AUTOMATED RAILWAY SURVEILLANCE SYSTEM

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Abstract: The objective of this paper is to design a framework for an automatic railway gate controller for automatic opening and closing of railway gates on arrival and departure of train respectively. It is developed with an intention to reduce the number of accidents particularly at unmanned level crossings. The system also reduces the time for which the gate remains closed. This type of gates can be employed in an unmanned level crossing where the chances of accidents are higher and reliable operation is required. Since, the operation is automatic; error due to manual operation can be prevented. The system works on a microcontroller based system. It receives the input signal from the two sensors and sends information to the gate motor driver for opening and closing of the gate. The arrival and leaving of the system is monitored and the gate is operated accordingly.

Keywords: IR Sensor; Microcontroller; Level Crossing

1. Introduction:

As civilization advances, we depend more and more upon the various inventions that make our day to day life easier. There is technology that saved many lives. Our life is affected greatly by technology. After all these years, technology has been evolving constantly; it has facilitated our life in all aspects. In other words, the automated devices that we are using in our daily life makes our life more comfortable and now a day it is hard to imagine a life without machines.The Indian Railways has the world's fourth largest railway network in the world, after that of the United States, Russia and China. The railways traverse the length and breadth of the country and carry over 20 million passengers and 2 million tons of freight daily. It is one of the world's largest commercial or utility employers, with more than 1.6 million employees. About 15000 trains work every day. Unfortunately there have been many accidents involved in the railways.

Railways being the cheapest mode of transportation are preferred over all the other means. When we go through the daily newspapers we come across many railway accidents occurring at unmanned railway crossings which are more dangerous than other transportation accidents in terms of severity and death rate etc. There are many railways crossing which are unmanned due to lack of manpower. Hence many accidents occur at such crossing since there is no one to take care of the functioning of the railway gate when a train approaches the crossing. Surveys conducted by Indian Railway found that about 17% of total railway accidents in India is crossing accidents of which majority occurs at passive railway crossings. And this is the reason why 'automatic gate controller' comes into vision for safety in operations and also for security of the travelling public.

2. Related Review:

In literature review it is found that the monitoring of obstacles and controlling the gate in the railway station consists of mainly the following steps:

- Sensing
- Transmitting
- Processing
- Controlling

a) Railway Sensors:

It is the sensor which detects the arrival and departure of a train to the railway crossing. IR sensor [1, 3, 4, 5, 6, 7, 8] is used to detect the arrival and departure of a train. The IR sensor is mainly consists of two part, transmitter and receiver. For transmitter IR LED is used to transmit 38 kHz IR signal, which is driven by an 555

IC. For receiver IR receiver is used to receive 38 kHz IR signal transmitted by the IR LED. The LED continuously transmit 38 kHz signal to the IR receiver, which is placed by the side of the railway track face to face. When a train reaches the position of the sensor then it breaks the continuity of the sensor, which confirms the arrival of a train to a railway crossing and similarly departure.

GPS [2] receiver is also used by the train to share the location of the train with the control unit. It is a satellite based navigation system made up of a network of 24 satellites placed into orbit, originally intended for military operations. GPS satellites circle the earth twice a day in a very precise orbit and transmit signal information to earth. GPS receiver takes the information and calculates the user's exact location. GPS receiver compares the time a signal was transmitted by a satellite with the time it was received. The time difference tells the GPS receiver how far away the satellite is.

b) Transmission:

It is used to send the information about of arrival and departure of a train. Zigbee [4,7] is used to transmit the information of train to the control unite wirelessly. Zigbee is a short range low data rate wireless network technology, which is based on the IEE 802.15.4 wireless personal area network, used to transmit their data between base station and train. FM [8] transmitter and receiver is used to send the message to the controlling unit. Using a specific frequency band the information can be transmitted.GSM [4] modem is also used to share about the train between the sensor and controlling unit.

c) Controlling Unit:

Microcontroller [1, 2, 3, 5, 6, 7, 8] is used to take the decision or control the gate based on the information received from the sensor. Various types of microcontrollers PIC 16F877A [1], ARM7 TDMI [2], 8051 [3], AT89S52 [7] are used.

d) Gate Control:

Two stepper motors [1, 3, 6, 7, 8] are used to control the gate, present in either side of the railway track. It converts electrical energy to mechanical energy.

This motor rotates a specific incremental distance per step. The number of steps executed controls the degree of rotation of motor's shaft. This characteristic makes the stepper motor excellent for positioning operations.

Servo motors [4] are also used to control the gate. A servo motor is a mechanical device that can be instructed to move the output shaft attached to a servo wheel or arm to a specific position.

3. Proposed System:

The accidents at unmanned level crossings and collision of trains running on same track are the major accidents in railways which cause heavy human causality and damage to train. Hence it is proposed to develop a fail proof system to avoid such accidents. The unmanned level crossing is fitted with obstacle sensor and automatic gate closing mechanisms and Zigbee. The microcontroller will receive information via Zigbee from the sensor and controls the gate.

