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Design of Safety Grill to avoid Railway Platform Accidents

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Abstract: ***The different modes of transport are air, water, and land transport, which include rail transport, road transport and off-road transport. Most commonly using transport system are Roadways, Railways and Airways. In these frequently we use the railways, because it is cheaper and it is more convenient than other transport systems. The third largest railway network in the world is Indian railway network. But the accident's occurs in the railways is higher. Mostly the accidents in the railway station occur between the railway platform and to the train, because of the platform gap. The platform gap is the gap exists between the train and to the platform. To avoid these accidents that the Indian government come with an indicative to increase the height of the platform. But it is not easy job to increase the height. At the time of working we cannot access the platforms. By applying my project it is easy to avoid the accidents as well as we can use the platform too. A human fall down in the gap exist between the platform and to the train can be totally avoided by introducing Mechanical platform edge extensions known as platform gap fillers is used to bridge the gap between platform and to the train. This is more useful in the case of safeguard the human life and also it is cheaper than the cost which is involved for increase the height of the platform. In which the safety grill setup present in the bottom of the locomotive compartment it will extracted automatically while reaching the platform with the help of sensor, so the platform gap is closed with the safety grill. And then it will retract again into the bottom of the locomotive compartment after leaving the station. By this project the platform gap accidents are avoided.***
Keywords: Platform gap, Safety grill, Bridge the gap

I. INTRODUCTION

Indian Railways is a state-owned railway company, responsible for rail transport in India. It is owned and operated by the 'Government of India' through the 'Ministry of Railways'. Indian Railways is a great national asset, being a single transport network connects far flung areas of the country since April 16th, 1853.[1] It is the fourth largest railway network in the world which runs 19,000 trains, out of which 12,000 trains carry over 23 million passengers per day connecting about 7216 stations spread across the country on both long-distance and suburban routes. It runs more than 7,000 freight trains per day carrying about 3 million tons of freight every day. It has a network of 66,687 kilometers which is more than one and half times the circumference of the earth. [2] And also it is the fourth-largest railway network in the world by size, with 121,407 kilometers of total track over a 67,368-kilometre route. Forty nine percent of the routes are electrified with 25 KV AC electric traction while thirty three percent of them are double or multi-tracked. Safety of both passengers and employees is a major concern for transit agencies [3]. Typical safety concerns for rail transit vary greatly depending on mode, location, climate, age of system, and various other factors. In general, the public often interact with rail transit at two primary locations. The first is at grade crossings, whether they be a pedestrian crossing or a roadway crossing. The second is at rail station platforms, which can vary from low level to high level. Passenger safety at rail stations can be a significant concern for rail transit operators. Stations can be in varying configurations [4] such as underground, at grade, and elevated. Stations along a single route can include multiple configurations and see varying levels of passenger flows. The specific safety concerns associated with each type of station [5-9] can differ significantly. Furthermore, there can be additional differing safety concerns in relation to island platforms versus side platforms and tangent versus curved track.

A railway station is provided for one or more of the following purposes, the purpose of the railway station can vary based on the requirement.

A. To entrain or detrain the passengers.
B. To load or off load the goods or parcels.
C. To control the movement of trains.
D. To enable the locomotives to take fuel, water or coal.
E. To collect food and water for passengers.
F. To provide facilities for the stay of the passengers.

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Generally, the size of the railway station depends on the town or city in which it is situated, the number of trains passing through that point, if any junctions are involved, if so the number of tracks (3-way, 4-way) totally decides the number of platforms in the particular railway station. But, Indian Railways has assigned a standard platform, track dimensions [10-12] and lengths for majority of railway stations.

