Automatic Railway Gate Control System using Arduino UNO and Ultrasonic Sensor

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***Abstract*—As human safety plays a vital role in railways.The accidents at level crossing has been increased and in rail traffic too,this has caused the concern for the Bangladesh railways. The main objective of this project is to provide an automatic railway gate control system at a level crossing by replacing the gates which is operated by the manual gate control. In this project we are preferring a simple solution at the level crossing we fix the Ultrasonic sensors to detect the train.our paper gives you a glance on automatic railway gate operation which is nothing but automatic railway gate at a level crossing replacing the gates operated by the gatekeeper,this majorly deals with two things, first it deals in reduction of time for which the gates is kept closed or open and secondly, to provide safety measures to the road users by reducing the accidents. By making use of the automatic railway gate control at the level crossing the sensor detects the train which is placed near to the gate.So, the time taken to be closed is less when compared to the manually operated gates.As the operation is totally automatic the errors due to manual operation get reduced. Arduino UNO plays as major role in Automatic railway gate control system and used to design for use in almost all the unmanned level crossing in the train. In order to overcome the accidents due to the above problem we have planned to design the project.**

I. Introduction

The railway system is one of the most common method of transportation in India. It also faces many problems due to human errors,mechanical failure,defective tracks,suicides etc.A level crossing is an area where road and railway track meet each other.Earlier Level crossing are operated by the gatekeepers.In order to keep away from the human errors that could occur during the operation of gates,the proposed paper introduces the concept of railway gate automation.Level crossings are managed by the gatekeeper and the gatekeeper is informed by the telephone from the control room.But the rate of human error that occurs at level crossing are increasing because people don't know the actual time of train arrival or departure.Detain in the opening and closing of the gate could lead to railway accidents.The major challenge that Indian railway system are facing is the increasing in accidents at the level crossing.This system require the manual gate operation by the gatekeepers based on the signals received from the control room.The human errors like delaying the gate operation by the gate keeper,delay in informing the gatekeeper about the arrival of the train,when any obstacle stuck at the level crossing etc. leads to increase in the accidents at level crossing.

Thus the objective of railway gate automatic system is to come up with two ideas. It decreases the time taken for the gate operation at the level crossing and also considering the safety of the passengers when the train passes at the level crossing.

When the human interference during the gate operation is reduced the problems like collision and accidents at the level crossings are balanced. Since the gate operations are automatic which is based on the ultrasonic sensors, the time taken for gates to gate is closed will be shorter. The paper aim is to develop an automatic railway gate control system which is responsible and secured than the already existing manual systems.The process of opening and closing of gate at the railway level crossing is totally based on the sensors in automatic railway gate system.when there is any obstacle found at the tracks of railway the arrival and departure of train for gate operation is done by using different types of sensors present. The detection of train plays a the major component in the train automatic system. This system needed two ultrasonic sensors to detect the arrival and departure of trains.here Ultrasonic Sensors and servo motors are programmed using Arduino UNO micro-controller.By implementing this automatic railway gate control system the train is sensed by the sensor which is placed on either sides of railway tracks which is about 3-4 km from the the level crossing. Once the arrival of the train is sensed, the sensed signal is sent to the Arduino UNO and again using the sensors it checks for possible presence of vehicle between the gates. Accordingly, buzzer indication is provided to the road users indicating the the gates are closing or opening. Once, no vehicle is sensed in between the gates it gets closed. But, if any obstacle is sensed the indication is sent to the train driver by signals which is placed around some distance so that there will be closing of gates before the level crossing.this type of gates can be placed at

the villages also where there is no need of station master.Since, the operation is automatic the errors due to humans will be reduced. Automatic railway gate control system is highly based on the microcontroller which is designed for the use in all unmanned level crossings.

II. DESCRIPTION

A. Hardware:

Arduino Uno, HC-SR04 Ultrasonic Sensor, Servo Motor, Power Supply, Buzzer, Breadboard, Connecting Wires, Toy Train, PVC Board.

