

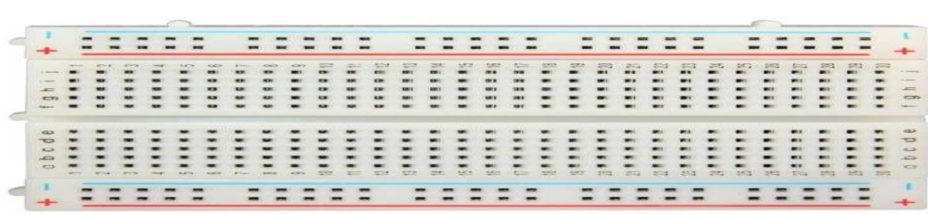
A breadboard, also known as a prototyping board or solder less breadboard, is a fundamental tool used in electronics prototyping and experimentation. It allows you to quickly and easily build temporary electronic circuits without the need for soldering. Here is some information about breadboards

The primary purpose of a breadboard is to provide a platform for connecting electronic components and building circuits for testing and prototyping purposes. It allows you to experiment with different circuit designs and connections without making any permanent changes.

The holes on a breadboard are usually spaced with a standard 0.1-inch (2.54 mm) pitch, which is the same as the standard spacing between the pins of most electronic components. This spacing allows for easy insertion of components like resistors, capacitors, LEDs, and integrated circuits.

Breadboards offer a way to create electrical connections between components without the need for soldering. When a component, such as a resistor or IC, is inserted into the breadboard, its leads make contact with metal spring clips or metal strips beneath the holes, creating an electrical connection. Components can be connected by inserting their leads into adjacent holes in the same row or by using jumper wires.

Breadboards typically have two sets of rails running vertically along the sides of the board. These rails are used for providing power to the circuit. The rails are often color-coded, with red typically used for the positive voltage rail (Vcc) and blue or black for the ground rail (GND). The rails are connected internally, allowing easy distribution of power to various points in the circuit.



Ultrasonic Distance Sensor (HC-SR04):

The HC-SR04 is a popular and affordable ultrasonic distance sensor module commonly used in robotics, automation, and other projects.

The HC-SR04 module operates on the same principle as any other sonar sensor. It emits ultrasonic sound waves and measures the time it takes for the sound waves to bounce back after hitting an object. Based on this time, the module calculates the distance to the object.

The sensor module typically consists of four pins: VCC (power supply), Trig (trigger input), Echo (echo output), and GND (ground). It operates at a voltage of 5V and uses a frequency of around 40 kHz for the ultrasonic pulses. The sensor has a maximum range of approximately 4 meters and a resolution of 3 mm.

Servo Motor:

A servo motor is a rotary actuator that is commonly used in robotics, automation, and other applications where precise control of angular position, speed, and torque is required. It is designed to provide accurate and controlled movement based on electrical input signals.

A servo motor consists of a motor, a feedback device (usually a potentiometer), and a control circuit. The control circuit receives a control signal (typically a pulse-width modulation signal) and compares it with the feedback signal from the potentiometer. Based on the difference between the two signals, the control circuit adjusts the motor's position, speed, and torque to match the desired position.

Servo motors are controlled using electrical pulses, often referred to as PWM (Pulse-Width Modulation) signals. The control signal specifies the desired position of the servo motor shaft. The pulse width determines the angle of rotation, with a typical range of 0 to 180 degrees, although some servo motors can rotate continuously.

The feedback mechanism in a servo motor provides information about the current position of the motor shaft. The control circuit compares this feedback with the desired position and adjusts the motor's movement accordingly. The feedback system enables precise control and helps maintain the motor's position even when external forces act upon it.

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Load Module and Load Cell:

Load Module: A load module, also known as a load cell module or a load cell amplifier, is an electronic device used to interface load cells with external systems. It is designed to measure and amplify the tiny electrical signals generated by load cells, which are transducers used to measure force or weight.

The primary function of a load module is to provide power and signal conditioning to the load cell. It receives the analog signal from the load cell and amplifies it to a usable level for further processing and measurement.

Load cells typically produce low-level electrical signals (mV range) in response to applied force or weight. Load modules amplify and condition these signals to improve their accuracy and compatibility with measurement systems. They may include features such as gain adjustment, filtering, temperature compensation, and calibration.