The railway track predominantly used in India is broad gauge in which the rails are 1676 mm (5 ft 6 in) apart from each other. This is a standard dimension which is used not only in India but also in many parts of the world. It is the widest gauge in regular operation in the world [13-15]. Except for a few hill stations and areas of North and Eastern India where Metre gauge shown in fig 1.1 (1000 mm or 3 ft 27/8 in) and Narrow gauge (762 mm or 2 ft 6 in) are employed. The railway gauge used is also a major consideration in the design. [16]

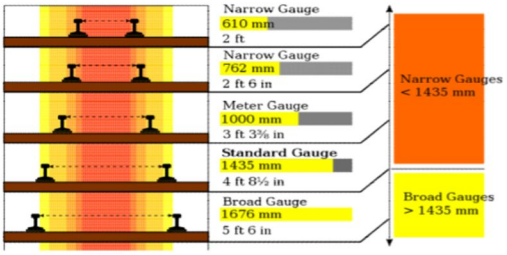


Fig 1.1: Different railway gauges used all across the world

A. Killer Gap

One of the primary factors that are often associated with platform-train-interface incidents is the size of killer gap shown in the fig 1.2. Excessive gaps are also seen on the platforms of many commuter lines. These gaps are based on sufficient offset from edge of platform to centerline of track to allow a variety of different vehicles to utilize the track at full operating speeds (more information in Regulations and Standards section). However, an eight-inch gap leaves ample room for an object or a person to fall or trip in between the train and platform. Gaps along curved sections of track may be even larger. The degree of curvature and amount of super elevation in a curve can also impact the gap significantly. As a general rule, for every one-degree of track curvature, one inch of additional gap is required to ensure the train cars do not strike the edge while passing. A similar convention is used for super elevation with one inch of super elevation corresponding with one additional inch of vertical gap needed for safe train operations

Fig 1.2: killer gap animation

II. STATISTIC REVIEW OF RAILWAY ACCIDENTS:

Of the 2,997 railway accidents that occurred between 2011 and 2013, 2,788 were urban railway accidents shown in fig 2.1 and 209 were conventional railway accidents [17]. Conducting a frequency analysis by accident type for both urban railway accidents and conventional railway accidents revealed the following: Urban railway accidents most frequently occurred in the order of falls (65%), train related slip/caught accidents (23%), minor collisions (7%), and becoming stuck between trains and platforms (5%), while conventional railway accidents were most common in the order of jumping in front of oncoming trains (45%), train-related slip/caught accidents (17%), falling on tracks (13%), and being on or near the tracks (10%). A comparative analysis of accident types showed that for urban railway accidents, accidents were mostly caused by passenger-driven mistakes such as falls, collisions, and becoming stuck between train and platform, whereas conventional railway accidents [18-19] mostly occurred in relation to external factors such as jumping in front of oncoming trains, falling on tracks, and being on or near tracks. This gap can be explained by the operational differences between conventional railways and urban railways.

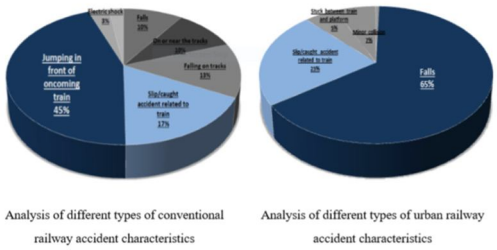


Fig 2.1: Analysis of railway accident characteristics according to accident types

Analysis of the age of passengers involved in accidents shown in fig 2.2 reveals that victims of railway accidents have a varying age range from infants to people in their 90s. Statistics indicate that victims in their 70s are most common at 20.9%. Those in their 50s amounted to 19.6%, 60s was 18.9%, and 20s was 10.6%. It was found that people in their 50s to 70s were most susceptible to railway accidents compared to other age groups.

