Railroad Switch and Anti-Collision System with Automatic Gate Control using Arduino

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***Abstract*— In India most of the train accidents occurs at level crossing due to carelessness in manual operation of railway gate or negligence of humans. Head-on collisions due to improper manual railroad switching and collision due to obstacles like animals or vehicles on the tracks. These train accidents cause huge financial losses as well as individuals and organizations may experience significant property damage. This paper provides an automatic railway gate controlling system to avoid accidents at level crossing and automatic railroad switching mechanism to avoid the head-on collisions due to errors made by human while switching manually. An anti-collision system which senses presence of obstacles on the track within certain range and alerts the loco-pilot in the train on that track to avoid the train accidents.**

Keywords- Radio Frequency Identification [RFID],Global Positioning System [GPS], Infrared sensor [IR], Liquid Crystal Display [LCD], Ultrasonic sensor [UV].

I. INTRODUCTION

The Indian Railways is the fourth largest railway network in the world. Railway system is one of the most popular and convenient system of transportation. As the major part of the public transport system railway is serving millions of passengers and carrying tones of goods every day. Railways provide a better alternative to other modes of transport by being energy efficient since it can carry large number of people and goods at the same time. As a result, the railways had grown over the years and also the number of people using it. It contributes a lot in our economy. Surveys conducted by Indian Railway found that about 17% of total railway accidents in India is at level crossing [6]. Accidents of which majority occurs at passive railway crossings. The old signaling and operating systems sometimes make wrong operation which causes severe train accident with a huge number of casualties as well as colossal financial losses.

The soul idea was to design a system to avoid the accidents at level crossing by employing an automatic railway gate controlling system at unmanned level crossing replacing the gates operated by the gate keepers. It deals with two things. Firstly, the reduction of time for which the gate is being kept closed. Secondly to provide safety to the road users by reducing the accidents that usually occur due to carelessness of road users and errors made by the gate keepers [1,2].

The automatic railroad switching system using RFID reader and cards to avoid errors made by human which causes head-on collisions [3] (It occurs only when two trains travel on the same track towards each other) of trains. An anti-collision system which is used to detect the obstacles on the track and inform the loco-pilot about the obstacle on the track [5]. The existing system uses traditional telecommunication systems like Walkie-Talkies or other communicational devices. Due to human carelessness if fails sometimes [3]. So, the proposing system will work automatically and send the information to the central control authorities for further processing.

II. LITERATURE REVIEW

[1] M.Duraishanmugapriyan, developed the concept of “Automatic Railway Gate Controlling System”, by the use of ATmega328P microcontroller with the help of two types of sensors. It has three IR sensors which are used to detect arrival and departure of the train. Even they have used RF transmitter and receiver for the transmission of sensor output to controller which is in remote location. The microcontroller forms the main unit of the system.it receives input signal from the sensors and sends the information to the gate motor driver for opening and closing the gate. The output signal Arduino will active LCD display and alarm.

[2] Dhanashree Anant Umbarkar, Khushabu Talele, Samrudhi Salunke, Geeta Salunke developed the concept of "PLC Based Fully Automated Railway System". This system consists of self-acting PLC system which works round the clock to alert train collision and accidents at the level crosses. Thus, enhances safety in train operations by providing a non-signal additional safety overlay over the existing signaling system. The system

operates without replacing any of the existing signaling and nowhere effects the vital functioning of the present safety system developed for the train operation, the proposed system gets data from the vibration sensors. The efficiency of the system is expected to the considerably increased as the proposed system takes input from sensor and also from the level crossing gates.

[3] Naga Hema Kumari.V, China Appala Naidu.R, developed a concept called "Train Collision Avoidance by Using Sensors" to provide safety to human lives and to reduce the accidents they developed a new product using UV sensor, IR sensor and LPC2184 processor. By this proposed system it can identify the both head-on and rear end collision and can be controlled. In this proposed system they are using sensor-based identification to prevent these accidents. The existing system uses traditional telecommunication systems like walkie-talkies or other communication devices. The anti-collision device uses radio modems for communication and received inputs from GPS through satellites.

[4] Dogan Ibrahim developed a new concept called as "Smart Train Collision Detection System using a Microcontroller" they introduced this system by using novel microcontroller-based system using RFID, GPS and an RF transmitter/receiver module to detect possible collisions and to inform the drivers, when the train travel on the same track. The design of novel microcontroller-based system is described that which helps to detect possible train collision. Here the system uses RFID to detect the unique track ID that a train is travelling on, a GPS to know the exact positions and speeds of other nearby trains, a powerful RF transmitter/receiver module for communication between the trains and buzzer to warn the drivers of any risk of collision.

