Automatic Railway gate controller with high-speed alerting system using PLC

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ABSTRACT

The present work attempts to automate the opening and closing of gates at a railway level crossing. In general, level crossing gates are operated manually by a gate keeper. The gate keeper receives the information about the train arrival from a near station. When the train starts to leave the station, the station in-charge delivers this information to the closest gatekeeper to get ready. This human intervention can be avoided by automating the process. In situations where the train is late due to some reason, the gates remain closed for long durations causing dense traffic jam near the gates. This too can be prevented by automation. The proposed system uses infrared sensors to detect the arrival and departure of trains at the railway level crossing and PLC (Programmable logic controller) to control the opening/closing of gates. The system uses two IR sensors to detect the arrival of the train and a third IR sensor to detect the departure of the train. When the arrival of the train is sensed, signals are provided to the traffic indicating the arrival of the train on the track. When the second sensor detects the train then the signal turns red and the motor operates to close the gate. The gate remains closed until the train completely moves away from the level cross. When the departure of the train is detected by the third sensor, the traffic signal turns green and the motor operates to open the gate. Thus automation of the gate operations at the railway level cross is achieved using sensors.

Keywords: PLC, Obstacle detection, Railway gate, IR Sensor.

INTRODUCTION:

Railway transport is one of transition mode, which has an important role in moving passengers and freights. However, railroad-related accidents are more dangerous than other transportation accidents. Therefore more efforts are necessary for improving its safety. This system is to manage the control system of railway gate using the PLC. The main purpose of this system is about railway gate control system and level crossing between railroad and highway for decreasing railroad-related accident and increasing safety. In addition, it also provides safety road users by reducing the accidents that usually occur due to carelessness of road users and errors made by the gatekeepers. Railways preferred the cheapest mode of transportation over all the other means.

This system is designed using Programmable Logic Controllers (PLC) to avoid railway accidents happening at railway gates where the level crossings. PLC performs the complete operation i.e., sensing, gate closing and opening. As a train approaches the railway crossing from either side, the sensors placed at a certain distance from the gate detects the approaching train and controls the operation of the gate. This system was operated after signal received from the sensors. This signal is used to trigger the PLC for operating the gate motor, alarm system and light indicators.

Present project is designed using microcontroller to avoid railway accidents happening at unattended railway gates, but due to the limitation in microcontroller we are moving on to PLC.

RELATED WORKS:

Previous related work are [1], [2], [3] and [4]. Xishi [2] discussed about the advanced train safety system. They defined that in the process of developing ATSS, a fault tolerance method is applied for both the hardware and the

software components. The railway gate automation system is successively implemented since 2000 in Korea. The implementation of the system effectively reduced the accident rate at the level cross and the sensors used in the Korean railway gate automation system is magnetic sensors. Magnetic sensors placed underground are less affected by environmental changes and recognizes the direction of movement of vehicles [2]. Jeong [3] defined the railway auto control system using OGSi and JESS. The method by which the state of railway cross is estimated using JESS is described in their paper. The different methods with which the locomotive pilots can avoid the accident situations and the safety measures to be taken in the level crossings are also discussed. In [4], a detailed introduction about the present railway technology is presented. It discusses the disadvantages of manually activated railway signals and the railway warnings at the level cross. The train detectors acts as the major component in the train automation system.

ADVANTAGES OF PLC OVER MICROCONTROLLER:

PLCs offer ease of installation, ease of programming and ease of communications to other systems. However, they are not very good at high speed high level calculations even using high speed counter cards. High speed counter cards generally do not have the ability to do logic level processing like simple IF/THEN statements.
PLC offers more than four different languages which makes ease to program when compare to microcontroller.
PLC has an inbuilt microcontroller and its outer cover is hard and it can withstand different environments and conditions.
Another advantage with using PLC's is that it is easier for a technician to understand, service, and troubleshoot. Ladder logic is easier for a technician to use.

