OBSTACLE DETECTION & GATE AUTOMATION AT RAILWAY CROSSINGS

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Abstract: Government has implemented safety measures such as Railway Under Bridges, Railway Over Bridges, etc. at railway crossings to avoid accidents, still there several railway crossings remaining which are accident prone. Some railway crossings are operated by gatekeepers. Delaying in opening and closing gate leads to human errors. Therefore, possibilities of accidents at railway crossings increases. To avoid this, all railway crossings must be automated. Hence proposed system detects obstacle and tries to avoid accidents. But prior to this system railway gate must be automated in accordance with timings of arriving train. Despite of the fact that Gate Automation System works in coordination with Obstacle Detection System, proposed system can be implemented in less cost, less efforts with highly accurate results.

***Keywords*- Railway gate, Sensors, Motors, Obstacle Detection, Gate opening-closing mechanism.**

I. INTRODUCTION

Goal of proposed system is to reduce possibilities of accidents and human errors across railway crossings. Gate automation and obstacle detection together forms powerful system at railway crossings to have safe and secure crossing across railway crossings and to reduce accident rates.

In Gate Automation System, all timings of arrival of train are set with Raspberry Pi. According to timings, Raspberry Pi will send signal simultaneously to motor, buzzer, LED lamp, sensors. Duration of time is set to allow vehicles to pass. At end of duration, if there is no obstacle is present, then motor will close gate. If any obstacle is detected, at end of duration time, gate will remain open.

Obstacle Detection System uses IR, Ultrasonic sensors to detect obstacle and LEDs, buzzer for early warnings. As soon IR sensor detects arrival of train, obstacle detection mechanism is activated. It uses Ultrasonic sensors to detect obstacle and measure its distance for identifying zone. If it detects obstacle, then feedback is sent to Gate Automation System accordingly and signal is sent to activate LEDS and buzzer according to zone detected. Also when IR sensor detects departure of train, as gates are closed, vehicles will not be allowed to cross thereby avoiding accidents.

II. LITERATURE REVIEW

L. N. Pattanaik, Gaurav Yadav, proposes system "Decision support model for automated railway level crossing system using fuzzy logic control", that uses Fuzzy logic which generates pre-defined control action signals. "Automated Unmanned Railway Level Crossing System" written by J. Banuchandar, V. Kaliraj, P. Balasubramanian, S. Deepa, N. Thamilarasi, proposes that according to inputs from sensor circuit, controller activates circuitry for closing and opening of gates and for track switching. They uses stepper motor used to open and close the gate, Keil software for coding in assembly language and converting it to HEX file.

S. Sharad, P. Bagavathi Sivakumar, V. Ananthanarayanan proposes system "An Automated System to Mitigate Loss of Life at Unmanned Level Crossings" that uses inputs from sensors to raise alarm when train approaches to crossing, MSP430 Microcontroller to control sensors, Beagle-Bone to monitor sensor nodes and to identify any malfunctions using XXTEA algorithm for encryption.

Karthik Krishnamurthi, Monica Bobby, Vidya V, Edwin Baby introduces "Sensor based automatic control of railway gates", to reduce human involvement in closing and opening of gate. "Raspberry Pi Based Vehicle Collision Avoidance System" is proposed by R. Surya Kumar, P. Kingston Stanley, A. Sanjeevi Gandhi, that uses camera to capture image, Open-CV for faster processing, Ultrasonic sensor for distance measuring.