B. Software:

Arduino IDE.

C. programming languages used

Embeded C

III. SYSTEM COMPONENTS

A. Arduino UNO

Arduino UNO is a development board which is open source and make use of the Microchip ATmega328P microcontroller. The board consists of input/output pins having digital and analog ,the board has 14 digital pins along with 6 analog pins which are used or made programmable with the help of an IDE (Integrated Development Environment).Ardunio is used for developing different types of electronics circuits using programmable circuit board and code running on laptop with USB cable connected between the laptop and arduino UNO.Programmaming language used in arduino is similar to c/c++.
object:Arduino uno
1.Microcontroller board based on the ATmega328P
2.Total No. of Pins: 32 (6 analog pins, 8 power pins, 18digital(PWM) pins)

Fig. 1. arduino UNO

B. Ultrasonic sensor(HC-SR04)

The Ultrasonic sensor is used to find the distance of an object which is located from a particular point . It has 4 pins;Trig pin,Echo pin,GND pin,VCC pin(+5V). The transmitter (trig) acts like input pin ,it initialize measurement by transmitting waves for 10us. receiver (echo) acts as output pin will be equal to the time taken for wave to return back to the sensor.This sensor is used in tinkercard with arduino to measure the distance.
Object: HC-SR04
1.Operating voltage: +5V
2.Practical Measuring Distance: 2cm to 80cm
3.Operating Current: ¡15mA
4.No. of Pins: 4 (Vcc to 5V, Trig(i/p) to pin (3 and 6), Echo(o/p)to pin (2 and 7), GND to GND)

Fig. 2. ultrasonic sensor

C. Servo motor

Servo motors are employed for very specific movement at a particular angle.Here the servo motor acts as gate when the train arrives the sensor sense the train and sends data to arduino and the output is given to servo motor that is to close likewise if the train is leaving the signals are sent to motor to open the gate. Moreover,the output shaft of this motor can be moved to a particular angle.Servo motors has many applications like in home electronics,toys,cars and many more devices.
Model N0:Servo Motor
1.Operating Speed (4.8V no load): 0.12sec/90 degrees
2.Operating Voltage: 4.2-6V
3.Temperature Range: 0°CC/55°CC

4.Connection pin (1) 8
5.Connection pin (2) 9

Fig. 3. servo motor

D. Buzzer

Buzzer can be of mechanical or electronic in nature.It has 2 pins one is connected to ground and other is connected to arduino pin,when the train arrival/departure is sensed by the ultrasonic sensors there will be indication of buzzer to know the train is coming or leaving.

E. Breadboard

A breadboard is a solderless device for test circuit designs. Many electronic components can be connected by inserting their terminals into the holes of breadboard and then making connections through wires.It has metal strips under the board,the top and bottom rows of holes are connected horizontally and remaining holes are connected vertically.

F. Connecting wires

Connecting wires allows current to pass from one point on a circuit to another because electricity needs a medium through move. connecting wires are made up of copper or aluminum. we Have used Male to Female, Female to Female, Male to Male Connecting wires in our project.

G. Toy train

A toy train plays a major role in this project .As this train moves the sensor does the work of it and the process takes place. A toy train is similar to other toys it may or maynot run on track, it can be operated by clockwork or a battery.

H. PVC Board

PVC board is the basement of our project ,this is used in making differnt types of models like block for educational and industrial environment.