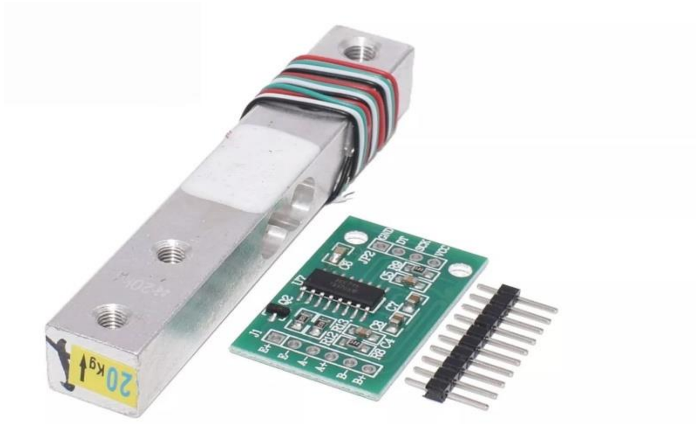
Load modules are designed to work specifically with load cells. They provide the necessary voltage excitation to the load cell and offer suitable amplification and filtering tailored to the load cell's characteristics.

Load modules typically provide analog output signals, such as voltage or current, which can be further processed by data acquisition systems, microcontrollers, or other measurement devices. Some load modules also offer digital output options, such as RS-232 or USB, for direct communication with computers or other digital interfaces.

Load Cell: A load cell is a transducer used to measure force or weight by converting mechanical force into an electrical signal. It is commonly used in various industries, including manufacturing, aerospace, automotive, and healthcare.

Load cells work based on different principles, including strain gauge, piezoelectric, hydraulic, or capacitive. The most commonly used type is the strain gauge load cell, which measures the deformation of strain gauges bonded to a load-sensitive element.

Load cells need to be properly mounted or integrated into a structure or system where the force or weight is to be measured. They require appropriate connections, such as electrical wiring, and may require calibration to ensure accurate measurements.



Buzzer:

As an electronic component, a buzzer is a small audio signaling device that produces a buzzing or beeping sound. It is commonly used in various electronic circuits, devices, and systems for audio feedback, alerts, and notifications.

When a voltage is applied to the buzzer, it causes an electromechanical component (usually a piezoelectric or magnetic element) inside the buzzer to vibrate rapidly. These vibrations create sound waves in the air, producing the characteristic buzzing or beeping sound.

LED:

LED stands for "Light-Emitting Diode." It is a semiconductor device that emits light when an electric current passes through it. LEDs are widely used in various applications due to their energy efficiency, long lifespan, and compact size.

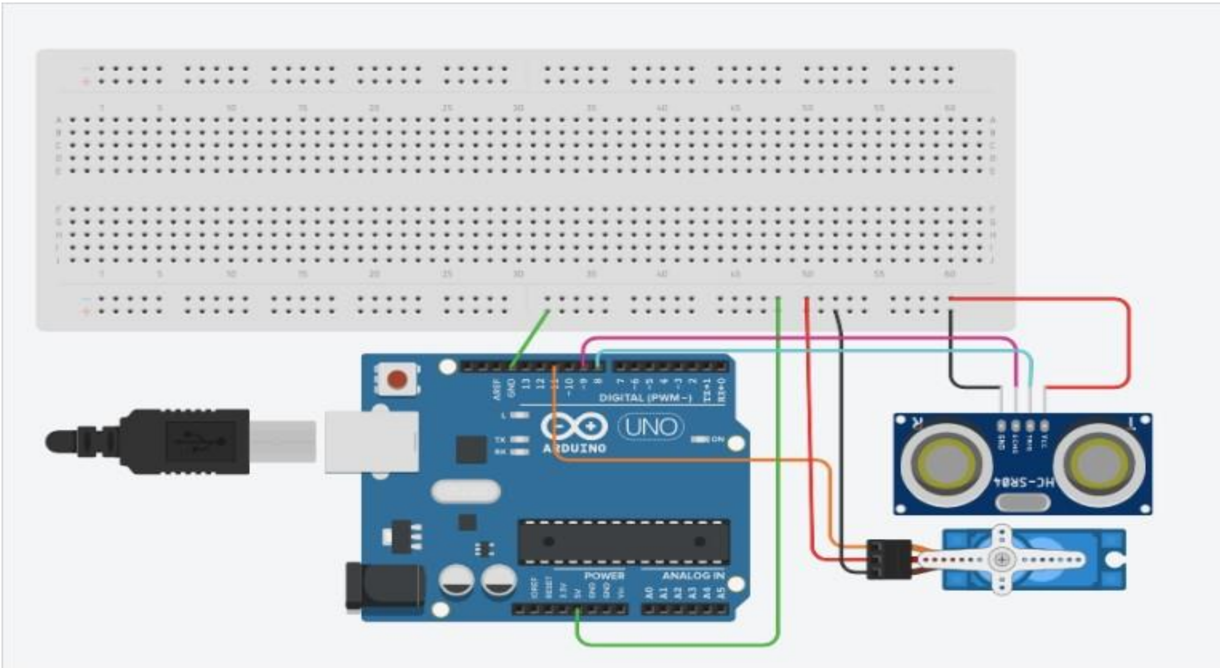
LEDs come in different colors, including red, green, blue, yellow, and white, among others. Each LED has two leads: the anode (positive) and the cathode (negative). The longer lead is usually the anode, while the shorter one is the cathode.