III. PROPOSED METHODOLOGY

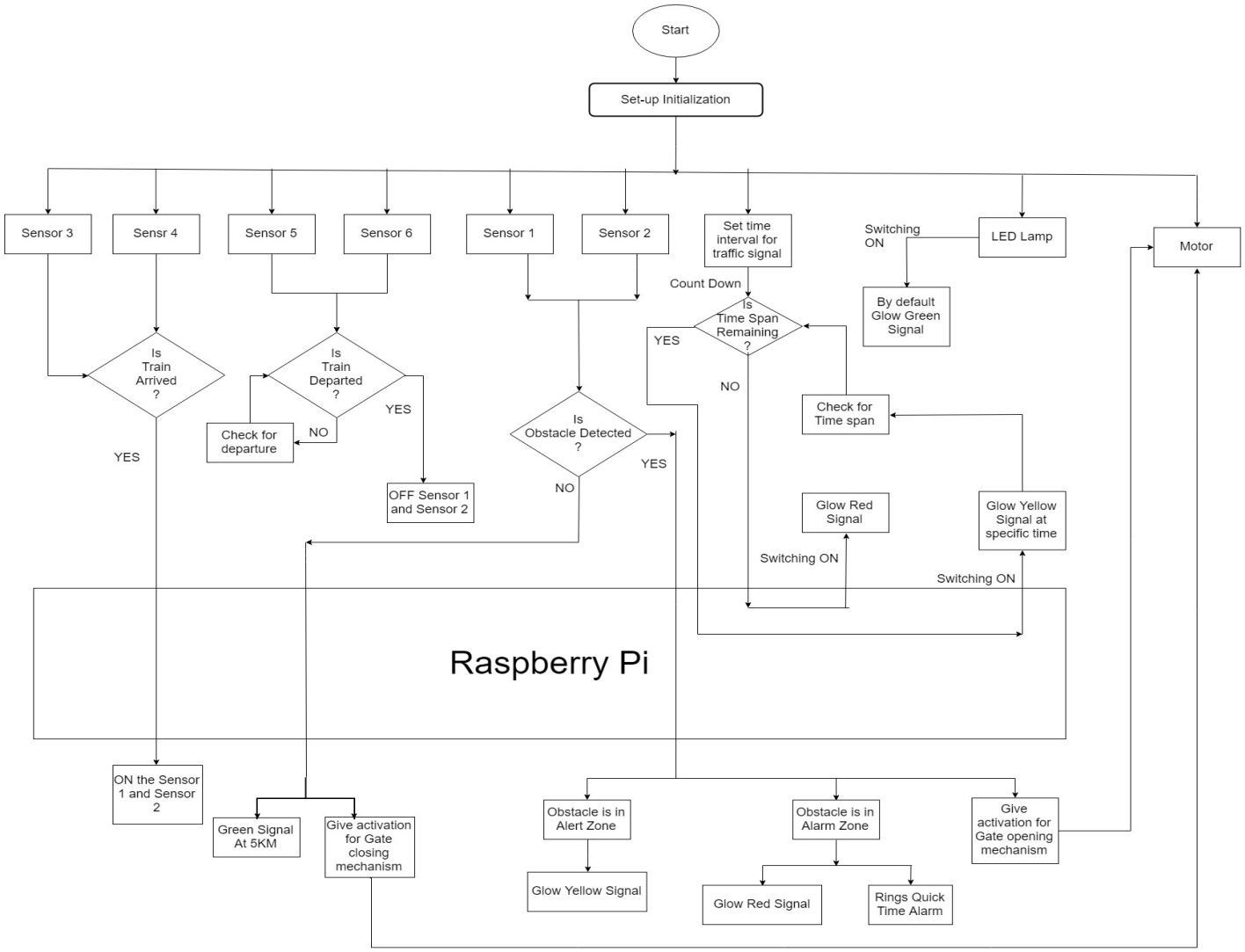


Figure 1 System Architecture

Firstly, counter of time interval for vehicles to cross is started which is set according to train arrival time. When time interval ends, red signal glows to stop vehicles from crossing.

When sensor 3 or sensor 4 detects arrival of train, obstacle detection mechanism gets activated. In it, sensor 1 or sensor 2 senses presence of obstacle. If obstacle is present then sensor provides its distance form obstacle. Depending upon this distance, zone of presence of obstacle is decided.

If no obstacle is detected, then green signal will glow for train to pass and gate closing mechanism is activated. In this, geared motor is used to close the gate. Then sensor 5 or sensor 6 will get activated.

If obstacle is detected, then gate opening mechanism is activated. In this, geared motor will keep gate open. If obstacle is present in alert zone, then yellow signal will glow so that train can slow down. If obstacle is present in alarm zone, then red signal will glow and buzzer will ring so that train could stop itself.

When sensor 5 or sensor 6 detect departure of train, obstacle detection mechanism is terminated and again gate opening mechanism is activated to allow vehicles to cross till next arrival of train.