IV. CIRCUIT DIAGRAM

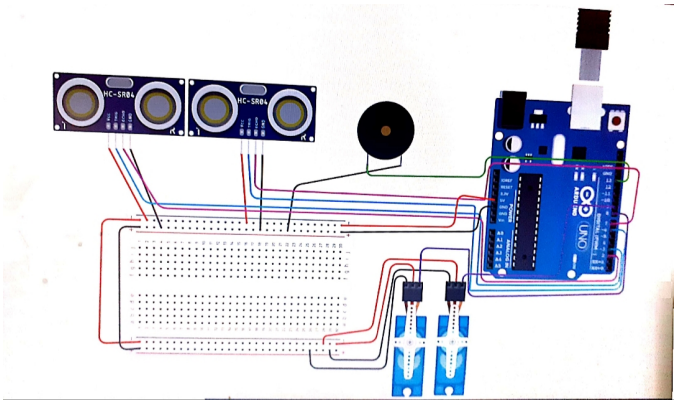
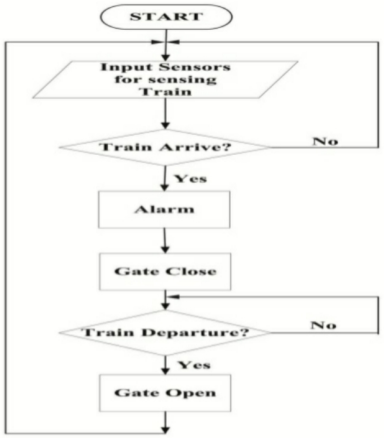


Fig. 4. connections of components

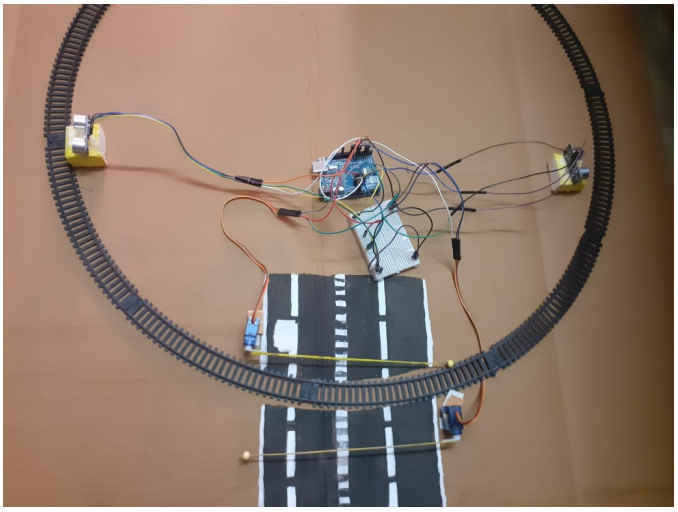
The Circuit Diagram is designed using two sensors,Arduino UNO, two servo motors,Buzzer,Breadboard,Connecting Wires,Toy Train and PVC Board.

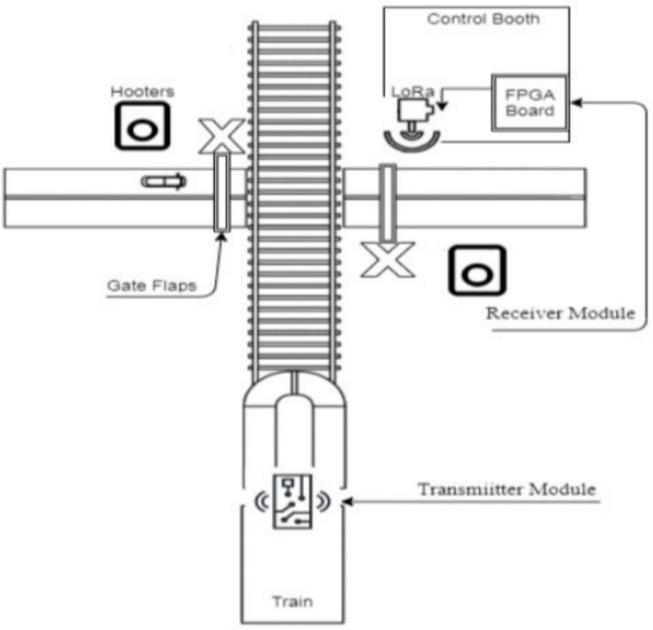
V. FLOW CHART



VI. WORKING PROCEDURE

To recognise the train arrival and departure time, we have used two Ultrasonic sensors. When the sensor detects the train, we will send the data using a wire connection to Arduino UNO board. Here we have used the received data as input in the Arduino and we will consider servo motor and buzzer as outputs. The buzzer will supply a signal to everybody at the level crossing. When the train will leave, the sensor at the other end will detect the departure and address the data using wire connection which will origin the level crossing to go up.





