Microcontroller-based Automatic Railway Gate Control and Smart Platform Crossing

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ABSTRACT

This project aims to create and deploy a smart railway crossing system that can control the crossing for cars and pedestrians on its own. To guarantee safe passage at railroad crossings, the system incorporates RFID (Radio Frequency Identification) sensors to detect incoming vehicles and people. When a vehicle crosses a railroad track, an automatic barrier system is activated. RFID sensors are used to identify the presence of vehicles on either side of the track. The barrier immediately closes in response to an approaching train, barring cars at one track and people walking off people in between platforms from passing until the train passes and the track is once again clean. The method allows pedestrians utilizing the same railway crossing to cross safely at the same time. Train is given with RFID tags, which are detected by RFID sensors positioned at the crossing. The system informs walkers and car drivers to the approaching pedestrian crossing by activating warning signals including flashing lights which indicate red and green when a pedestrian approaches the crossing and when. Until people can cross the railroad tracks safely, the barriers stay in place. Among the many benefits of integrating RFID sensors are the ability to precisely control barrier operations, monitor crossing activities in real-time, and detect approaching cars and people. By reducing the possibility of collisions involving automobiles, pedestrians, and trains at railroad crossings, the technology also improves safety. By offering a clever and automated method for controlling railroad crossings and guaranteeing the safe and easy passage of both cars and people, this initiative seeks to enhance railway safety. Future improvements might include networked systems for centralized monitoring and management of numerous railroad crossings and the integration of cutting-edge technology like computer vision for better detection and recognition capabilities.

I. INTRODUCTION:

Human and mechanical mistakes are the causes of train accidents. Due to train cancellations, the Indian Railway has suffered enormous financial losses as a result. Our train system may be made more automated to prevent such mishaps. This RFID and RFID module-based railway automation system is the simplest and least expensive. Information transmission and reception are handled

by an RFID module. Since each RFID has a unique code, each track has a distinct identification. Utilizing an RF module, the train and control station may communicate.

Wireless communication is used by this system to function. An RFID card with sensors at the track is present on trains that run on tracks. When a train gets close to the section of track where cars are moving, a sensor detects the card and sends a signal to close the barrier, preventing cars from passing. However, the barrier is first opened to allow people to walk over in order to move from one station to another. The train detects the card as soon as it gets on the track and raises the barrier to deter people from walking.

This paper's remaining sections are arranged as follows: In order to ensure user safety when automobiles and trains interact, Section II addresses railway crossings. In order to begin working with electronics and coding, Section III acquires the Arduino UNO board. Section IV introduces the Arduino IDE, which is used to write, compile, and upload code to the Arduino device. The installation of RFID readers, vehicle detection with barrier operation, and warning signals are covered in Section V. The integration of RFID technology at railway crossings to increase the dependability and security of railway systems was covered in Section VI.

II. LITERATURE SURVEY

Railroad crossings, sometimes called grade crossings or level crossings, are essential places where the road and rail networks meet to allow safe interactions between cars and trains. Assuring public education and awareness, safety, efficiency, accessibility, compliance, integration, and risk reduction are the primary objectives of these crossings.

To ensure user safety, railway crossings serve this primary purpose. Preventing collisions between vehicles and trains as well as lowering the likelihood of accidents or incidents at crossing sites are part of this. Advanced sensing technologies, signals, warning signs, barriers, and other safety measures are implemented to lower risks and raise safety standards.

Railway crossings are there to facilitate the smooth passage of vehicles on the roadways and to permit trains to pass. By providing the required access points, these crossings enable vehicles, pedestrians, and bicyclists to cross railway tracks safely and effectively. This lessens delays for both drivers and railroads, increasing overall traffic flow and mobility. The important function of accessibility is also fulfilled by railway crossings. They are necessary to promote ties within the community and to make it easier for people and goods to move about. These crossings provide essential access points over railway tracks, which promotes connectivity and facilitates transit within and between communities.

The objective of railway crossings is to support the efficiency-based transportation system optimisation. By guaranteeing timely and orderly passage at crossing sites through effective signalling, barrier operation, and traffic management processes, these crossings reduce delays for both road users and trains. Efficiency gains improve the transportation system's overall performance and dependability.

Regulation compliance is essential to maintaining safety standards and ensuring the integrity of railway crossings. It is necessary to abide by the laws and regulations pertaining to the design, operation, and maintenance of these crossings. Compliance with safety standards set by railway and transportation authorities is essential to reduce risks and ensure legal compliance.

Integration with transport networks is essential for increasing mobility and accessibility. Railway crossings can be effortlessly integrated into more extensive transportation systems, such highways, trains, and public transportation. Because these crossings provide vital linkages between different modes of transportation, they enhance the overall efficiency and interconnectivity of transportation networks.

