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***Research paper***

# Automated railway operations and control services

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**Abstract**

The automatic railway system is a better replacement for the manual standard. The system directs to the controlling of railway gate, track switching, ticket buying and checking, train arrival recognizing and the security system enhancing in railway platform with cloud services. The entire system is automated; errors occurring due to manual operation can be prevented to minimize accidents occurring due to the indifferent and the negligent nature of the today's world. The system employs two pair of IR sensors, one for the automatic gate control, and another for the track switching system. The IR sensors are the pivot in the detection of the arrival and departure of the train thus forming the Gate control system. The same mechanism used in the track switching unit to switch the track. The system that checks for proximity employs a KFS beacon, an on-off switch that forces the train to stop upon its presence and depart later. An electric vibrating motor is set in place to vibrate the platform upon train's arrival and to alert the passenger who unknowingly steps over the specified limit. A rotating ultrasonic sensor embedded between the tracks, does the job of sensing a living being on the track near the platform and the gate controlling unit. Train Ticket payment and checker is initiated with Radio Frequency reader, GPS system and finger print scanning device with zero wait strategy. Therefore, the efficiently reliable system is operated automatically throughout the railway system.

***Keywords***: *IR Sensors; DC Motor; Vibrating Motor; GI Sheet; RFID Scanner.*

## 1. Introduction

The automatic control directs to the controlling of railway gate, switching of the tracks, buying and checking of the ticket and monitoring the train's arrival. Sensors are employed in all the mentioned areas. In the areas such as track switching, mechanism of gate control and platform, the IR sensors are used to detect the arrival and departure of the trains. At the station gate, these sensors are placed at some distance apart and are positioned at the opposite sides in the level crossing. The sensors that track the advent and departure of the train are called as the upside and the downside sensors, owing to the direction movement respectively. The movement of the railway gates is facilitated by a motor which is controlled when the sensors are triggered. To tend to the automatic track switching, the proposal is to place a couple of sensors at the switching junction which will also work using the above principle of sensor triggered motor. The intention of the automatic switching junction is to ensure the uninterrupted, scheduled journey of the local trains that could possibly be hindered by the goods train on its path. Since it is pivotal to control the movement of the train, a KFS beacon is employed. With a magnet fixed under the coach and the beacon placed at the track for the purpose of detection, the train can be forced to halt and allowed to depart flexibly. This project also proposes a thoughtful solution to avoid accidents at the tracks. To achieve this, a rotating Ultrasonic sensor is placed in the track between the platforms, which will be activated when the train is close enough, to identify any moving object, mainly to target living beings, on the track. As a safety measure, to prevent people from slipping into the tracks unintentionally or otherwise, a mechanism involving vibrating motors will be planted on the platform which alerts the passengers, on nearing the station, through vibration.

## 2. Literature survey

Though the existing systems include the mechanism of automatic gate control and track switching with the sensors, with automated system, no efficient system is derived for the safety of the passengers. The currently used ticketing systems are reliable but with no zero wait strategy.
The key idea of the project is to automate the control of railways as much as possible and also ensure the safety of passengers which is much of a question as per statistics. The main elements include Mechanized or Automatic Gate Control and Switching of tracks, Monitoring safety of passengers on the platforms and alert those who carelessly cross on the tracks. Efficient Allocation of tickets in trains is another added feature.

## 3. The findings

### 3.1. Microcontroller AT89S51

The microcontroller receives the signal from the transmitter and controls various operations at the end. The Relay driving unit magnifies the produced current that energizes the coils of the electromagnetic relay which is connected with dc motor. Totally, 4 relays are needed to control the units. In gate controlling unit, 2 relays are used to connect with a DC motor for the opening and closing of the

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gate. In track switching unit, 2 relays are used to connect with a DC motor to switch the tracks.

### 3.2. IR transmitter and receiver

The IR components including transmitter and receiver units are placed on the inner sides of the platform facing each other. The IR transmitter is an IR led that emits photons frequently to the receiving end and it has the current limiting resistor of 1Kilo Ohms. The IR receiver is p-n junction photo diode that also has a resistor of 1 kilo ohms. The IR transmitter sends the LED signal to the receiver. The receiver grabs the signal continuously to track the train. Whenever a train passes, the LED signal sent by the transmitter is interrupted and is not caught by the receiver. Hence, the presence of the train is acknowledged, and corresponding operations are taken place.