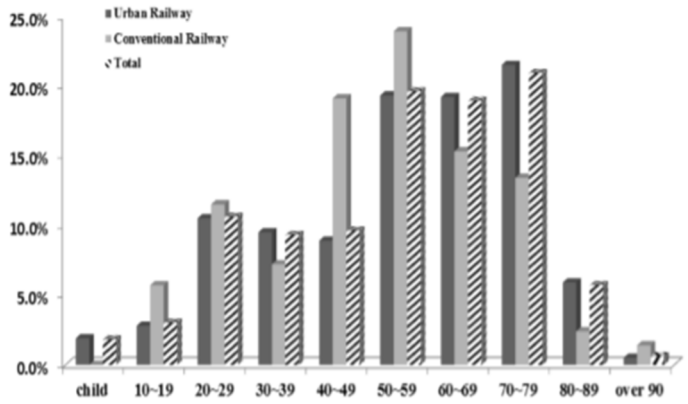


Fig 2.2: Analysis of railway accident characteristics according to passenger age

Each train station contains a number of main facilities: stairs, gates, waiting rooms, moving walks, tracks, platforms, escalators, elevators, connecting corridors, trains, tunnels, restrooms, etc… This means that railway accidents [20-21] may occur in any of these places as shown in fig 2.3. This section focuses on subtotaling railway accidents for each facility, as well as comparing and analyzing their rate of occurrence. For conventional railways, 80% of all accidents occurred on the platform, followed by escalators (9%), tracks (6%), and stairs (3%). Urban railway accidents, on the other hand, instead of mainly occurring in one area, had a similar level of frequency in various locations such as trains (28%), stairs (24%), escalators (20%), and platforms (16%). A similar rate of occurrence in multiple locations can be explained by the fact that urban railway has a higher user density, leading to passenger-passenger collisions as well as passenger-facility collisions. As for conventional railway accidents, institutional factors such as low-level platforms and lack of screen doors contribute to higher accident frequency.

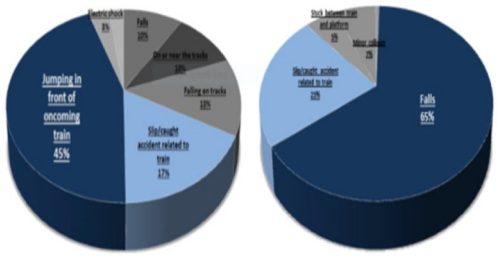
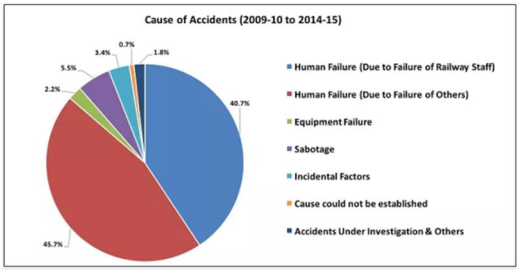


Fig 2.3: Analysis of railway accident characteristics according to accident location



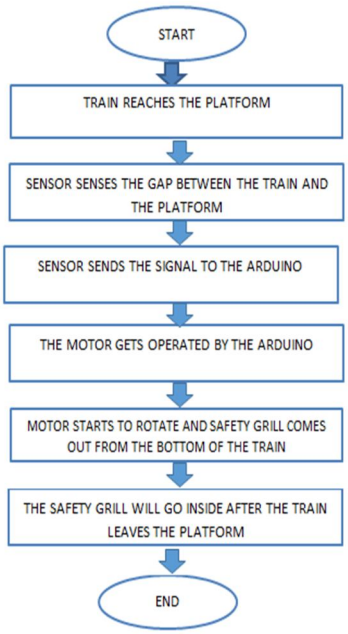
Railway platform height is the built height above top of rail of passenger platforms at stations. A connected term is train floor height, which refers to the ATR height of the floor of rail vehicles. Worldwide, there are many, frequently incompatible, standards for platform [22-25] heights and train floor heights. Where raised platforms are in use, train widths must also be compatible, in order to avoid both large gaps between platform and trains and mechanical interference liable to cause equipment damage.
Recent studies have shown that although fatalities in railway accidents are relatively uncommon, the number of passenger injuries is increasing. Sadly, the rate of passengers injured while traveling on Amtrak trains is a shocking 58 times higher than for French rail passengers. Although high-profile accidents involving passenger trains more regularly make the news, studies show that a person or vehicle is struck by a train about every three hours. Trend data don't provide much comfort, as The National Transportation Safety Board reports that deaths resulting from injuries sustained in train wrecks were up 6% in 2012.

A. Process Involved

In this project the human life safety is concerned more, it is designed that to avoid accidents and also to reduce the cost which involved for this process. With that concern the idea is converted into an idea and that idea flow is given below in the flow process.