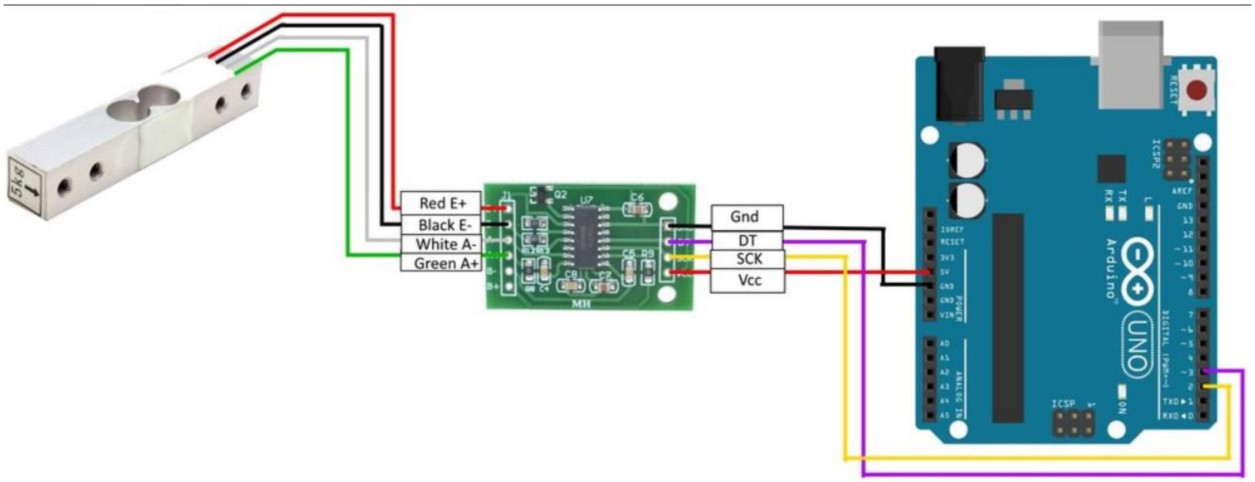
LEDs have a specific forward voltage (Vf) and forward current (If) rating. It's important to use appropriate resistors to limit the current and prevent damage to the LED. The forward voltage rating determines the power supply voltage required for the LED to function correctly.

LEDs can be used for a variety of purposes, such as lighting, indicators, displays, and even in electronic projects with microcontrollers like Arduino. By controlling the voltage and current applied to an LED, you can turn it on or off, adjust its brightness, or create various lighting effects.

To connect an LED to a power source, you typically need a current-limiting resistor in series with the LED. The resistor ensures that the current flowing through the LED remains within its safe operating range.