IV. IMPLEMENTATION

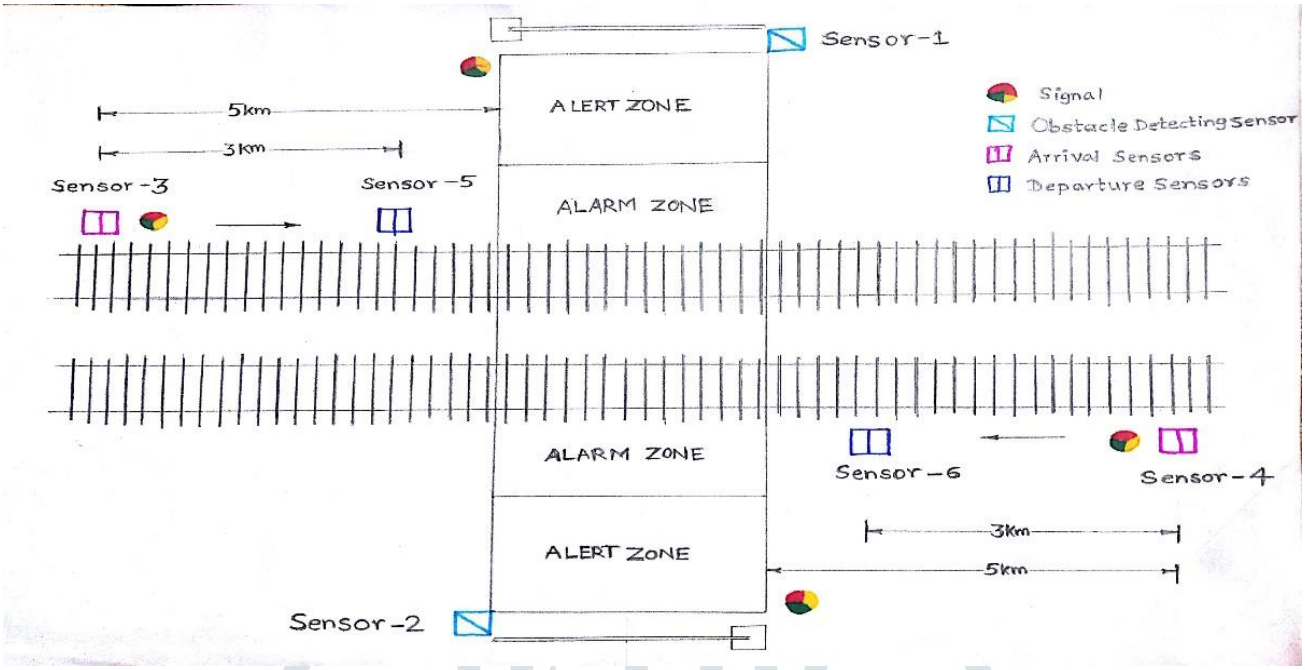


Figure 2 System View

We have considered railway crossing as alert and alarm zones with specific range. Area near crossings is treated as alert zone and area beyond it up-to certain distance is treated as alert zone. Sensors are installed parallel to railway track facing towards crossing. Signals are installed near sensors 3 and 4.

At the edge of alert zone, we have planted two ultrasonic sensors namely sensor 1 and 2 diagonally to detect obstacle across two railway tracks. IR sensors i.e. sensors 3 and 4 which detect arrival of train, are installed 5 km away from zone. IR sensors i.e. sensors 5 and 6 which detect departure of train, are installed 3 km away from sensor 3 and 4.

V. PROPOSED ALGORITHM

Step 1: Start.
Step 2: Turn on motor, and traffic signal. Open the gates.
Step 3: Yellow signal glows for specific time interval. and then red signal.
Step 4: If sensor 3 or 4 detects arrival of train then start Obstacle detection mechanism.
Step 5: Gather data from sensor 1 and 2.
Step 6: If no obstacle is present, glow green signal then go to step 8. Otherwise go to step 7.
Step 7: If obstacle is present then,

- **i.** If data is in range of alert zone then glow yellow signal to slow down train.
- **ii.** Else if data is in range of alarm zone then,
  - **a.** Glow red signal to stop train.
  - **b.** Ring the buzzer.
- **iii.** Go to step 10.