B. Flow Chart

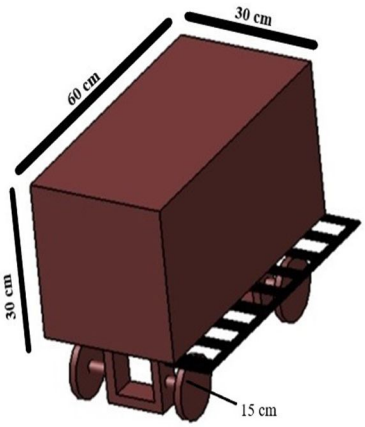
This is the simple way by which the working methodology of the project is explained easily. In this method the safety grill is attached in the bottom of the locomotives and the sensor is also attached in the train itself. Initially the train reaches the platform, and the working of this project starts. While train reaching the platform the senor attached in the locomotive is started to work. Sensor measures the distance between the train and to the platform by sending the light signal. Immediately the sensor send the signal to the Arduino .The Arduino is the one which receives the signal and the program which is done in the Arduino is helpful to operate the motor driver. The motor drive is used to operate the motor which make the motion of the safety grill which is attached in the bottom of the locomotive compartment.

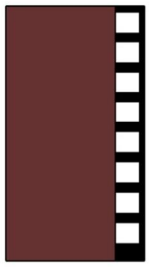


The grill is present all over the train so that the passenger's fall in between the killer gap is avoided. The grill is used to bridge the killer gap [25-26] present in between the train and to the platform. This grill is opened while the locomotive reaches the platform and then it will open till the train leaves the platform. The grill is retracted into the train after the train leaves the platform. This is the simple technique but it is the effective way to avoid the killer gap accidents and also we can safeguard the human life.

C. Design Diagram

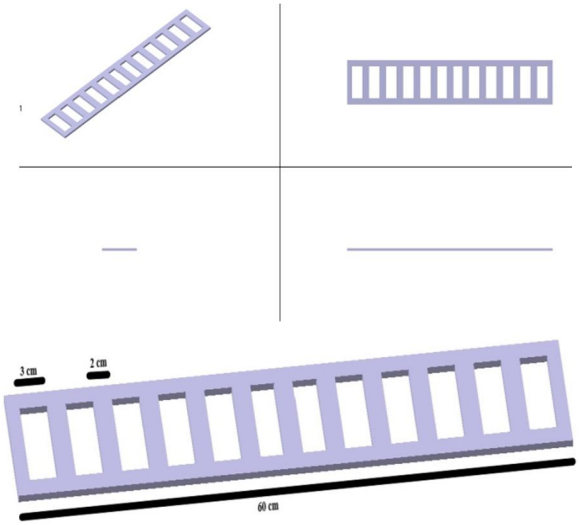
The design diagram is used to picturise the total view of the project in the real image.





Length of the wagon setup = 60cm
Width of the wagon setup = 30cm
Height of the wagon setup =30cm

D. Design Of Safety Grill



Length of the grill =60 cm
Thickness of the grill =0.5 cm
Width of the grill = 7 cm
Groove in the safety grill = 3 cm
The groove are made in the grill is to reduce the weight of the grill setup. The 3 cm gap is not a big gap and human cannot fall in that gap. Because of the groove is made in the grill, the weight is reduced and the work done by the motor is also reduced by this groove.

E. Control System

A control system manages commands, directs, or regulates the behaviour of other devices or systems using control loops.

1) Ultrasonic sensor
2) Arduino
3) Motor driver L293d
4) 12v DC Gear motor

F. Sensor

A sensor is a device, module, or subsystem whose purpose is to detect events or changes in its environment and send the information to other electronics, frequently a computer processor. A sensor is always used with other electronics. Sensors are used in everyday objects such as touch-sensitive elevator buttons (tactile sensor) and lamps which dim or brighten by touching the base, besides innumerable applications of which most people are never aware.
With advances in micromachinery and easy-to use microcontroller platforms, the uses of sensors have expanded beyond the traditional fields of temperature, pressure or flow measurement, for example into MARG sensors. Moreover, analog sensors such as potentiometers and force-sensing resistors are still widely used. Applications include manufacturing and machinery, airplanes and aerospace, cars, medicine, robotics and many other aspects of our day-to-day life.

G. Ultrasonic Sensor

The sensor head emits an ultrasonic wave and receives the wave reflected back from the target. Ultrasonic Sensors measure the distance to the target by measuring the time between the emission and reception. Ultrasonic sensors shown in the fig 6.1 work on the principle of reflected sound waves and are used to measure distance. One sensor can detect others operating nearby. Distance is then estimated by the time interval between sensor and object. Basic Sonar Illustration – A transducer generates a sound pulse and then listens to the echo It emits an ultrasound at 40 000 Hz which travels through the air and if there is an object or obstacle on its path It will bounce back to the module. Considering the travel time and the speed of the sound you can calculate the distance.

