INTELLIGENT SYSTEM FOR AUTOMATIC RAILWAY GATE CONTROLLING AND OBSTACLE DETECTION

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Abstract

An improvising system for Indian Railways that can be utilized to account for the problems with the level crossing gates operated manually by a gate keeper. Over 43.6% of railway accidents were held at level crossings in our country. No fruitful steps have been taken so far. In the proposed system the arrival or departure of the train near level crossing determines the opening or closing of the level crossing gate automatically with the help of IR sensor and warning signal (i.e. Buzzer sound) at level crossings. But there may be a chance that during this automation process, a vehicle may be locked between the crossing gates. At this situation, the obstacle between the crossing gates could be detected with the help of ultrasonic sensor and it will be intimated to the train through GSM module. Thus, the man power could be reduced and at the same time accidents at level crossings can be avoided into maximum extent.

Index terms: PIC Microcontroller, Ultrasonic sensor, IR sensor.

I. INTRODUCTION

Indian Railways is one of the world's largest railway and operate on gigantic dimensions covering over 63,000 route kilometres with daily loading of 1.6 million tons of freight and daily transporting of 14 million passengers by logging more than 2 million train kilometres per day. One of the sun rising industry in India as per Mckinsey is that of Indian Railways. Indian Railway is also accorded with the title of "super JEWEL" by Mckinsey. Having the largest network in India, it contributes a lump sum amount of revenue in terms of freight and passengers. Indian Railways is one of the modes of transport with a share of 22% in the passenger transport. Under the Information Technology Vision 2012, announced in the Railway Budget for 2008-09 and 2009-10, the railway ministry plans to give the Railways a modern look and feel by implementing Modern Communication systems such as RFID, GPS and Automation.

Modernization of Indian Railways has always been a question in focus for the development of the basic infrastructure of India. Since the railways represent one of the best modes of transport available to the common people, it would be impossible to just keeping increasing the fares to meet the costs incurred due to maintenance, the large workforce and the expansion activities. The Railways should therefore, consider upgrading itself to cutting-edge technologies for better efficiency and cost reduction. Improvising includes automating the railway gate operation and reduces the man-power into maximum extent. In general, level crossing gates are operated manually by a gate keeper. When the train starts to leave the station, the station in-charge delivers this information to the closest gatekeeper to get ready. In situations where the train gets delayed, the gates remain closed for long durations causing dense traffic jam at the level crossings.

The rate of manual error that could occur at these level crossings are high because they are unsafe to perform without actual knowledge about the train time table. These human interventions can be avoided by automating the process. Over 43.6% of railway accidents were held at level crossings in our country. No fruitful steps have been taken so far. In the proposed system, while automating the railway gates operation, there may be a chance that a vehicle may be locked between the crossing gates. That obstacle could be easily detected and intimated this information to the train unit with the help of Ultrasonic sensor and GSM. Thus, the possibility of accidents at the level crossings would be avoided into maximum extent. Survey of Statistics of percentage of Railway accidents and Accidents, deaths and unmanned level crossing accidents are shown in Figure 1 and 2.

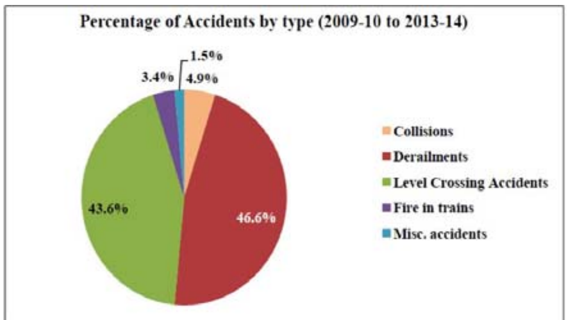

Figure 1. Statistics of percentage of Railway accidents (2009-2014)

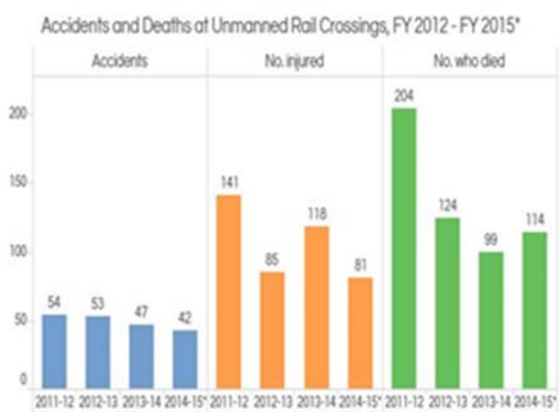

Figure 2. Accidents, deaths and unmanned level crossing accidents (2011-2015)

II. LITERATURE SURVEY

The automatic railway gates operation has been projected using various methods. As proposed by Xishi Wang (1992), the process of developing fault tolerance method has been applied for both the hardware and the software components. Magnetic sensors placed underground to detect the train are less affected by environmental changes and recognizes the direction of movement of vehicles.