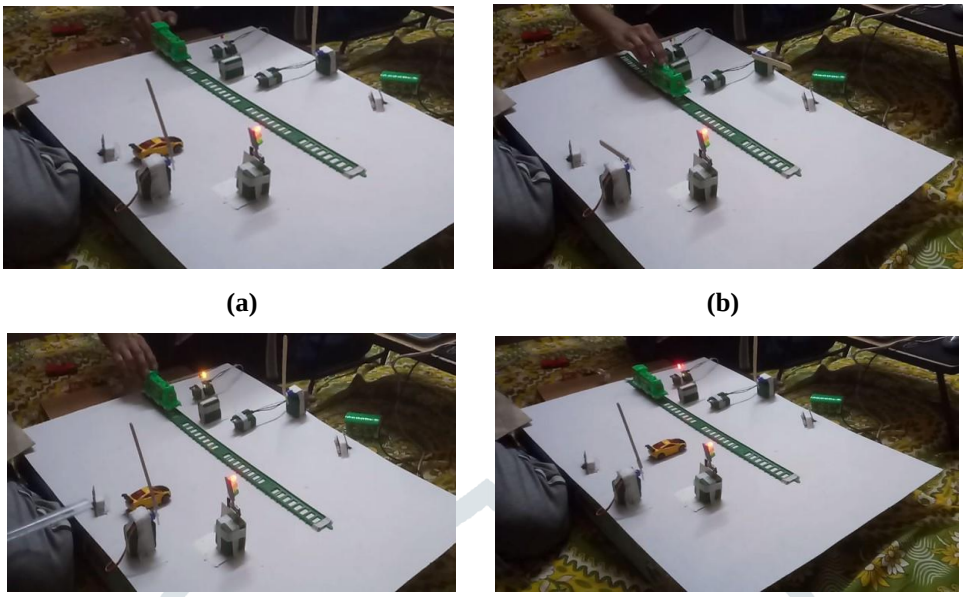
Step 8: If sensor 5 or 6 detects departure of train then,

- **i.** Stop Obstacle detection mechanism.
- **ii.** Activate gate closing mechanism.

Step 9: After specific time, open the gates.
Step 10: Stop.

VI. RESULTS AND DISCUSSION

6.1 Actual Results



(a) (b)

(c) (d)

Figure 3 (a) Red signal for vehicles at crossings (b) No Obstacle (c) Obstacle in Alert Zone (d) Obstacle in Alarm zone

As time interval specified for signal completes, red signal glows to indicate that vehicles could not cross till the departure of train (refer Fig. 3 (a)). As soon as Obstacle Detection System detects arrival of train, it activates obstacle detection system and detects zone of presence of obstacle if any.

If Obstacle Detection System detects no obstacle (refer Fig. 3 (b)) then it provides feedback to Gate Automation System. And hence if no obstacle is there at crossing, gate closing mechanism gets activated and closes gate to not allow vehicles to pass through but let the train depart.

If Obstacle Detection System detects obstacle then it finds out zone of presence of obstacle and then provides feedback to Gate Automation System. If obstacle is present in alert zone (refer Fig. 3 (c)), gate opening mechanism gets activated and opens gate. Also, yellow signal glows to indicate train to get slow down.

If Obstacle Detection System detects that the obstacle is present in alarm zone (refer Fig. 3 (d)), gate opening mechanism gets activated and opens gate. Also red signal glows and buzzer rings to indicate train to get stopped.

6.2 Analysis

Initially, Gate Automation System initializes specific time interval to allow vehicles to pass. According to count down, first yellow signal glows and then red signal to stop vehicles.

Sr. no.	Test case	Input	Expected Result	Actual Result	Status [pass/fail]
1	Detection of arrival of train	Data from Infrared Sensor (IR3,IR4)	Detect of arrival of train and ON sensor 1,2	Detects of arrival of train and ON sensor 1,2	Pass
2	Detect no presence of obstacle	Data from Ultrasonic Sensor 1 and 2	Provide feedback to Gate Automation System as " No Obstacle is present"	Provides feedback to Gate Automation System as " No Obstacle is present"	Pass
2	Obstacle is present in alert zone	Data from Ultrasonic Sensor 1 and 2	Provide feedback to Gate Automation System as "Obstacle is present in Alert zone"	Provides feedback to Gate Automation System as "Obstacle is present in Alert zone"	Pass
3	Obstacle is present in alarm zone	Data from Ultrasonic Sensor 1 and 2	Provide feedback to Gate Automation System as "Obstacle is present in Alarm zone"	Provide feedback to Gate Automation System as "Obstacle is present in Alarm zone"	Pass
4	Detection of departure of train	Data from Infrared Sensor (IR5,IR6)	Detects of departure of train	Detects of departure of train	Pass