Fig 6.1 Ultrasonic sensor

Fig: Sensor working

When an electrical pulse of high voltage is applied to the ultrasonic transducer it vibrates across a specific spectrum of frequencies and generates a burst of sound waves. Whenever any obstacle comes ahead of the ultrasonic sensor the sound waves will reflect back in the form of echo and generates an electric pulse

Ultrasonic sensors work by emitting sound waves at a frequency too high for humans to hear. They then wait for the sound to be reflected back, calculating distance based on the time required. This is similar to how radar measures the time it takes a radio wave to return after hitting an object.

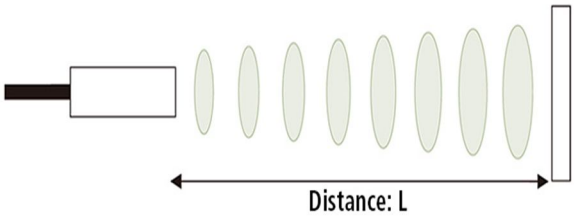


Fig 6.2: Ultrasonic wave propagation

An optical sensor has a transmitter and receiver, whereas an ultrasonic sensor uses a single ultrasonic element for both emission and reception which is shown in the fig6.2. In a reflective model ultrasonic sensor, a single oscillator emits and receives ultrasonic waves alternately. This enables miniaturization of the sensor head.

Distance calculation

The distance can be calculated with the following formula:

Distance

$$L = 1/2 \times T \times C$$

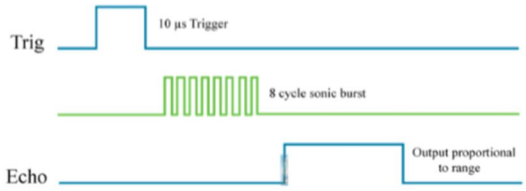
Where,

L is the distance

T is the time between the emission and reception

C is the sonic speed. (The value is multiplied by 1/2 because T is the time for go-and-return distance.)

In order to generate the ultrasound you need to set the Trig on a High State for 10 µs. That will send out an 8 cycle sonic burst which will travel at the speed sound and it will be received in the Echo pin. The Echo pin will output the time in microseconds the sound wave travelled.



For example, if the object is 10 cm away from the sensor, and the speed of the sound is 340 m/s or 0.034 cm/µs the sound wave will need to travel about 294 u seconds. But what you will get from the Echo pin will be double that number because the sound wave needs to travel forward and bounce backward. So in order to get the distance in cm we need to multiply the received travel time value from the echo pin by 0.034 and divide it by 2.

H. Features

The following list shows typical characteristics enabled by the detection system.

1) Transparent object detectable
2) Since ultrasonic waves can reflect off a glass or liquid surface and return to the sensor head, even transparent targets can be detected
3) Resistant to mist and dirt
4) Detection is not affected by accumulation of dust or dirt.
5) Complex shaped objects detectable
6) Presence detection is stable even for targets such as mesh trays or springs.

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I. Arduino

Arduino is an open-source shown in the fig 6.3 electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. You can tell your board what to do by sending a set of instructions to the microcontroller on the board. To do so you use the Arduino programming language (based on Wiring), and the Arduino Software (IDE), based on Processing. Over the years Arduino has been the brain of thousands of projects, from everyday objects to complex scientific instruments. A worldwide community of makers - students, hobbyists, artists, programmers, and professionals - has gathered around this open-source platform, their contributions have added up to an incredible amount of accessible knowledge that can be of great help to novices and experts alike.