Jeong Y (2008) defined the railway auto control system using OSGi and JESS. The state of railway cross has been estimated using JESS in the technique. The issues in the technique are the insufficient inline citations and also multiple issues related to OSGi. The different methods used by locomotive pilots which can avoid the accidents and the safety measures while crossing the level crossings are also discussed.

Atul Kumar Dewangan (2012) gave a detailed introduction about the present railway technology and also discussed the disadvantages of manually activated railway signals and the railway warnings at the level cross. The train detectors act as the major component in the train automation system.

Banuchander J (2012) developed a method to concentrate on anti-collision system to identify the collision points and to report these error cases to main control room, nearby station as well as grid control stations.Efficient Zig-Bee based Train Anti-Collision using Zig-Bee technology for railways is implemented.

Greene R.J. (2006) anticipated an intelligent railway crossing control system for multiple tracks that features a controller which receives messages from incoming and outgoing trains by sensors. These messages contain detail information including the direction and identity of a train. Depending on those messages the controller device decides whenever the railroad crossing gate will close or open. But this technique has the issue of high maintenance cost.

Kawshik Shikder (2014) projected the automatic operation of railway gates using RF technology. The major issue of this technique was every train could be provided with RF technology. Thus it was economically feasible to implement.Anil M.D. (2014) proposed advanced railway accident prevention system using sensor networks. He used ZigBee RF module to communicate between base station and trains. But, ZigBee was a short distance communicating device. Therefore it is practically not possible to implement his technique.

III. OBSTACLE DETECTION BETWEEN RAILWAY GATES

Anuj Tyagi R (2006) has projected four sub modules namely, train module, control centre module, signalling post module and level crossing gate module. According to him, a safe distance of 1 Km has been maintained between the trains after applying the emergency brake in case of obstacle at the Manned/Unmanned level crossing gate. But the issues was, its unable to control the speed of the train within 1 Km. Qiao Jian-hua (2008) has conveyed a technique to control the railway tracks by using anti-collision techniques. His model was implemented using sensor technique. Sensors placed at a distance detects the approaching train and controls the operation of the gate accordingly. Also an indicator light has been provided to alert the motorists about the approaching train. But he didn't take any fruitful steps to safe any obstacle has detected between the gates.

Gunyoung Kim (2002) discusses several features which prevent train accidents at level crossings. It includes automatic speed controlling in curves, collision detection, fire detection, detaching of couch automatically when fire is detected in it, automatic railway gate control and track continuity. This system makes use of IR sensors, fire sensor, Zig Bee and other embedded systems. Kawshik Shikder (2014) proposed automatic railway gate controlling using RF technology. He describes that if any obstacle has detected, Red signal will be displayed for train and train will be stopped as it detects the vehicle as obstacle on the track. The major drawback of this technique was its impossible to stop the train using this Red signal displayed at the level crossing.

Karthik Krishnamurthi (2015) has projected sensor based automatic control of railway gates. In this technique, he used a laser beam and Light Dependent Resistor (LDR) to detect the obstacle between the railway gates. Therefore any obstacle in the way of LDR has been detected and intimated to the train about the obstacle. In such case, the Locomotive Pilot will stop the train according to the information conveyed to them. This issue tends to the process to be complicated and results in unnecessary delay. Vikash Kumar (2015) has introduced a high speed alerting system to control the railway gates automatically. In this technique, he used IR LED and photodiodes to detect the arrival and departure of the trains. But, he doesn't focus on the obstacles detected between the gates during this automation process.

Kiruthiga.M (2014) has anticipated wireless communication system for controlling the railway gates automatically. She used obstacle sensor to detect any hindrance on the level crossing of the moving train. After detecting the hindrance, the signal is passed to the controller to activate the red traffic signal at the level crossing in order to stop the train. The major negative aspect of this technique was its impossible to control the speed of the train or stop the train using this Red signal displayed at the level crossing.