SYSTEM OVERVIEW:

Automatic railway gate controller with high speed alerting system using PLC is developed to automate the process of opening and closing of gate at the railway level crosses. The system detects the arrival and the departure of train for the gate operation using plc. The proposed system uses four infrared sensors to identify the arrival and departure of trains. The system also implements obstacle sensor which detects any obstacle on the track and controls the operation of the train. IR Sensors, Relay, LED, and DC motor are programmed using PLC. The major components used in the automation of railway gate at the level gates are sensors.

SYSTEM ARCHITECTURE:

In India the maximum speed at which a train moves is 160km/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 of the train is 5km from the level cross and the departure of the train is 1km and thus the gate will not be closed for more than 8 minutes. Our paper proposes a system which uses PLC, four IR Sensors (IR1, IR2, IR3 and IR4),LED light, Relay, and one buzzer. In real time, the IR Sensors are placed on the track at a distance of 5km and 1km on both sides of the level crossing. LED is used to indicate the arrival and departure of train by Green and Red light. Relay is usually an electromechanical device, the current flowing in one circuit causes the opening or closing of another circuit. The system also uses DC motors to control the operation of the gates. The buzzer is used to indicate the arrival of the train within a stipulated time.
IR1 detects the arrival of a train. Once it detects a train, it sends a signal to Buzzer and Relay, and Buzzer is triggered and Counter starts count down, and train then travels to IR2. When the train nears IR2, DC motors are powered on. The DC motors starts and the gates begin to close. Parallel red LEDs are switched on. After the train passes the gates and nears IR3, a signal is again sent to the DC motors and the gates open and green LEDs are switched on for the road traffic to pass. The proposed system architecture is shown in Fig. 1.

Closing and Opening of gates:

Fig. 2 shows the flow chart of the gate closing operation. After the train is detected and the gate is closed the next immediate operation is to detect the departure of the train from the level cross. The sensors IR3 and IR4 detects the departure of the train and the motor is then operated to open the gate. Fig. 3 shows the flow chart of the gate opening operation.

Software Requirements:
Ladder diagram language.
"WPL SOFT" for Delta PLC.