### 3.3. Level crossing unit

The level crossing unit has four sensors (in pairs) with a dc motor. The DC motor is fitted with the gate controlling unit and whenever the DC motor rotates, the gate closes or opens respectively. One pair of sensors, located before the gate, called upside sensor detects the arrival of the train. Hence whenever the pair of sensors is deactivated, the DC motor is rotated forward, which in turn closes the gate. The second pair of sensors, located away from the gate, called downside sensor detects the departure of the train. Whenever this pair of sensors is disengaged, the DC motor rotates backward, which in turn opens the gate

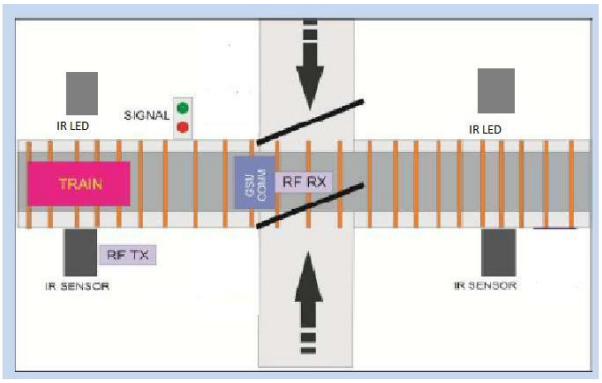



**Fig. 1:** Level crossing.

### 3.4. Track shifting unit

The track switching unit uses two sets of sensors to analyze the track that should be availed by the train. The first pair of sensors detects the advent of the train. If the alternate (bypass) track is already in use by a train, this is sensed and the concerned train is signaled to take a different (normal) track. Alternatively if the normal track is occupied then the newly arrived train must use the bypass track.

The DC motor switches the track based on the information from the cloud. The DC motor rotates either forward or backward to switch the tracks,

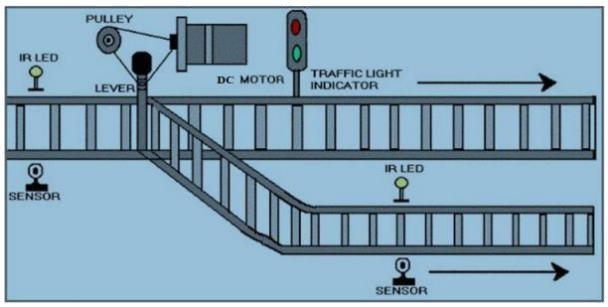



**Fig. 2:** Track Shifting.

#### 3.4.1. Proximity alert system

In an effort to prevent people from falling off the platform and preventing them from getting hurt at the tracks, an alert system is proposed. The platform (portion close to the track, about 1.5m) has in place three electric motors each located at the extreme right, left and the centre. These will be set to motion and will vibrate once the train's arrival to the platform is detected by the KFS beacon. To transmit this vibration to the complete length and specified width of the platform a simple mechanism comprising of GI sheet and steel pipes are employed.

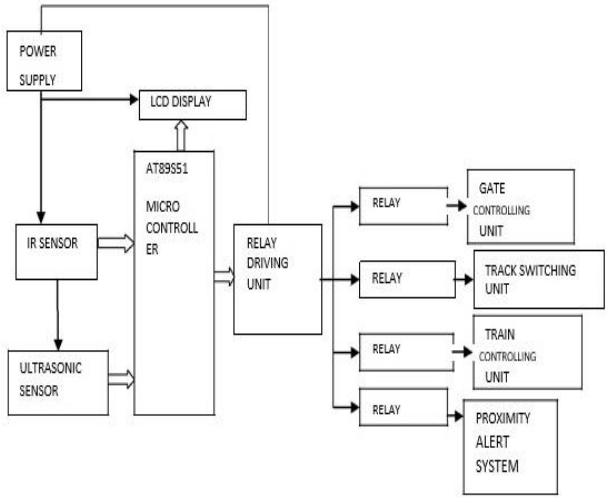



**Fig. 3:** Diagram of Automated Railway System.

## 4. Components of proximity alert system

### 4.1. LED light

12V high power LEDs, deck light which has a power of 1w or 3w with its body made of stainless steel and consists of LED lens diffuser covered with IP67 protection class. Its specifications include stainless steel grade with 316 marine grades and 304 grades. The body consists of electrophoresis finishing and the fitting cable length is selected in accordance to the application requirement.

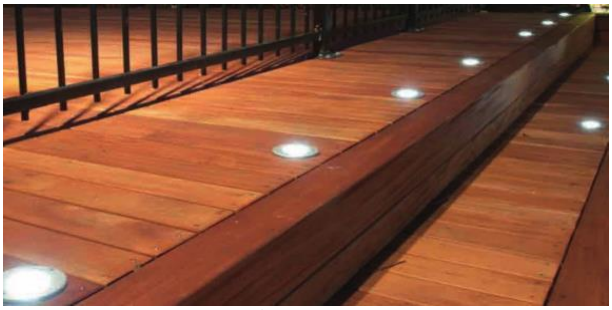


**Fig. 4:** Platform with LED Lights.

### 4.2. Steel pipe

The stainless steel square pipe that is welded having a standard of ASTM A554, the grade is about 201(ni 0.8%). The outer diameter of the annealed 201 grade steel is about 6mm thickness given by 0.3mm, length varies according to our requirement. It has commendable degree of tensile strength, yield strength and hardness.