The primary objective of railway crossings is risk reduction, which aims to lessen the number of accidents, injuries, and fatalities caused by the interplay between rail and road traffic. Many safety precautions, such as sophisticated detecting systems, obstacles, signals, and warning signs, are implemented to lessen risks and increase security.

To promote responsible behaviour and prevent mishaps or accidents at railway crossings, it is imperative that public awareness be raised and education campaigns be launched. These programmes teach bikers, pedestrians, and cars how to cross safely and how important it is to pay attention to traffic signals and warnings. Public awareness campaigns make places safer and enhance the experience of using them for all users.

In general, railway crossings are necessary to improve transportation networks' risk reduction, integration, accessibility, safety, and public awareness. By achieving these objectives, these crossings enhance the overall operation and safety of the road and rail networks as well as the user experience for all parties involved.

III. ARDUINO UNO

The greatest board for learning electronics and coding is the UNO. The UNO is the most durable board you can begin experimenting with if this is your first time modifying the platform. Among the entire Arduino family, the UNO is the board that is used and documented the most.

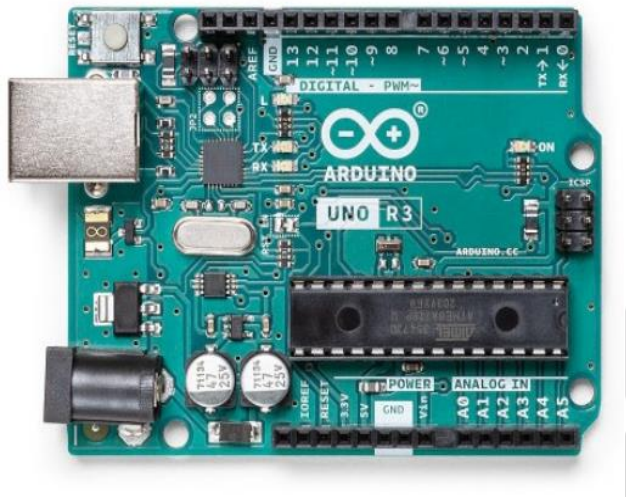

Fig 1: ARDUINO UNO

The ATmega328P is the basis for the Arduino Uno microcontroller board (datasheet). It contains a 16 MHz quartz crystal, 6 analogue inputs, 14 digital input/output pins (six of which can be used as PWM outputs), a USB port, a power jack, an ICSP header, and a reset button. It comes with everything required to support the microcontroller; all you need to do is power it with an AC-to-DC adapter or battery or connect it to a computer via a USB cable to get going.

If something goes wrong, you can always replace the chip for a few bucks and start over, so you may play about with your UNO without too much fear of making a mistake. Because it signifies "one" in Italian, "Uno" was chosen to commemorate the release of the Arduino Software (IDE) 1.0. The original Arduino software (IDE) version 1.0 and the Uno board served as the platform for later iterations of the Arduino system. See the Arduino index of boards for a comprehensive list of previous, present, and out-of-date Arduino boards. The Uno board is the first in a line of USB Arduino boards and serves as the platform's reference model.

IV. SOFTWARE TOOL

INTRODUCTION TO ARDUINO IDE:

The IDE (Integrated Development Environment), the official software provided by Arduino.cc, is mostly used for writing, assembling, and uploading code to the Arduino gadget. You may quickly install this open-source software and start writing code for practically any Arduino module right away.
This tutorial will guide you through the installation process, a brief introduction to the programme, and configuring it for the required Arduino module. Let's take a closer look at the details of this software.