[5] Ranu Dewangan, Pratibhadevi Umesh, developed the concept of “Automatic Accident Control System on Railway Tracks”, This system is used to develop the presence and absence of vehicle or any object on the track within a certain range by setting the appropriate duration. Their function is when train is coming in any track and same track is damaged or any fault are present or any object are present or from other side other train is coming in speed at that time RED light which is present in engine boogie automatically GLOW or ON, they inform that the driver who is driving the same train by using this system it is difficult in winter seasons to detect the light due to snow fall we cannot detect the light in the snow fall.

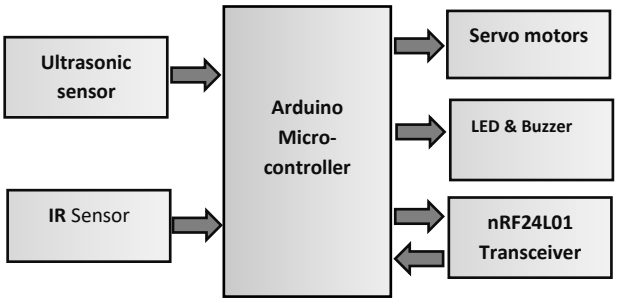
III. OBJECTIVES

- This project is designed to control the railway gate at the level crossing automatically through sensors such as IR sensors or ultrasonic sensor and controlling through actuators such as buzzers, LED display, servo motors.
- Manual track switching errors are to be minimized by an automatic railroad switching mechanism using RFID readers and servo motors.
- Train accidents because of obstacles like animals on the railway track in an accidental zone can be detected by ‘Anti-collision system’ which has ultrasonic sensor and servo motor, which alerts the loco-pilot in the train on that track.

IV. METHODOLOGY

An Automatic railway gate controlling system is shown in Fig.1 at unmanned level crossing. By employing the automatic railway gate control at the level crossing the arrival of train is detected by the sensors placed on either side of the gate at about 5km from the level crossing. Once the arrival is sensed, the sensed signal is sent to the microcontroller and it checks for possible presence of vehicles between the gates, again using sensors.

Fig.1Railway gate controlling system



Subsequently, buzzer indication and light signals on either side of the road to alerts the road users about the train arrival. If no vehicles are sensed between the gate, the motor is activated and gates are closed. But for the worst case if any obstacle is sensed the it will inform the loco-pilot in the train using nRF24L01 transceiver before the train reaches 2km from the gate.

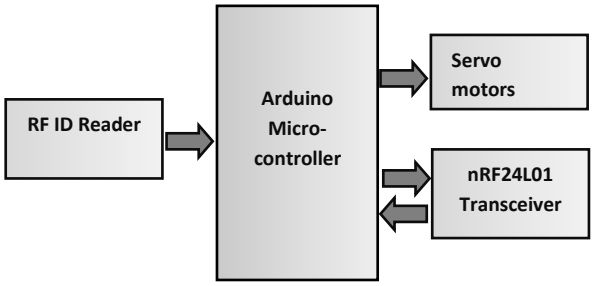


Fig.2 Railroad Switching system

An automatic railroad switching system is shown in Fig.2, it operates on Radio Frequency Identification number which is sensed by the RFID reader placed at certain distance from the track switching system and Arduino microcontroller as a controlling unit. According to the unique ID of the train, the track is switched using servo motor and it sends the acknowledgement to the loco-pilot.

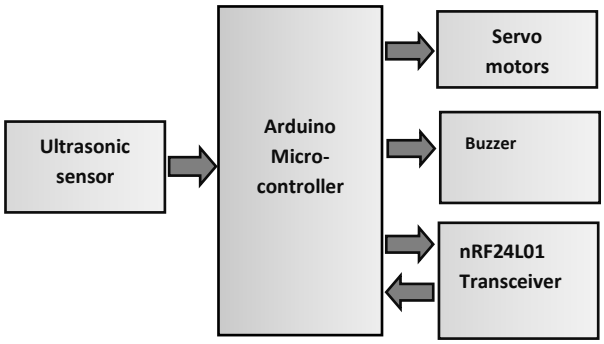


Fig.3 Anti-collision System

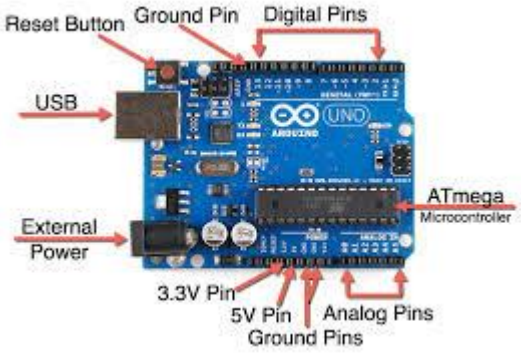
An anti-collision system is shown in Fig.3, which is used to sense the obstacles like animals or vehicles on the railway track for certain distance using ultrasonic sensor and servo motor to rotate the ultrasonic sensor for 0 to 180 degree. If the obstacle is present on the track it will send the information about the obstacle using nRF24L01 transceiver module, to the present train on that track.