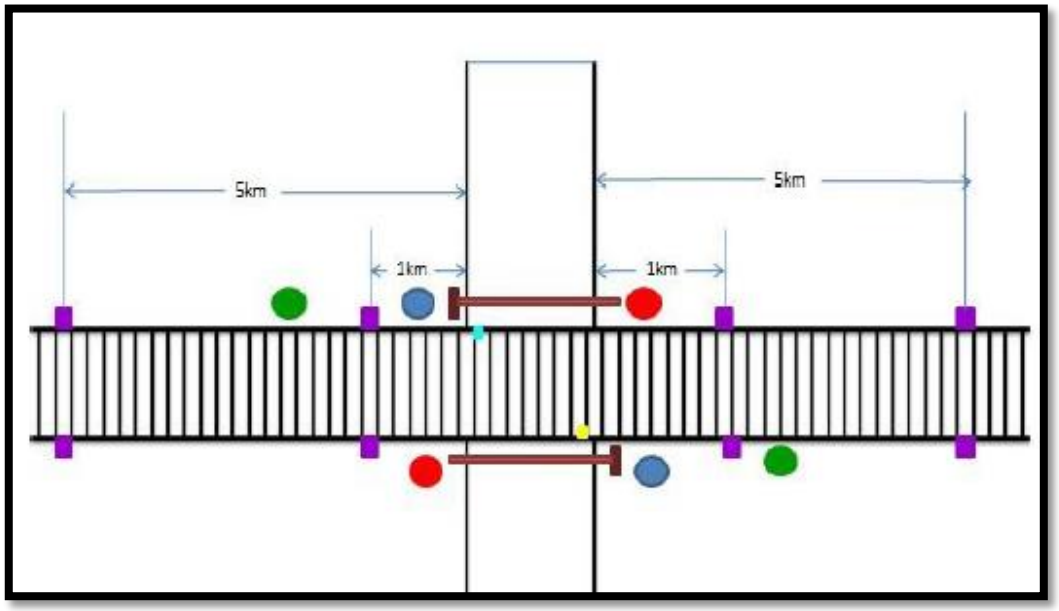


Fig. 1: Architecture diagram

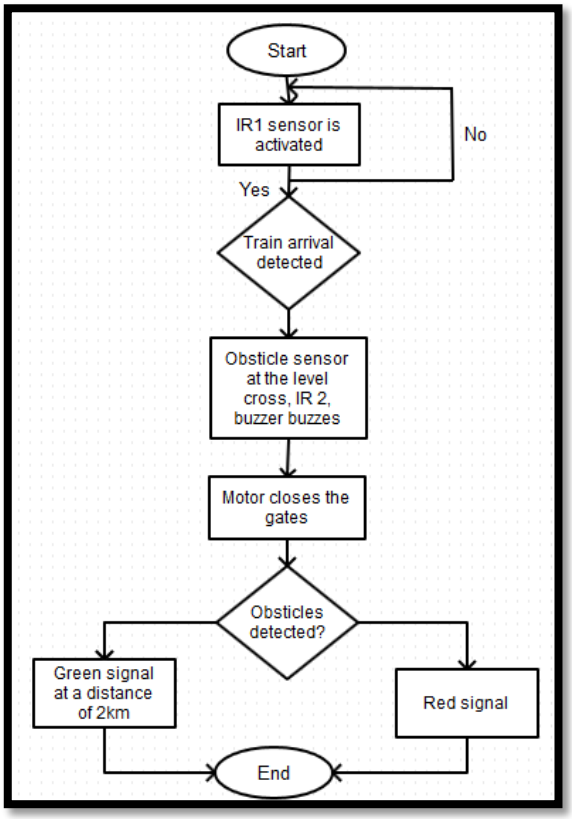


Fig. 2: Flowchart of closing the gate

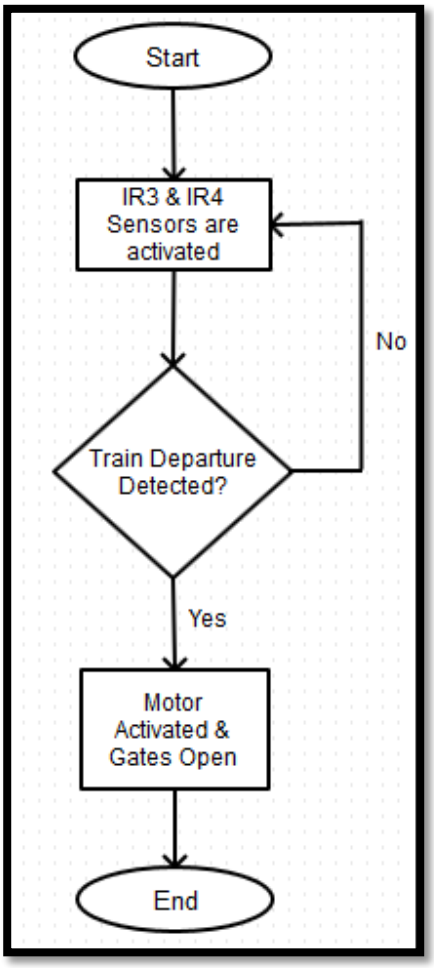


Fig. 3: Flowchart of opening the gate

OPERATION:

Automatic Railway Gate Control System with High Speed Alerting System is an innovative circuit which automatically controls the operation of railway gates detecting the arrival and departure of trains at the gate. It has detectors at the far away distance on the railway track which allows us to know the arrival and departure of the train. These detectors are given to Programmable Logic Controller (PLC) which activates the motors which open/close the railway gate correspondingly.