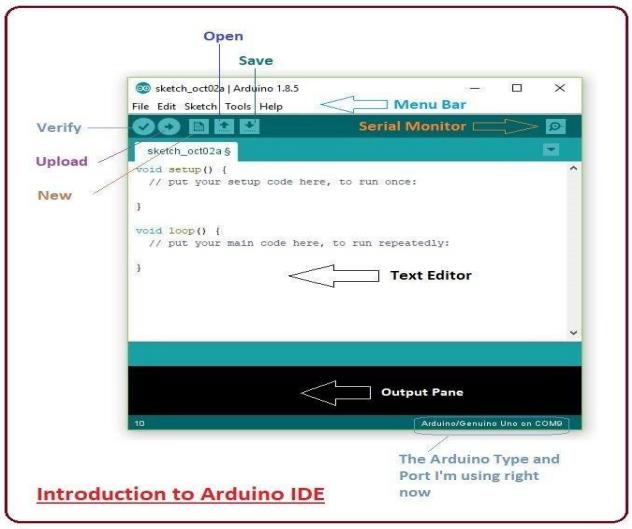

Fig 2: Introduction to Arduino IDE

- The primary function of the open-source Arduino IDE software is to write and compile code for the Arduino Module.
- Because it is an official Arduino programme, code generation is so simple that even a layperson with no prior technical experience may begin learning the basics.
- It operates on the Java Platform, which is readily available for MAC, Windows, and Linux operating systems. The Java Platform has built-in functions and commands that are essential for debugging, editing, and compiling code in an environment.
- There is a variety of Arduino modules available, such as the Uno, Mega, Leonardo, Micro, and many others.
- A microcontroller that is programmed and accepts information in the form of code is present on the board of each of them.
- A Hex File is produced by the primary code, sometimes referred to as a sketch, that is made on the IDE platform and uploaded into the board's controller.
- The two primary components of the IDE environment are the editor and compiler. The editor is used to write the necessary code, and the compiler is used to compile and upload the code into the designated Arduino Module. Both C and C++ are supported in this environment.

V. WORKING

A. RFID READERS INSTALLATION:

- At key points close to the railway crossing, RFID readers are installed.
- RFID technology is the essential component of the railway crossing safety system. It functions based on the idea of wireless communication via electromagnetic fields.
- These RFID readers are placed strategically near railway crossings to provide easy communication with RFID tags attached to trains and other railway vehicles.
- Railway operators can monitor train movements in real time thanks to this advanced network of tags and readers, which improves management and coordination of railway traffic.
- The planning procedure involves considering multiple elements, including traffic patterns, train track layouts, and environmental conditions, while strategically placing RFID readers.
- Several RFID scanners have been strategically placed close to the railway crossing.
- The process of strategically placing RFID readers involves careful planning, considering multiple elements such railway track layout, traffic patterns, and environmental conditions.
- Operators can monitor train movements and guarantee adherence to safety regulations by strategically placing RFID readers at key intersections close to railway crossings.
- Furthermore, RFID readers are crucial parts of automated signalling systems, allowing for the timely identification of oncoming trains and the activation of the proper warning signs for drivers and pedestrians.
- Additionally, RFID readers are crucial parts of automated signalling systems, allowing for the timely identification of incoming trains and the activation of the proper warning lights for drivers and pedestrians.

B. DETECTION OF VEHICLES:

- When a car with an RFID tag gets closer to the railway crossing, the RFID reader uses radio frequency communication to find the tag. The code or unique identifying number included in the tag is read by the RFID reader.
- The crossing control system starts the necessary measures, like turning on warning lights, lowering barriers, and alerting approaching trains to slow down or halt if needed, as soon as a vehicle is recognised using any of these ways.
- The efficient and safe operation of automatic railway crossings is enhanced by the integration of detecting technology, which guarantees the fast and dependable identification of cars.
- Red and green lights represent the signals, which are preserved on either side to signify those signals.
- As soon as the car gets close to the station, it recognises it and transmits the operation communication.
- The seamless integration of detecting technologies guarantees dependable and prompt vehicle detection, enhancing the security and effectiveness of automated railway crossings.

Fig 3: Hardware kit1

Fig.4: Hardware kit2

C. BARRIER OPERATION:

- The RFID reader transmits data regarding the vehicle's approach to the railway crossing's control system. The control system makes the decision to open or close the crossing's barriers based on this data.
- For the protection of both road and rail users, barrier operation at automated railway crossings is essential. These crossings have advanced technology installed that recognise the presence of cars and trains and set off a series of events to secure the crossing and avert collisions.
- Upon activation of the warning signals and the completion of an adequate warning period, the crossing control system lowers the barriers. To prevent cars from accessing the railway tracks, the barriers which are often big gates constructed of durable materials begin to fall.
- The initial phase of barrier operation involves identifying approaching cars at the railway crossing. RFID sensors are used to do this. These sensors are arranged in a deliberate manner to keep an eye on approaching vehicles from various angles.
- The functioning of barriers at automated railway crossings is essential for guaranteeing the security of both road and rail users. These crossings have advanced sensors that identify the presence of cars and trains, triggering a series of events to lock off the area and stop collisions.
- The crossing control system promptly notifies drivers of the approaching closure of the railway crossing barriers by triggering warning signals upon detecting a vehicle.
- The crossing control system lowers the barriers after the warning signals have been engaged and enough warning time has passed. The barriers which are sometimes big, robust gates begin to descend to prevent cars from accessing the railway tracks.
- The train is allowed to travel through the intersection once the crossing is secured and the barriers have been fully lowered.
- This project has two requirements: one is to raise the barrier to prevent pedestrians from walking, and the other is to lower the barrier to prevent automobiles from crossing.