VII. REAL WORLD APPLICATION

As we cannot send data using USB cable to servo motor which lies around 3km away from Arduino board.here we introduce LORA which is a wireless technology. As shown in Fig the system consists of two modules, a transmitter and receiver module. Transmitter module is a microcontroller circuit with Lora Transciever set down in the arriving train, which continuously transmits data packets.Receiver Module, placed at the level crossing booth, is a programmable hardware circuit with LoRa which constant checks for data and the hardware is also connected to the Gate Flaps and buzzer. The hardware is planned to close the gates and release buzzer when this data is received. When the train leaves the range of the receiver, the gates and buzzer are released.

Transmitter system which is arranged over the train consists of an Arduino UNO board attached to wireless communication module SX1278 chip designed by SemtechTechnologies, which is form of spread spectrum modulation technique, widely known as LoRa Technology. LoRa has an operating frequency of 433 MHz and operates at 3.3V,providing range up to 5Km. The chip constantly sends data.
The base station has LoRa module SX1278 which is connected to the main controller of the receiver section, Spartan 6 Numato MIMAS V2 board which has a programmable hardware, this makes coding the system more vigorous and VHDL Hardware description language is used for coding the board. The communication module is associated to FPGA by SPI protocol. The receiver chip continuously spot the signals caught by the antenna for data packets. The transmitted signals are in the scope of a receiver, this detected signal activate the controller to command the Servo motor to shift the Flaps downwards, and the Buzzer alarms are assailed. These will persist so until the arriving train is in the range of the receiver, once the connection between transceivers is vanished the buzzers are signalled off and gate flaps are pulled up.

VIII. INJURIES CAUSED BY DIFFERENT ACCIDENTS

Human errors are common cause for any accident. Trains are estimated to kill 1 person every 100 minutes.Every year nearly 1,000 people are killed in train related accidents.Major part of railway road accidents occur at unprotected crossings.Unfortunately, when train accidents happens,frequently they face serious injuries.The main causes of train accidents are: Negligence,Human error,mechanical failure,derailments,suicides,unprotected railway crossings.

Table 1: Consequential accidents by category (2010-2020)											
Description	**2010-11**	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**Total**
Derailments	80	55	49	53	63	65	78	53	46	29	571
Manned level crossing	5	7	5	4	6	6	0	13	6	1	354
Unmanned level crossing	48	54	53	47	50	29	20				
Collisions	5	9	6	4	5	3	5	3	0	3	43
Fire	2	4	9	7	6	0	1	3	6	7	45
Others	1	2	0	3	5	4	0	0	1	1	17
Total	**141**	**131**	**122**	**118**	**135**	**107**	**104**	**72**	**59**	**41**	**1030**

Through this data we can get the information on injuries caused by different accidents in the past 10 years.

PREVENT TRAIN ACCIDENTS BY SOME OF THE POINTS GIVEN BELOW:

1)Do not drive around lowered gates.

2)Always check the surroundings before crossing a track.

3)Realize it can take a train traveling 55 mph up to a mile to come to a complete stop.

4)Always look out for warning signs and signals.

5)Never walk on or along railroad tracks—trespassing is illegal!

6)Ultrasonic Flaw Detection (USFD) can be implemented to test the rails detecting flaws and making sure of removing of defective rails in time.

we can find the predicted values of the accidents through any method of Machine learning model ,this helps us to get the reduced accidents by our project.

IX. CONCLUSION AND FUTURE SCOPE

Automatic railway gate control system brings an idea of reducing human activities for closing and opening the railway gate and making safety measures at the level crossing.At railway gate many deaths and accidents takes place. Hence, automating the gate can lead us from prevention of accidents and control the gates.As we know people make errors or mistakes.To avoid the accidents at level crossings we have to change the manual work to latest technology.

X. REFERENCES

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