Figure 4 Test Cases for Obstacle Detection System

Obstacle Detection System detects arrival of train using sensors 3,4 (IR sensors) and thus sensors 1,2 starts detecting presence of obstacle. If no obstacle is present, then feedback as "No Obstacle is present" is sent to Gate Automation System. If obstacle is detected and it is present in specified range of alert zone, then feedback as "Obstacle is present in Alert zone" is sent to Gate

Automation System. If obstacle is detected and it is present in specified range of alarm zone, then feedback as "Obstacle is present in Alarm zone" is sent. Obstacle Detection System detects departure of train using sensors 5,6 (IR sensors) to off sensors 1,2 so that they will not detect train as obstacle.

When train arrives, Obstacle Detection System activates obstacle detection mechanism upon which, decision about activation of gate opening-closing mechanism is taken. Thus, consideration of feedback from Obstacle Detection System plays important role in decision making for Gate Automation System.

Sr. no.	Test case	Input	Expected Result	Actual Result	Status [pass/fail]
1	Gate should be closed if no obstacle is present	Feedback from Obstacle Detection System about status of presence of obstacle	▪ Gate is closed ▪ Green signal is glowing for railway to pass through	▪ Gate is closed ▪ Green signal is glowing for railway to pass through	Pass
2	Gate should remain open if obstacle is present in alert zone	Feedback from Obstacle Detection System about status of presence of obstacle	▪ Gate is opened ▪ Yellow signal is glowing for railway to slow down	▪ Gate is opened ▪ Yellow signal is glowing ▪ Railway slows down	Pass
3	Gate should remain open if obstacle is present in alarm zone	Feedback from Obstacle Detection System about status of presence of obstacle	▪ Gate is opened ▪ Red signal is glowing for railway to stop ▪ Buzzer rings as alarm	▪ Gate is opened ▪ Red signal is glowing ▪ Railway stops ▪ Buzzer rings	Pass

Figure 5 Test Cases for Gate Automation System

If no obstacle is detected, then gate closing mechanism will be activated and green signal will glow. In Gate Automation System, if obstacle is present, gates will remain open until obstacle disappears. If obstacle is detected in alert zone, then gate opening mechanism is activated and yellow signal glows to provide indication for train to get slow down. If obstacle is detected in alarm zone, then gate opening mechanism is activated and red signal glows, buzzer rings to make the train stop.

VII. CONCLUSION

Traditional ways followed for avoiding accidents at railway crossing are ROBs i.e. Railway Over Bridge, RUBs i.e. Railway Under Bridge or Manned Supervised System. In Manned Supervised systems, accidents cannot be eliminated. To avoid human errors and to prevent or at-most eliminate accidents across railway crossings, safe and secure obstacle detection and gate automation system is built.

According to news published in 'The IndianEXPRESS' dated February 26,2019, only 73 accidents are recorded at railway crossing in year 2017-2018. This has happened first time in last 35 years as count of accidents was below 100. Though accident rate is reduced, still so many railway crossings are in India which are unmanned i.e. 5,792 railway crossings are unmanned among which 3,479 broad gauge railway crossings cause major security concerns for local traffic. Also, some railway crossings under manned supervision lead to human errors. Due to this, possibilities of accidents at railway crossings increases. Thus, this system exactly avoids total manual gate closing system by using gate automation mechanism and controls train movements according to results obtained using obstacle detection mechanism.

VIII. FUTURE WORK

With this proposed system, Indian Railway can move towards modernization. Prosed system can be best applied at Bus Rapid Transit i.e. BRT to stop vehicles except bus from entering into the busway. Also system can also be applicable in areas of man-animal conflicts.

IX. ACKNOWLEDGMENT

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