Wiring Diagram:





Rating Of Components:

- Arduino Uno: Microcontroller: ATmega328P
- Operating Voltage: 5 volts
- Input Voltage (recommended): 7-12 volts
- Input Voltage (limits): 6-20 volts
- Digital I/O Pins: 14 (of which 6 provide PWM output)
- Analog Input Pins: 6
- DC Current per I/O Pin: 20 mA
- DC Current for 3.3V Pin: 50 mA
- Flash Memory: 32 KB (ATmega328P), of which 0.5 KB is used by the bootloader
- SRAM: 2 KB (ATmega328P)
- EEPROM: 1 KB (ATmega328P)
- Clock Speed: 16 MHz

Working Principle:

The working principle of the project is straightforward. When a train is approaching towards a station, an ultrasonic distance sensor detects the train by a specific distance and causes the servo motor to rotate 90^0 which eventually open the platform. When there is no train in the station or a train is leaving the station, platform remains closed.

Same working method is implemented in level-crossing also. A sensor detects the train by measuring the distance; a load module is also place alongside the railway track to detect the train by measuring its weight. These detection causes servo motor to rotate 90^0. As a result the gate will get closed. After some delay when the train leaves, the gate will be opened again. Some buzzers and LED are placed to give warning about upcoming train.

Psedocode of the project:

Include the Servo library

Declare variables:

- trigpin, echopin: Pins for the first ultrasonic sensor
- trigPin2, echoPin2: Pins for the second ultrasonic sensor
- LED1, LED3: Pins for the LEDs
- distance, distance2: Variables to store measured distances
- duration, duration2: Variables to store pulse durations
- cm, cm1: Variables to store calculated distances in centimeters
- sound: Variable to store tone frequency

Setup:

Initialize serial communication

Attach servo motors to specific pins

Set pin modes for ultrasonic sensors and LEDs

Loop:

Measure distance using the first ultrasonic sensor:

- Send a trigger pulse
- Calculate pulse duration and convert it to distance
- Store the distance in the variable "distance"

Measure distance using the second ultrasonic sensor:

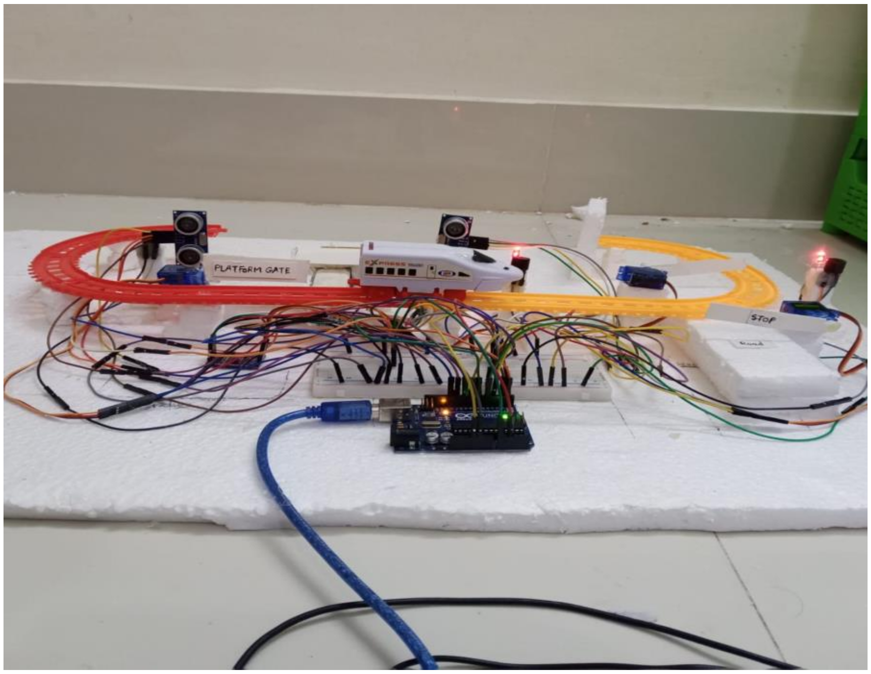
- Send a trigger pulse
- Calculate pulse duration and convert it to distance
- Store the distance in the variable "distance2"