3.1 Methodology:

The methodology employed for proposed research can be given by the following block diagram:

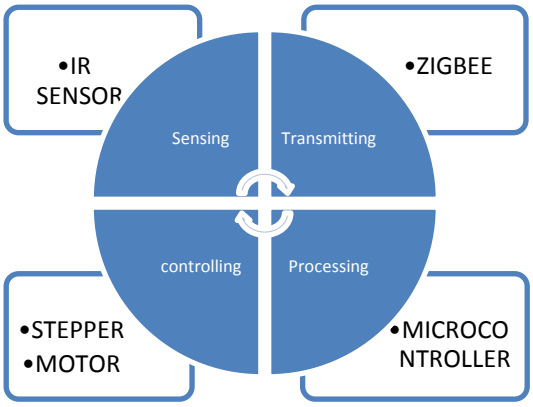

Figure 1: Block diagram showing the methodology.

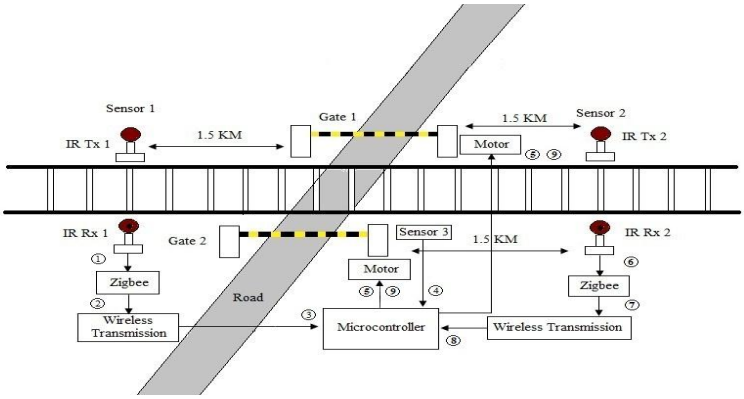

Figure 2: Schematic diagram of railway gate controller.

Basically automatic railway gate control system consists of 4 main parts. Sensing, transmitting, processing and controlling. Let us consider the train is coming from left side, when the train reach near the sensor 1, then the sensor gets activated and will send the information to the microcontroller via wireless transmission medium. Then microcontroller check the status of sensor 3, whether the road is busy or not. If busy then it will provide a signal to the train to slow down and alarm for the vehicles to clear the road. Then the gate will be closed. When the train reach the sensor 2 it gets activated and send the information to the microcontroller via zigbee. The microcontroller will open the gate. If the train comes from right side then the same process will continue. Transmission of the information of the train to the processing unit located at 1.5km apart from the sensor.

4. Hardware Implementation:

4.1. IR sensor:

This circuit has two stages: a transmitter unit and a receiver unit. The transmitter unit consists of an infrared LED and its associated circuitry.

- ***IR transmitter:***

The IR LED emitting infrared light is put on in the transmitting unit. To generate IR signal, 555 IC based astable multivibrator is used. Infrared LED is driven through transistor BC 548. IC 555 is used to construct an astable multivibrator which has two quasi-stable states. It generates a square wave of frequency 38 kHz and amplitude 5Volts. It is required to switch 'ON' the IR LED.

- ***IR receiver:***

The receiver unit consists of a sensor and its associated circuitry. In receiver section, the first part is a sensor, which detects IR pulses transmitted by IR-LED. Whenever a train crosses the sensor, the output of IR sensor momentarily transits through a low state. As a result the monostable is triggered and a short pulse is applied to the port pin of the 8051 microcontroller. On receiving a pulse from the sensor circuit, the controller activates the

circuitry required for closing and opening of the gates and for track switching. The IR receiver circuit is shown in the figure below.

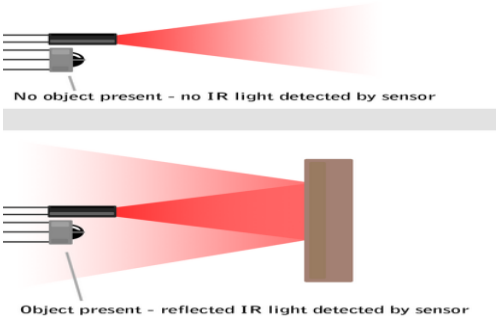

Figure 3: Working of IR sensor.

4.2. Zigbee:

For transmission OFC cables, FM transmitter can be used. But we are going to use Zigbee in this project for transmitting the signal to the processing unit. It is used for transmission of train data, station data, and train accident information between base station and trains. ZigBee standard is managed by the Zigbee Alliance, a global consortium of more than 50 companies. ZigBee is a short-range, low data- rate wireless network technology, which is based on the IEEE 802.15.4 wireless personal area network standard. And the ZigBee's data rate is between l0 Kbit/s and 250 Kbit/s, so it is suitable for low-rate wireless transmission applications. But ZigBee can build up to a few tens of thousands of wireless transmission module consisting of wireless-data transmission network platform through the network node, which is very similar to the existed CDMA mobile communications network or GSM Network. And each network node can extend the distance from the standard 75 meters to several hundred meters, and even a few kilometers. And ZigBee network primarily for the automatic control and the establishment of data transmission but the mobile communications network for voice communications is established, which is the difference between ZigBee network and the mobile communications network. ZigBee technology has low data rate and the characteristics of the smaller range of communication, which also determines the ZigBee technology is suitable for carrying data traffic smaller business.