IV. PROPOSED SYSTEM

In general, Gate keeper manually operates the level crossing gates. When the train starts to leave the station, the station in-charge delivers this information to the closest gatekeeper to get ready. In situations where the train gets delayed, the gates remain closed for long durations causing dense traffic jam at the level crossings. The rate of manual error that could occur at these level crossings are high because they are unsafe to perform without actual knowledge about the train time table. These human interventions can be avoided by automating the process and it doesn't degrade the existing safety level.

A. Automatic Railway Gates Operation

In India the average maximum speed at which a train moves is 91.82km/hr and the minimum speed of a passenger/goods train is 59km/hr. Hence the ideal distance at which the sensors could be placed to detect the arrival and departure of the train is 3 Km from the level crossings and thus the gate will not be closed for more than 5 minutes. The proposed technique uses two IR sensors (IR1, IR2), one 16x2 LCD, an ULN driver, a relay, a DC motor and one Buzzer (B) for the automation process of railway gates operation.

B. Opening of Railway Gates

In real time, the IR sensors are placed behind the track at a distance of 3 Km on both sides of the level crossing. If IR1 detects the arrival of the train, it sends the signal to the microcontroller. Then the microcontroller activates the buzzer for warning the level crossing users that the railway gates are yet to be closed and the arrival of the train within a stipulated time. The controller then activates the pair of DC motors which acts as the railway gates. The DC motor rotates in forward direction for 5 seconds in order to close the railway gates perfectly. A 16X2 LCD has employed to display the status of the operation. When the IR1 detects the train, "TRAIN ARRIVED" has been displayed and when the gates are closed, "GATES CLOSED" has been displayed by the LCD for the level crossing exploiters.

C. Closing of Railway Gates

After the train crossed the level crossing, when IR2 detects the departure of the train, it sends the signal to the controller. Then the microcontroller again activates the buzzer to notify that the railway gates are yet to be closed. Then the controller again activates the pair of DC motor in backward direction for 5 seconds to open the railway gates perfectly. The current status of the operation has been displayed through the LCD, i.e. when the IR2 detects the train, “TRAIN DEPARTURED” has been displayed and when the gates are opened, “GATES OPENED” has been displayed by the LCD.

D. Obstacle Detection Between the Railway Gates

In the proposed system, while automating the railway gates operation, there may be a chance that a vehicle may be locked between the crossing gates. Thus, in order to save them, the system has been taken some fruitful steps. An Ultrasonic sensor has been placed at the level crossings in cross manner in one side. A constant obstacle has been placed at the other side of the level crossing. The ultrasonic sensor has inbuilt transmitter and receiver. The transmitter continuously transmits the ultrasonic waves and this could be reflected by the constant obstacle.

The reflected waves (i.e., echoes) are measured by the receiver in the ultrasonic sensor. This distance could be programmed into the controller as the threshold distance. The detection principle is shown in Figure 3.

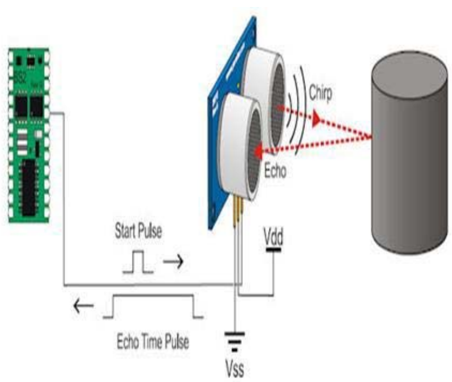

Figure 3. Detection principle of Ultrasonic sensor

The ultrasonic sensor has been activated only when the railway gates are closed. In case if any obstacle has locked between the railway gates, the ultrasonic sensor measures the distance between the sensor and the locked obstacle. If the obstacles detected, the measured distance varied from the threshold distance. The ultrasonic sensor then conveys this information to the controller.

D. Safety Measure to Avoid Collision

In this situation, the microcontroller activates the Global System for Mobile communication (GSM). The GSM then sends the information about the obstacle through the alert SMS to the Locomotive Pilot who operates the train. The SMS has been sent by gathering the contacts from the updated database of Indian Railways. When the system once synchronized with the server’s database, the time table of the trains for each level crossing will be loaded into the system.

Even though the information conveyed to the Locomotive Pilot, they can manage the situation by reduce the speed of the train or by stop the train before reaching the respective level crossing.