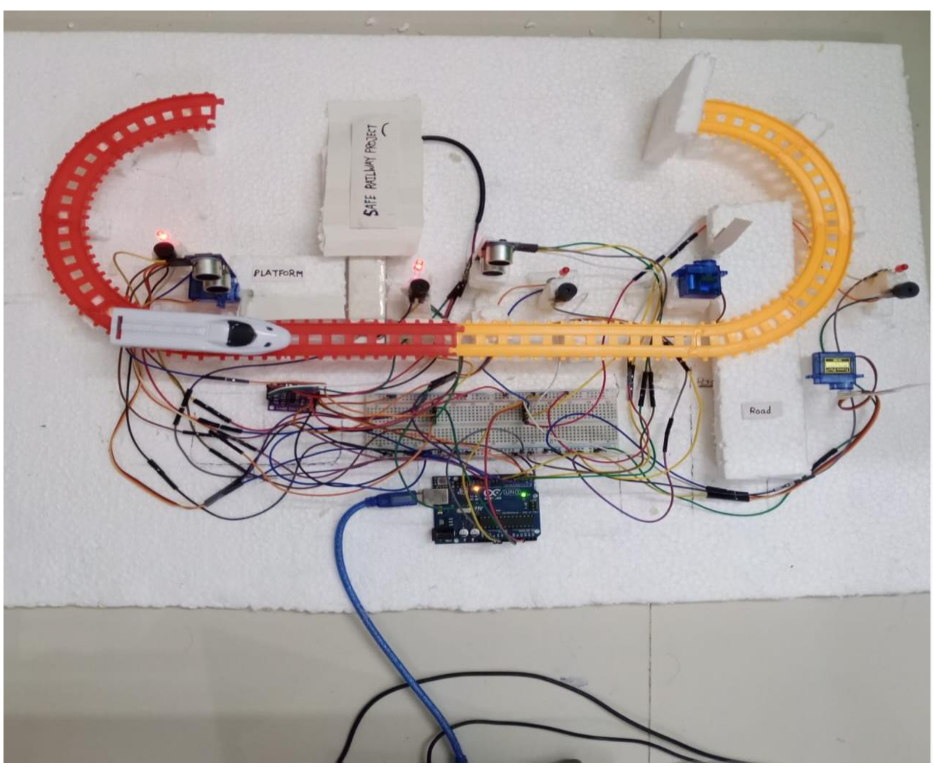
Perform actions based on measured distances:

- If distance2 < 3:
  - Rotate servo1 to 90 degrees
  - Turn on LED1
  - Play a tone on LED1 pin
  - Delay for 400 milliseconds
- Else:
  - Reset servo1 position
  - Turn off LED1
  - Stop playing tone
  - Delay for 50 milliseconds

- If distance <= 3:
  - Rotate servo and servo2 to 90 degrees
  - Turn on LED3
  - Play a tone on LED3 pin
  - Delay for 2400 milliseconds
- Else:
  - Reset servo and servo2 positions
  - Turn off LED3
  - Stop playing tone
  - Delay for 50 milliseconds

Final View:


PLATFORM GATE
STOP
Road


SAFE RAILWAY PROJECT
PLATFORM
Road

Discussion and Conclusion:

The implementation of a railway safety management project using Arduino is an innovative and practical approach to ensuring the safety and efficiency of railway systems. Arduino, being an open-source electronic platform with a wide range of compatible sensors and modules, provides a flexible and cost-effective solution for monitoring and controlling various aspects of railway safety.

One key aspect of this project is the ability to detect and trains. By using proximity sensors and communication modules, the Arduino-based system can monitor the distance between trains and issue warnings or take preventive measures if the distance falls below a safe threshold. This feature greatly enhances the safety of railway operations and reduces the risk of accidents.

The railway safety management project utilizing Arduino demonstrates the potential for leveraging technology to enhance safety and efficiency in railway operations. By incorporating various sensors, communication modules, and control mechanisms, the Arduino-based system can effectively monitor train movements and signaling information.

The project's implementation can significantly reduce the risk of accidents by providing early warnings and taking preventive measures when necessary. It enables real-time monitoring of train positions and distances, allowing for better coordination and control of train movements. Additionally, by continuously monitoring track conditions, the system contributes to the maintenance and integrity of the railway infrastructure, minimizing the chances of failures and derailments.

Overall, the Arduino-based railway safety management project presents a scalable and adaptable solution that can be customized to fit different railway systems and requirements. It showcases the potential of integrating technology into the railway industry, leading to improved safety, reliability, and efficiency in train operations.

However, it is essential to ensure thorough testing, validation, and compliance with safety standards during the implementation process to guarantee the system's reliability and effectiveness.