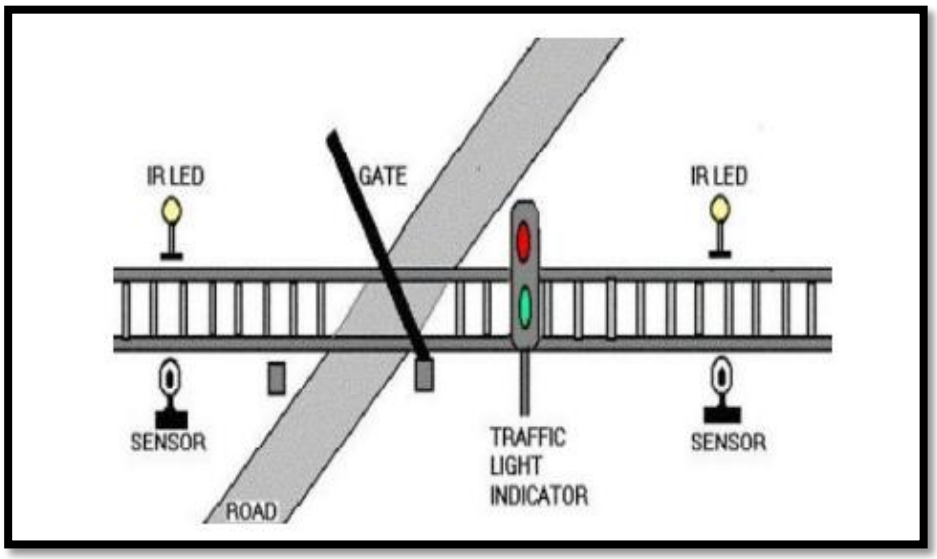
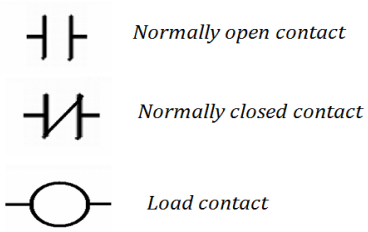


Fig. 4: Railway gate

Another feature of this circuit is that it has an intelligent alerting system which detects the speed of the train that is arriving. If the speed is found to be higher than the normal speed, then the PLC automatically activates the alarm present at the gate. This alerts the passengers at the railway crossing on the road about this. Also this circuit has the feature for Identification of train from other intruders i.e., animals etc .This can be implemented in manned level crossings also, as manual errors can be eliminated by automation.
Initially transmitter is continuously transmitting the IR light which is made to fall on the receiver. When the train arrives it cuts the light falling on receiver. Let us assume the train is arriving from left to right, now when the train cuts the 1st sensor pair a counter is activated and when it crosses 2nd sensor pair the counter is stopped. This counter value gives the time period which is used to calculate the velocity of the train.
The sensor2 output is sent to PLC which makes the relay activate which causes the gate to be closed. Now when the last carriage of the train cuts the sensor 4, PLC de-activates the relay and gates are opened.
Here as previously mentioned the counter value is used to calculate the velocity of the train, which means that every wheel of the carriage cuts the sensor pair within small fraction of time based on its velocity. After the last carriage is passed there is no obstacle to the sensor pair within that fraction of time hence it knows that the train has left.
One more feature of this circuit is detecting a train accurately i.e., there may be a chance that some obstacle (for e.g. some animal) may cut the sensor then in such a case the counter is made to run for certain period of time (this time period is set considering the possible lowest speed of train) if the obstacle does not cut the 2nd sensor before this predefined time then this obstacle is not considered as train and gates remain opened.
One more advantage of calculating the velocity of train is, if the speed of the train crosses a limit i.e., if it is traveling at an over speed then the passengers are alerted using a by activating a buzzer.

SOFTWARE: Ladder diagram logic
Symbols used in Ladder diagram:



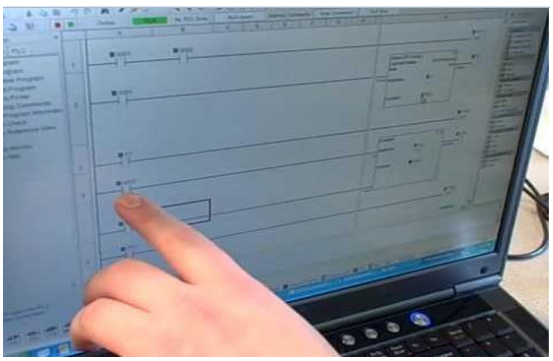
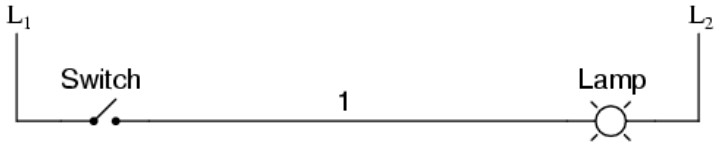