V. HARDWARE AND SOFTWARE REQUIREMENTS AND SPECIFICATION

- *Hardware Requirements*

1. *Arduino microcontroller*

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino microcontroller basically uses the Harvard architecture where the program code and program data have separate memory. It consists of two memories- Program memory



and the data memory. The code is stored in the flash program memory, whereas the data is stored in the data memory. The Atmega328 has 32 KB of flash memory for storing code.

- Microcontroller: ATmega328.
- Operating Voltage: 5 V.
- Input Voltage (recommended): 7-12V.
- Input Voltage (limits): 6-20V.
- Digital I/O Pins: 14 (of which 6 provide PWM output).
- Analog Input Pins: 6.

- DC Current per I/O Pin: 40 mA.

2. *nRF24L01 Transceiver*

- The nRF24L01 is a 'Wireless Transceiver Module'.
- Operates within 2.4 GHz radio frequency.
- Operating Voltage is 3.3 volts.
- Distance covered within range of 1100 meters.
- Channel range is 125.
- Baud rate is 250 Kbps – 2 Mbps.
- Maximum pipelines/nodes are 6.

3. *RF ID Reader & Card*

- Radio Frequency Identification (RFID) uses electromagnetic fields to automatically identify and track tags attached to objects.
- Operating frequency is up to 13.56 MHz.
- Data processing speed starts from 26 kbps (minimum).
- Detection range is up to 15 meters.
- Operating voltage is 9 V.
- Configurable up to 2 to 4 Antenna's.
- High in operating speed.
- Highly reliable.

4. *Ultrasonic Sensor*

- Ultrasonic Sensors measure distance by using ultrasonic waves.
- Range of ultrasonic detection is 100 KHz – 50MHz.
- Ranging distance 2cm – 350 cm.
- Effectual angle <*15*.
- Resolution of 0.3 cm.
- Power supply 5 volts DC.
- Pulse in/outcommunication.

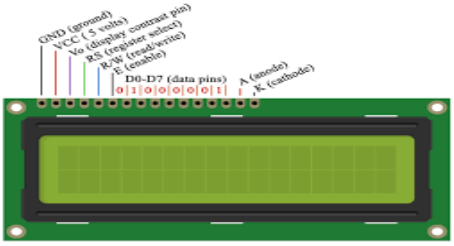
5. IR Sensor

- An infrared sensor is an electronic device that emits IR light in order to sense some aspects of the surroundings.
- Forward voltage of 1.24 volts to 1.4 volts.
- Spectral bandwidth of 45 nm.
- Viewing angle is 30 to 40 degree.
- Forward current of 1.5 amps.

6. Servo motors

- A servomotor is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration.
- The servo motor is controlled by a signal (data) better known as a pulse-width modulator (PWM).
- Forward voltage of 6 V.
- Rotating speed is 0.12sec/60degree.

7. LCD Display



- A liquid-crystal display is a flat-panel display that uses the light modulating properties of liquid crystals.
- Liquid crystals using a backlight or reflector to produce images in color or monochrome.
- LCD's are available to display Arbitrary images or fixed images with low information content.
- Operating voltage is 3.3 volts.

8. Buzzer

- A Buzzer is an Audio signaling device, which may be mechanical, electromechanical, or piezoelectric.
- Operating voltage DC 3.0 – 30.0 V.
- Sound pressure level 85 dB minimum (continuous tone).
- Current consumption of 9 mA (maximum).

- *Software*

1. Arduino IDE (Embedded c)

Arduino is a tool for making computers that can sense and control more of the physical world than your desktop computer. It's an open-source physical computing platform based on a simple microcontroller board and a development environment for writing software for the board.

Arduino can be used to develop interactive objectives, taking inputs from a variety of switches or sensors, and controlling a variety of lights, motors, and other physical outputs. Arduino projects can be stand-alone or they can be communicated with software running on your computer (e.g. Flash, Processors, MaxMSP.) The boards can be assembled by hand or purchased preassembled and it is open-source IDE can be downloaded for free. The Arduino programming language is an implementation of writing, a similar physical computing platform, which is based on the Processing multimedia programming environment.

VI. Advantages

- The system provides safety for the road users by reducing the accidents inside the gate as there is no manual operations.
- The reduction of time for which the gate is being kept closed.
- Error due to manual operations in track switching is prevented.

- It senses the obstacle in accidental zone and transmit the information to current train on that track.
- Due to automatic sensing and controlling no need of man power.
- It is reliable, economical and cost-effective system compared to existing system.

VII. CONCLUSION

The proposed project has many major advantages it will reduce the accidents at the railway level crossing, it will increase the accuracy and reduce errors occurring due to manual operations. 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 cars and humans from crossing railway tracks. Hence, automating the gate can bring about a ring of surety to controlling the gates. While coming to automatic railroad switching system it will reduce the errors of switching two trains on same track and anti-collision system reduces the collisions of train with obstacles.

VIII. REFERENCES

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