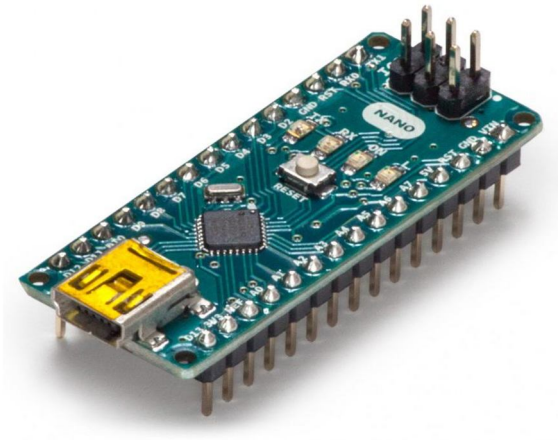


Fig: 6.3 Arduino

Arduino was born at the Ivrea Interaction Design Institute as an easy tool for fast prototyping, aimed at students without a background in electronics and programming. As soon as it reached a wider community, the Arduino board started changing to adapt to new needs and challenges, differentiating its offer from simple 8-bit boards to products for IOT applications, wearable, 3D printing, and embedded environments. All Arduino boards are completely open-source, empowering users to build them independently and eventually adapt them to their particular needs. The software, too, is open-source, and it is growing through the contributions of users worldwide.

Thanks to its simple and accessible user experience, Arduino has been used in thousands of different projects and applications. The Arduino software is easy-to-use for beginners, yet flexible enough for advanced users. It runs on Mac, Windows, and Linux. Teachers and students use it to build low cost scientific instruments, to prove chemistry and physics principles, or to get started with programming and robotics. Designers and architects build interactive prototypes, musicians and artists use it for installations and to experiment with new musical instruments. Makers, of course, use it to build many of the projects exhibited at the Maker Faire, for example. Arduino is a key tool to learn new things. Anyone - children, hobbyists, artists, programmers - can start tinkering just following the step by step instructions of a kit, or sharing ideas online with other members of the Arduino community.

There are many other microcontrollers and microcontroller platforms available for physical computing. Parallax Basic Stamp, Netmedia's BX-24, Phidgets, MIT's Handyboard, and many others offer similar functionality. All of these tools take the messy details of microcontroller programming and wrap it up in an easy-to-use package. Arduino also simplifies the process of working with microcontrollers, but it offers some advantage for teachers, students, and interested amateurs over other systems:

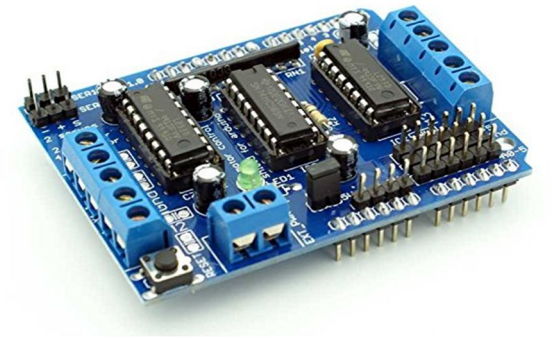
1) Inexpensive: Arduino boards are relatively inexpensive compared to other microcontroller platforms. The least expensive version of the Arduino module can be assembled by hand.
2) Cross-platform: The Arduino Software (IDE) runs on Windows, Macintosh OSX, and Linux operating systems. Most microcontroller systems are limited to Windows.
3) Simple, Clear Programming Environment: The Arduino Software (IDE) is easy-to-use for beginners, yet flexible enough for advanced users to take advantage of as well. For teachers, it's conveniently based on the Processing programming environment, so students learning to program in that environment will be familiar with how the Arduino IDE works.
4) Open Source and Extensible Software: The Arduino software is published as open source tools, available for extension by experienced programmers. The language can be expanded through C++ libraries, and people wanting to understand the

technical details can make the leap from Arduino to the AVR C programming language on which it's based. Similarly, you can add AVR-C code directly into your Arduino programs if you want to.

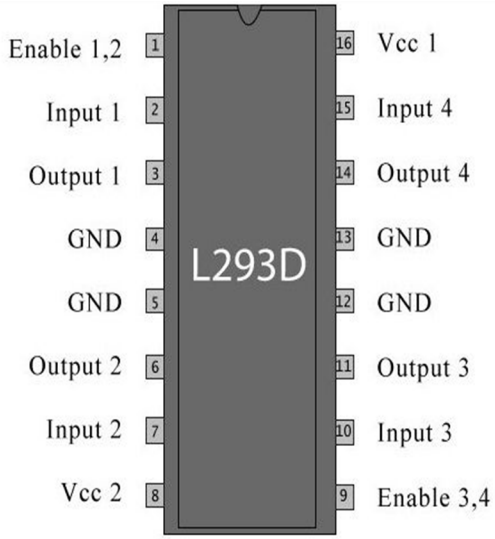
5) *Open Source and Scalable Equipment:* Arduino board is issued in accordance with the Creative Commons license, so experienced designers can create their own version of the module, stretching and improved. Even relatively inexperienced users can create a version of the module, in order to understand how it works, and save money