D. WARNING SIGNALS:

- The control system alerts cars and pedestrians to the approaching pedestrian crossing by activating crossing gates or flashing lights when it detects the presence of pedestrians.
- At railway crossings, warning signals are essential for informing drivers about oncoming trains and the impending closure of barriers. Red lights warn of impending danger and instruct drivers to halt right away.
- Green lights may turn on to let cars know that they can proceed straight ahead across the crossing when the barriers are raised and there are no trains in the area.
- Flashing red lights are frequently utilised as warning signals at railway crossings. These lights flash in time with the music when they are turned on, drawing attention, and warning other cars that a train is approaching. To further emphasise the message of danger, red flags may occasionally be exhibited alongside flashing lights. On the other side, green signals signify safety and approval to move on.
- Having warning signals at railway crossings is essential for informing drivers about trains that are coming and about to close barriers. Red lights alert vehicles to impending danger and demand that they stop right away.
- Green lights at railway crossings are commonly utilised to signal that it is safe for cars to cross the rails.
- The crossing may have green lights to indicate to drivers that they can proceed without interruption once the barriers are raised and there are no trains passing through.
- The RFID technology keeps an eye on everything going on at the railway crossing.

In conclusion, implementing RFID technology at railway crossings is a proactive move that will enhance the efficacy, security, and dependability of railway systems. By employing RFID technology, railway crossings may now better meet the evolving requirements of modern transportation networks, bringing in a new era of enhanced automation, efficiency, and safety.

RFID technology has several advantages for railway crossings, including improved detection and response protocols. With RFID-enabled equipment, railway crossings may automate the detection of approaching vehicles, trains, and other relevant entities, allowing for quick and accurate response actions. This automation reduces the likelihood of human error while ensuring prompt and accurate reactions to potential safety threats.

Furthermore, RFID technology can help with the ongoing development of smart transport systems by enabling seamless interaction with other cutting-edge technologies like intelligent traffic control systems and driverless cars. Railway crossings can be included into networked transportation networks by using RFID technology, giving people in both urban and rural areas efficient and sustainable mobility options.

In conclusion, the installation of RFID technology at train crossings represents a significant advancement in the efficacy, dependability, and security of railroad systems.

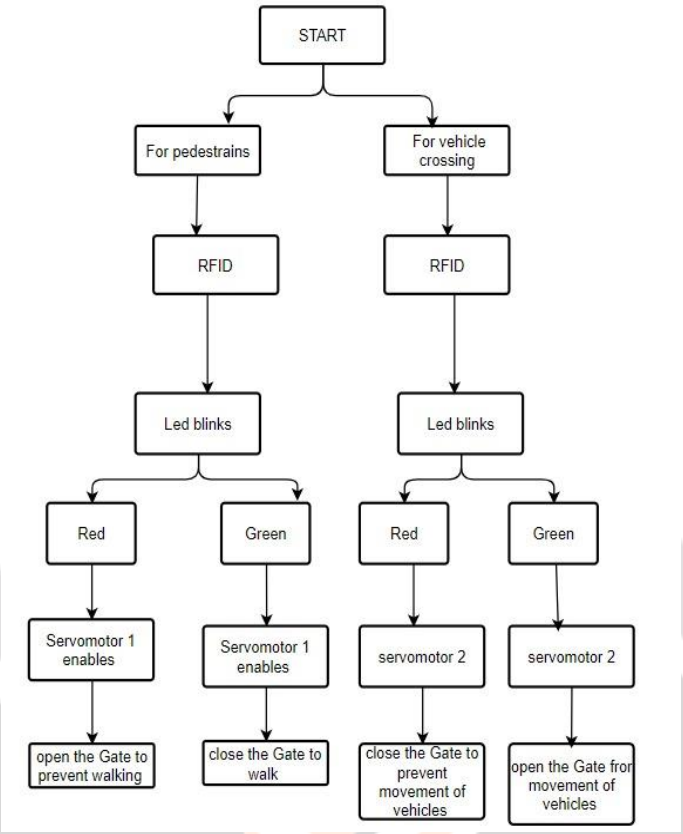

Fig.5: Flow chat

VI. CONCLUSION

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Moreover, RFID technology can help the development of smart transport systems going forward by enabling seamless interaction with other cutting-edge technologies like intelligent traffic management systems and driverless cars. By employing RFID technology, railway crossings can be included into interconnected transportation networks, offering sustainable and effective mobility choices to both urban and rural populations.

In conclusion, implementing RFID technology at train crossings is a significant step in the right direction towards enhancing the efficacy, security, and dependability of railroad systems.

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