V. BLOCK DIAGRAM

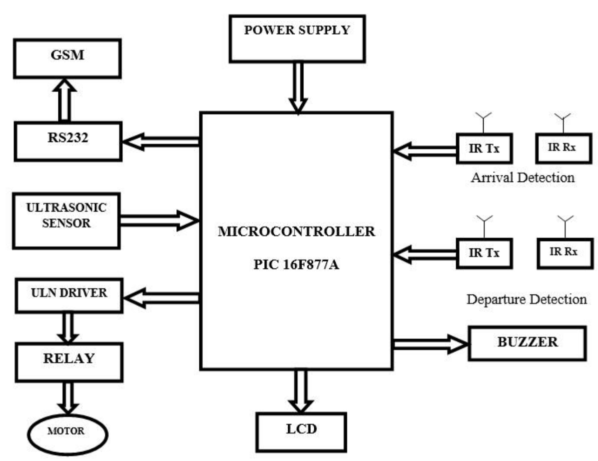

Figure 4. Block diagram of the proposed system

The major blocks in the proposed system consists of PIC16F877A Microcontroller, Infrared sensor and Ultrasonic sensor and is shown in Figure 4. The IR Sensor-Single is a general purpose proximity sensor. Here the system uses it for collision detection. The module consists of an IR emitter and IR receiver pair. The high precision IR receiver always detects an IR signal. The module consists of 358 comparator IC. The output of sensor is high and low otherwise. The status of the sensor is checked by the LED which is present on-board without using any additional hardware. The power consumption of this module is low. It gives a digital output.The proposed system uses Piezoelectric buzzer for the alert signals.

VI. SOFTWARE IMPLEMENTATION

MPLAB IDE is comprises a host of free software components and it is easy to use. It consists of compiler, linker and debugger in it. It serves as a single and a unified graphical user interface to Microchip, third party software and also hardware development tools.

VII. RESULTS AND DISCUSSIONS

The prototype of the proposed system is given below. The system uses PIC16F877A.IR Sensor is used to detect obstacle and when train arrives gates are closed. The prototype of the proposed system is shown in Figure 5.

Figure 5. Prototype of the proposed system

The various figures associated with the various stages are shown in the Figures 6 to 12. The following figure shows the arrival of train.

Figure 6. Arrival of the train

When train cross at level crossing it is detected.

Figure 7. Constant obstacle at level crossing

The following system detects if any obstacle is present after closing of gates. It uses ultrasonic sensor and measures the distance between it and the obstacle.

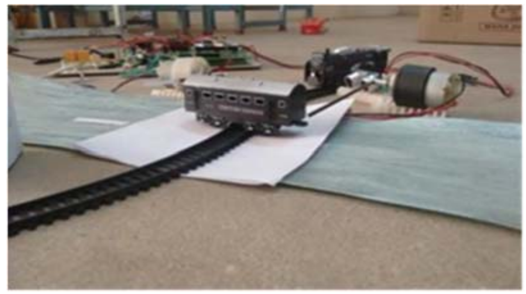

Figure 8. Ultrasonic sensor checks for obstacle after closing the gates

The distance between obstacle and ultrasonic sensor is displayed on LCD.

Figure 9. LCD continuously displays the distance between ultrasonic sensor and constant obstacle

The following figure shows the status of gates when train arrives and is detected by ultrasonic sensor.

Figure 10. LCD displays the status of gates closed automatically at level crossing

The following figure shows the status of gates when train departured and is detected by ultrasonic sensor.

Figure 11. LCD displays the status of the process after the gates opened

The following figure shows the message sent to the train through GSM.

Figure 12. Alert SMS to the Train through GSM

VIII. CONCLUSION

The proposed system is highly reliable, effective and economical at dense traffic area, suburban area and the route where frequency of trains is more. Using automatic railway crossing system, we improve the rail road transportation facility by reducing the chances of occurrence of accidents at unmanned level crossings and providing immense safety. Also this technique has fast operation than older system, it saves a lot of time as it is automated whereas manual systems take time for the line man to inform the station master to close and open the gate which will consume a considerable amount of time. The obstacle detection unit has been employed in the proposed system to reduce the accidents at level crossings into maximum extent. Since the design is completely automated it can be used in remote areas where no station master or line man is present and it doesn't degrade than existing system. Thus this system finds its applications in many cases.

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