J. Motor Driverl293d

The L293D is quadruple high-current half-H drivers. It is designed to provide bidirectional drive currents of up to 600-mA at voltages from 4.5 V to 36 V. Both devices are designed to drive inductive loads such as relays, solenoids, dc and bipolar stepping motors, as well as other high-current/high-voltage loads in positive-supply applications. All inputs are TTL compatible.



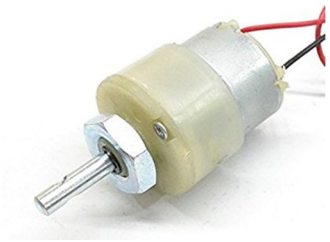
Each output is a complete totem-pole drive circuit, with a Darlington transistor sink and a pseudo- Darlington source. Drivers are enabled in pairs, with drivers 1 and 2 enabled by 1,2EN and drivers 3 and 4 enabled by 3,4EN.When an enable input is high, the associated drivers are enabled, and their outputs are active and in phase with their inputs. When the enable input is low, those drivers are disabled, and their outputs are off and in the high-impedance state. With the proper data inputs, each pair of drivers forms a full-H (or bridge) reversible drive suitable for solenoid or motor applications.



Connecting directly will result in not working motor and destroying the microcontroller due to high currents. Drivers are not used only for motors. They are used for any device that usually draws more than 50-100 mA. Maximum current of microcontroller output (typically 10-20mA) is not enough to drive motor coil. In electronics, a driver is an electrical circuit or other electronic component used to control another circuit or component, such as a high-power transistor, liquid crystal display (LCD), and numerous others.

K. DC Motor

A DC motor is any of a class of rotary electrical machines that converts direct current electrical energy into mechanical energy. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic, to periodically change the direction of current flow in part of the motor



DC motors were the first form of motor widely used, as they could be powered from existing direct-current lighting power distribution systems. A DC motor's speed can be controlled over a wide range, using either a variable supply voltage or by changing the strength of current in its field windings. Small DC motors are used in tools, toys, and appliances. The universal motor can operate on direct current but is a lightweight brushed motor used for portable power tools and appliances. Larger DC motors are currently used in propulsion of electric vehicles, elevator and hoists, and in drives for steel rolling mills. The advent of power electronics has made replacement of DC motors with AC motors possible in many applications.

The working of the gears is explained by the principal of conservation of angular momentum. The gear having smaller radius will cover more RPM than the one with larger radius, the larger gear will give more torque to the smaller gear than vice versa. RPM and torque are inversely proportional. The gear having more torque will provide a lesser RPM and converse.

The gear connecting the motor and the gear head is quite small, it transfers more speed to the larger teeth part of the gear head and makes it rotate. The larger part of the gear further turns the smaller duplex part. The small duplex part receives the torque but not the speed from its predecessor which it transfers to larger part of other gear and so on

A relay is an electrically operated switch. Many relays use an electromagnet to operate a switching mechanism, but other operating principles are also used .Relays find application where it is necessary to control a circuit by a low-power signal. Relay found extensive use in telephones exchange and early computer to perform logical operations. Solid-state relays control power circuits with no moving parts, instead using a semiconductor device triggered by light to perform switching.

A small electronic relay consist of a coil surrounding a soft iron core, an iron yoke, which produces a low reluctance path for magnetic flux, a movable iron armature, when the relay id de-energized there is an air-gap in the magnetic circuit. In this condition, one of the two sets of contacts in the relay is closed, and the other set is open. Other relays may have more or fewer sets of contacts depending on their function .When an electric current is passed through the coil, the resulting magnetic field attracts the armature ,and the consequent moment of the movable contact or contacts either makes or breaks a connection with a fixed contact. If the set of contacts was closed when the relay was de-energized, then the movement opens the contacts and breaks the connection ,if the contacts were open.