**Fig. 5:** Steel Pipes.

### 4.3. Electric motor

The single phase asynchronous electric motor gives the output power of about 200w. The AC voltage is given by 240v. The speed is about 1180 rpm and the power of the capacitor is 10µF.

### 4.4. Rotating ultrasonic sensor

The rotating Ultrasonic sensor having the capability of analyzing the existence of a being can ensure the safety of the passenger. The ultrasonic sensor rotates at 50rpm and therefore able to sense the movement of any living being. Only if the person is present at the sensor location for the entire 50 rotations, the microcontroller sends the problem to the railway system via the cloud. The railway system halts the successive train as well as alerts the signal in that direction, therefore halting all the successive trains. The main aim is to avoid massive accidents across the platform.

### 4.5. Automatic ticketing

A strict mechanism is followed to generate automatic ticketing and checking. Foremost, the passenger must scan the smart railway card to the reader. The data to be provided from the card is given in the microcontroller section and transmit the data via Radio Frequency tags. The reader must have a GPS enabled service to retrieve the current location service. The association of individual finger prints, via aadhar card, to the smart card must be taken into account. When the passenger enters the train, he is supposed to connect to the reader with remote contactless radio frequency interface, where the interface is placed next to the entry door and the information of the current location is stored. The motion detector is inserted in the metal detector with the optical biometric scanner. The passenger after getting to the destination may place his finger on the finger print scanner, at the exit door, which has GPS location service. The finger print scanner by gathering the information of the destination detects the starting location of the passenger by collaborating with the information in the smart card. If a location is present, the allocated ticket fare is deducted by knowing the destination location (current location). If a location is not present, assuming that the passenger failed to Swipe the card, it deducts the maximum ticket fare of the journey. The sensor in the detector analyses whether the detected passenger had used finger print scanner. If the detector employs with negative scanning input at the exit door, the alarm sound is turned on.

This detector is useful in knowing whether the passenger had purchased the ticket. Hence, ticket buying and checking via GPS services is introduced efficiently with zero wait strategy.

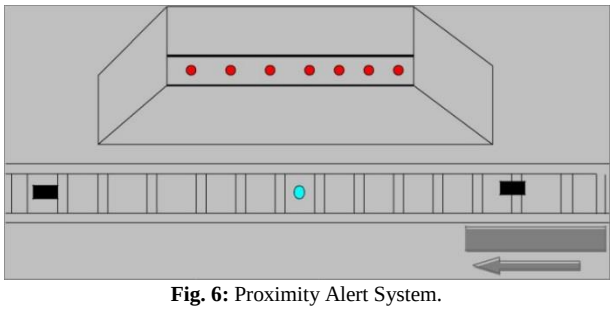


**Fig. 6:** Proximity Alert System.

### 4.6. KFS beacon

The KFS uses a DOPPLER radar that uses the Doppler Effect to produce velocity data about objects at a distance which is done by bouncing a microwave signal off a desired target. This radar measures the train and it stops the train after comparing it with the programmed setting. The KFS sensor is fitted below the train, and the KFS beacon is placed on the track, certain distance before and after the platform. When the KFS beacon having the presence sensing radar, detects the sensor and the transmitting electromagnetic waves detects the KFS sensor, (i.e., nearing the platform), then the train is forced to halt.

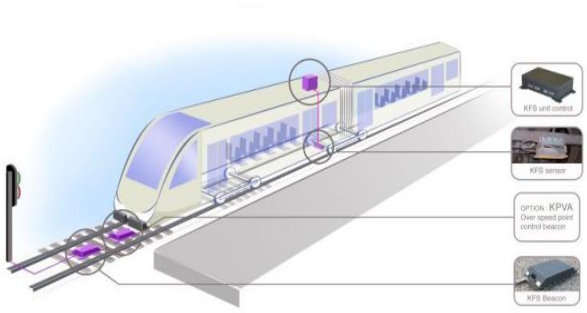



**Fig. 6:** KFS System.

## 5. Implementation of proposed system

The following deals with the circuitry operation, the sensors are attached to port1 of the micro controller, the two gate controlling sensors get associated to pin number p1.0 and p1.1.The track switching control sensors are joined to pin number p1.2 and p1.3.The kfs beacon used in the proximity system are attached to p1.4 and p1.5.The led lights are associated with p1.6.To port 0, a 16×2 LCD is connected. The LCD is interfaced with the controller by two ports, the data lines are correlated with one port and the control signals on the other. The controls elements are connected to port 2.The track switching motor are connected to pin number p2.1 and p2.2. The train mechanism is connected to pin number p2.0. The gate controlling motors are connected to p2.3 and p2.4.The alert system motors are connected to pin number p2.5 and p2.6.