4.3. Microcontroller:

Microcontroller is used to take the decision or control the gate based on the information received from the sensor. Microcontroller 8051 is used in this project. The microcontroller AT89S52 of Atmel is used as hardware platform to monitor and control the track and train operations like checking track continuity, detecting obstacles and curves using IR sensors connected to microcontroller. It is used to start train and gate motors by sending appropriate control signals.

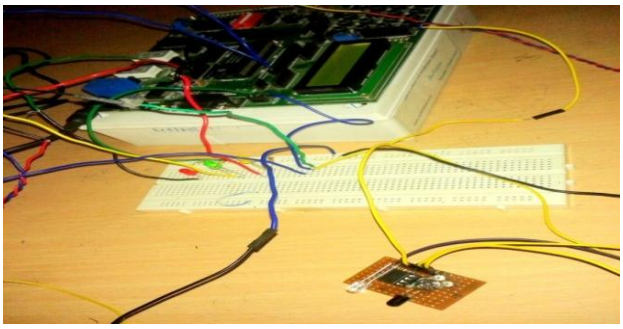

Figure 4: Microcontroller.

4.4. Flow Chart of Micro-controller:

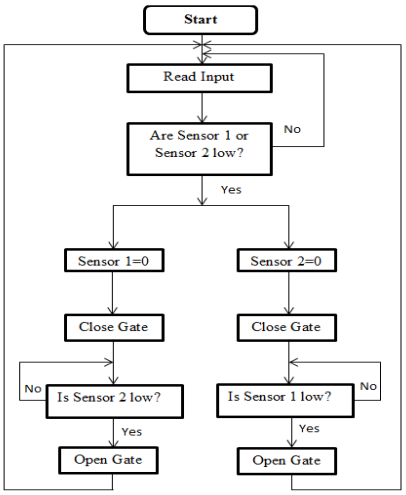

Figure 5: Flow chart of micro-controller.

- ***Algorithm of Micro-controller:***
  - (a) Start the program.
  - (b) Check the sensors (sensor 1 & sensor 2) whether the train is coming or not.
  - (c) If sensor 1 or sensor 2 is activated
  - (d) Check sensor 3 whether level crossing is busy or not. If busy, provide a signal and alarm to clear the road.
  - (e) Close the gate.
  - (f) Check the sensor on the other side whether the train crossed the level crossing.
  - (g) Open the gate.
  - (h) Repeat the process

4.5. Stepper motor:

Out control unit takes the information from the microprocessor .Two stepper motors are used to control the gate, present in either side of the railway track. Servo motors are also used to control the gate. DC brushed motors rotate continuously when voltage is applied to their terminals. The rotation angle of the motor is proportional to the input pulse. It can be controlled by microcontroller, binary bit.

5. Future prospects and challenges:

5.1. Future Prospects:

There are many future prospects of this project. By doing some modification we can monitor the traffic at the level crossing, can detect the obstacles, can detect the continuity of the track and can open and close the gate in both ways.

5.2. Challenges:

- If human or trolley passes through the IR sensor it may cause unwanted closing of railway gate.
- In winter season fog may create problem for sensing a train.
- For obstacle detection sometimes human may cross the track before passing the train, which the train may consider as obstacle.

6. Result and discussion:

Figure a) shows when the train passes sensor 1, the gate is closed and (b) shows when the train passes sensor 2, the gate is opened. The figure shows the actual scene of detecting object and opening and closing of the gate. We are using Keil software and Flash Magic through which Hex file is dumped into micro controller and the ROM is burnt.

Figure 6: (a) shows when the train passes sensor 1, the gate is closed and (b) shows when the train passes sensor 2, the gate is opened.

The present existing system is manually and human controlled system, once the train leaves the station, the station master informs the gatekeeper about the arrival of the train through the telephone. Once the gatekeeper receives the information, he closes the depending on the timing at which the train arrives. Hence, if the train is late due to certain reasons, then gate remain closed for a long time causing traffic near the gates. No centralized system is available, recently signals are control by mean of interlocking and warning signs and signal device, which is totally semiautomatic system. By employing the automatic railway gate control at the level crossing, the time for which it is closed is less compared to the manually operated gates and also reduces the human labour. This type of gates can be employed in an unmanned level crossing where the chances of accidents are higher and reliable operation is required. Since, the operation is automatic; error due to manual operation is prevented. And implementing the work railway system can be centralized which can control the accidents.

7. Conclusion:

Level Crossing protection systems is developed using microcontroller to give additional safety shield at manned and unmanned level crossings, through an audio-visual indication to road users. The automatic railway gate controller thus can be used in unmanned level crossings to reduce the occurrence of accidents. Since the design is completely automated it can be used in remote villages where no station master or line man is present. Also it saves lot of times 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. Also since it is completely automated there are fewer chances for error to occur. Thus this design is very useful in railway applications.

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