L. Photography

III. CONCLUSION

The project avoids the killer gap accidents in the railway platform. This is done with the effective use of safety grill implemented in the bottom of the coach. This is used to safeguard the valuable human life. The killer gap accidents are the most dangerous, it is happening because of the carelessness. But the killer gap accidents are to be avoided, because human life is most precious. By this project implemented in the railway compartments it is easy to avoid the accidents happen in the railway station as well as we can safeguard the human life. It is concluded that this project will be more useful and also it is easy to implement rather than increase the platform height.

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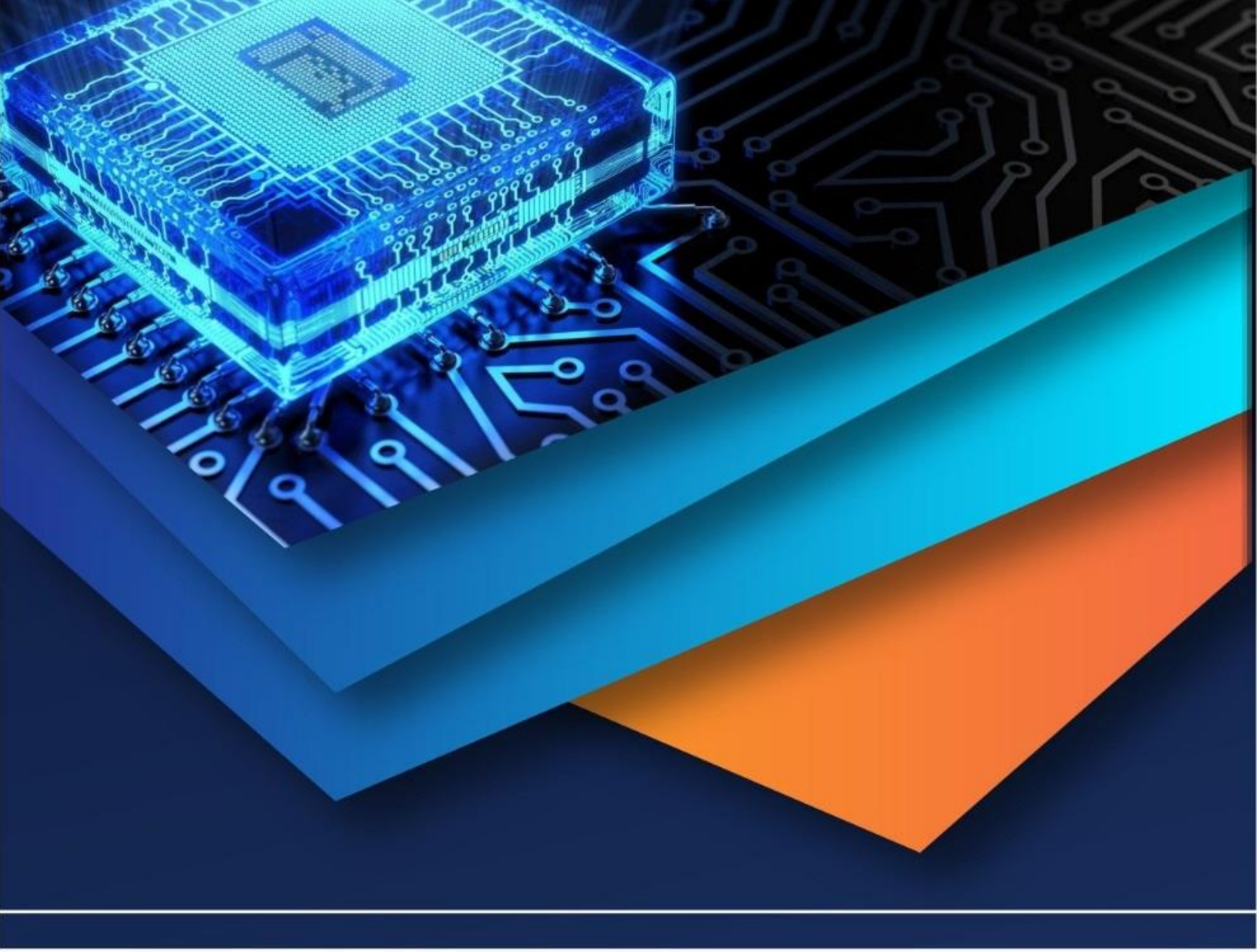

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