The transmitter unit uses +5v to produce the sufficient light energy required for the transmission. The anode gets attached to +5v and cathode to the ground via the resistor of 1Kilo ohms.

The receiver unit embedded with a p-n junction photodiode in which the photons emitted by the transmitting led is received by it. Since the photodiode is reverse biased, there will be the generation of leakage current and it is amplified by a transistor BC549 to raise the signal which is then fed into the microcontroller.

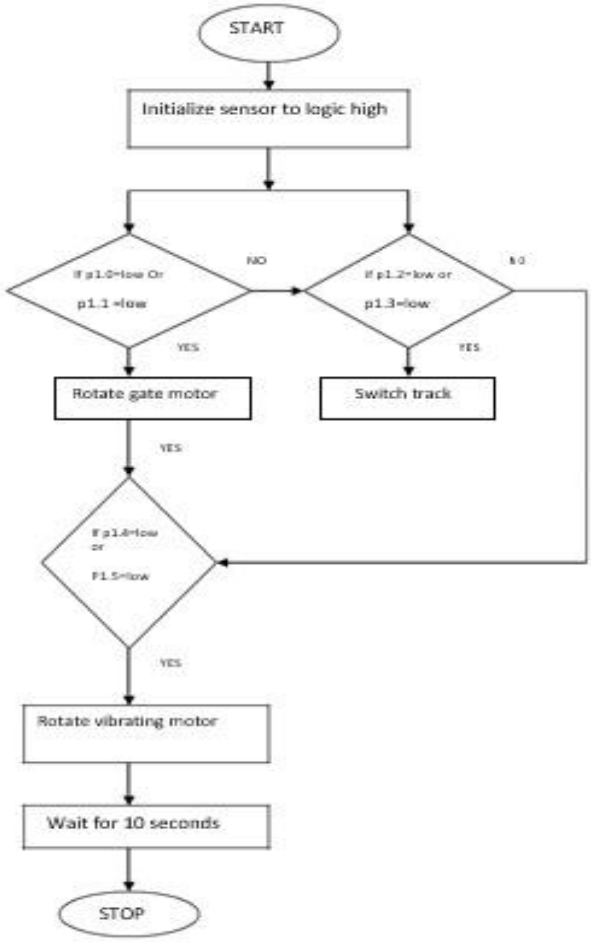



**Fig. 6:** Flow Chart.

### 5.1. Logical operation

The transistor gets switched on, at once the light is incident on the photo diode, hence the supply of the Infra Red receiver flows to ground and the microcontroller receives the logic 0 as input ,thus it generates logic0 as output and therefore the system is in the off state. When train passes through, the light beam from the IR receiver is cut by the train .Then the transistor consisting of the photodiode is off and therefore 5v from the IR receiver gets the microcontroller. Now, the transistor connected to the controller runs the relay on which in turn energizes the relay coil and hence the motor vibrates.

### 5.2. Logic levels for motor rotation

If p2.4 is logic1 and p2.3 is logic 0, the motor rotates in forward direction closing the railway gate. When p2.3 is logic1 the motor rotates in reverse direction opening the door.
For track switching, when p2.2 is logic1 and p2.1 is logic 0, the motor start rotating in forward direction and when p2.2 is logic0 and p2.1 is logic 1 the motor starts rotating in reverse direction, hence it switched the track.
For proximity alert system, when p2.6 is logic 1, the motor rotates and vibrates the GI sheet and when the p2.6 is logic 0 the motor gets switched off.

## 6. Software description

Keil C compiler has been used as the language of the program. From the flowchart, if p1.0 or p1.1 is set to logic low then the gate controlling motor will rotate. For p1.0, the level crossing motor rotates in forward direction and for p1.1; the track shifting motor will rotate in reverse direction. If p1.2 or p1.3 is set to low, then the track will switch based on the status of the other sensor. If p1.5is set to logic low then the train will stop the train. If p2.6 is logic 1 the motor vibrates and for logic 0 the motor is switched off.

## 7. Conclusion

The proposed project helps in minimizing the number of accidents occurring at the railway stations and level crossing. The railway system will increase the accuracy and eliminate the errors in manual system. It removes the collision of trains and controls the automatic change of signals via cloud. The notifications of the passenger in danger across the track, the updates of the signal are detected to avoid accidents. The entire system is operated automatically from the track shifting to the ticket checking. The efficient collision free system is accounted for the enhancement of future works.

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