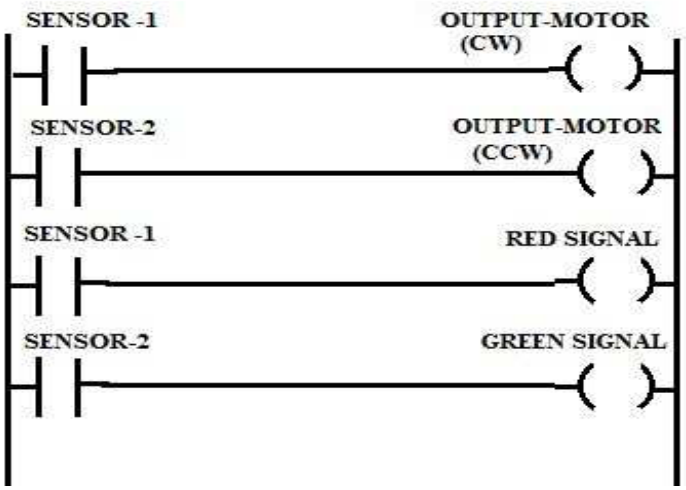
Fig. 5: The program is entered using the ladder logic programming language.

Ladder diagram : are specialized schematics commonly used to document industrial control logic systems. They are called "ladder" diagrams because they resemble a ladder, with two vertical rails (supply power) and as many "rungs" (horizontal lines) as there are control circuits to represent. If we wanted to draw a simple ladder diagram showing a lamp that is controlled by a hand switch, it would look like this:



The "L_1" and "L_2" designations refer to the two poles of a supply, unless otherwise noted. L_1 is the "hot" conductor, and L_2 is the grounded ("neutral") conductor.

LADDER DIAGRAM :



This is the ladder diagram to control the gate with the help of input signal from the sensor.
This diagram shows the control ladder for uni-directional passage of train.

CONCLUSION:

Automatic railway gate control system is centered on the idea of reducing human involvement for closing and opening the railway gate which allows and prevents vehicles and humans from crossing railway tracks. The railway gate is a cause of many deaths and accidents. Hence, automating the gate can bring about a ring of surety to controlling the gates. Human may make errors or mistakes so automating this process will reduce the chances of gate failures. Automation of the closing and opening of the railway gate using the switch circuit reduces the accidents to a greater extend. The obstacle detection system implemented reduces the accidents which are usually caused when the railway line passes through the forest.
Using the same principle as that for gate control, we can developed a concept of automatic track switching.
This system can also developed for control and monitor by using SCADA Screen in remote areas.

REFERENCES:

Atul Kumar Dewangan, Meenu Gupta, and Pratibha Patel, "Automation of Railway Gate Control Using Micro-controller, *International Journal of Engineering Research & Technology,* pp.1-8, 2012.

Jeong Y., Choon-Sung Nam, Hee-Jin Jeong, and Dong Shin, "Train Auto Control System based on OSGi", *International Conference on Advanced Communication Technology*, pp.276-279, 2008.

Karthik Krishnamurthi, Monica Bobby, Vidya V, Edwin Baby, "Sensor based automatic control of railway gates" *International Journal of Advanced Research in Computer Engineering & Technology (IJARCET) Volume 4 Issue 2, February 2015*

Pradeep Raj, "Increasing accidents in the unmanned level crossing of the railways", 2012.

Xishi Wang, Ning Bin, and Cheng Yinhang, "A new microprocessor based approach to an automatic control system.", *International Symposium on Industrial Electronics*, pp. 842-843, 1992.
