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Pressure Sensed Fast Response Anti-Collision System for Automated Railway Gate Control

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Abstract: **-** This paper presents an innovative project design of a pressure sensor based swift response anti-collision system for an automatic railway gate control. By replacing the manual system of railway gate control at the level crossing it has been develop an automatic system in which the arrival and departure of the train will be sensed automatically to control the gate. The novelty of this project based paper is the use of pressure switch which has been integrated in this anti-collision system for the railway. By chance if a vehicle gets stuck at the level crossing of the rail-line, the pressure sensor will detect the object and will take necessary action by following the developed algorithm. The whole operation of this project has been controlled by a Microcontroller PIC16F84A. Two IR sensors have been used to detect the arrival and departure of the train. IR sensor will give the signal to the Microcontroller and the Microcontroller will pass this signal to the DC motor and it will rotate as its requirement. This noble project is very much reliable, safe and cost effective.

Keywords: *- Anti-collision, Automatic, Microcontroller, MPLAB IDE, Proteus, Receiver, Sensor, Transmitter.*

I. INTRODUCTION

Now a days in Bangladesh numerous number of railways are running on track every day. A railway has its way of running that is straight and it is risky and dangerous as per as public and traffic concern. Every year many people died at the level crossing of the rail-line due to the carelessness of the gate keeper. Also some major collisions occur when any vehicle gets stuck at the level crossing. The rate of these accidents is increasing day by day. That's why our concept is to make an automatic system to avoid the collisions at the level crossing of the rail-line.

An automatic railway gate control system is an arrangement of physical components which sense the arrival of the train and make the gate pull up and pull down automatically. As a train approaches at the railway crossing from either side, the sensors placed at a certain distance from the gate detect the approaching train and accordingly controls the operation of the gate. Also an indicator light has been provided to alert the driver of the train if any vehicle or living object gets stuck at the level crossing of the rail-line. [1]

By employing the automatic gate control at the railway level crossing the arrival of the trains are detected by the IR sensors placed on either side of the gate. Once the arrival is sensed, the sensed signal is sent to the microcontroller and it checks the possible presence of any vehicle between the gates, again using sensor. Once no vehicle is sensed in between the railway gate then the motor is activated and the gates are closed. But if any obstacle is sensed it is indicated to the train drivers and necessary steps are taken according to solve the emergency problems. When the train is passed through using the same process gate is opened.

Earlier, railway gate is controlled manually all over the world. Now a day's many countries of the world are practicing automatic railway gate control system. But it was not the scenario in the late past. Walkie-talkie sets were provided to drivers and guards of all the trains for communication in static mode or at low speeds. VHF

sets was also used at stations on board gauge double line or multiple line sections so that train crew can communicate with the nearest station masters in the case of emergencies. In early age, guards used conventional kerosene lit tail lamps to pass the signals to the driver after closing the gates at the railway level crossing. But this system has less reliability. Due the carelessness of the gate keepers and the guards many accidents took place in the past. [2]

Now a days, a system has been designed to reduce the complexity and tried to make a reliable system. In this system when a train is about to its arrival at the railway crossing which is shown in Fig. 1, the station master informs the gate keeper who stands at the side of the railway gate by calling him through telephone and then he closes the gate so that the traffic cannot pass through the rail-line. Sooner he passes this information to the station master using same process and the station master gives signal to the train to pass through. When the train passes through the level crossing completely gate keeper gives this information to the station master and the station master gives him the right to open the gate.

Sometimes vehicles get stuck at the level crossing of the rail-line; at that time there is huge chance of occurrence of accident. In fact, such situation triggered many accidents in the past. The ordinary system of railway gate control has no safety purpose as it is operated manually. In manual system, road users have to suffer many hours at the level crossing due to the laziness of the gatekeeper. And the more important thing there is no anti-collision system in manual operated railway gate control system.

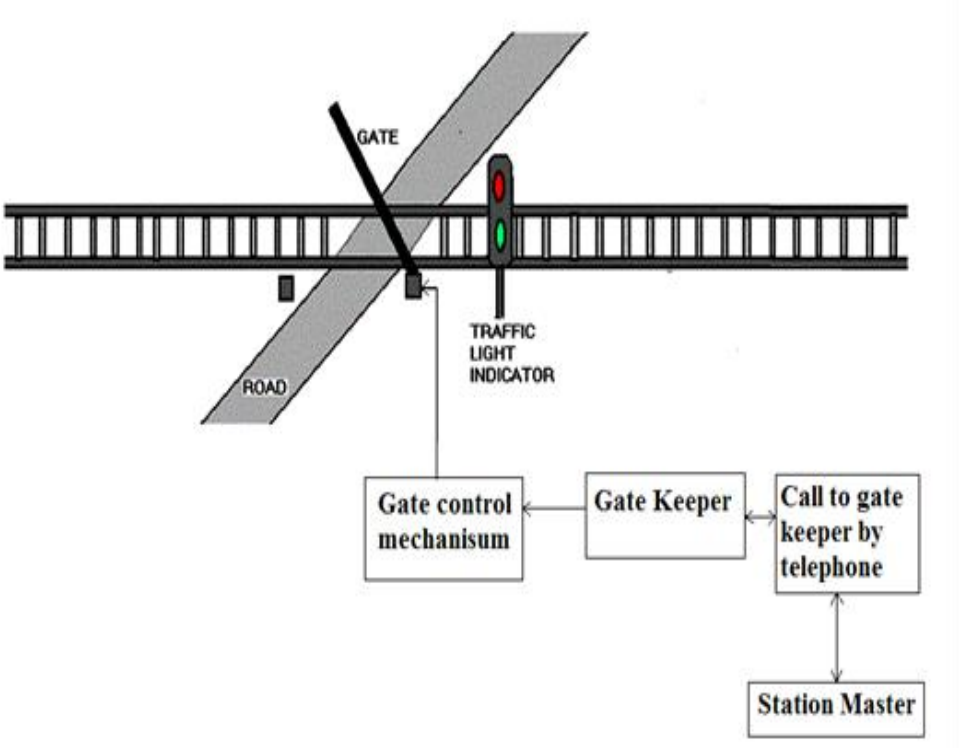

Fig. 1. Oldest technique of gate control [3]

II. OVERVIEW OF THE PROJECT

2.1 Block Diagram of the Project

We can describe the whole operation of the circuit briefly by using some block diagrams. A block diagram is a graphical method used to explain the concept of a system without the need to understand the individual components within that system. This type of diagram might be used in a variety of industries to illustrate and educate individuals about how a system operates, either in part or in its entirety. Block diagrams usually will have a logical, methodical flow from beginning to end. [4]

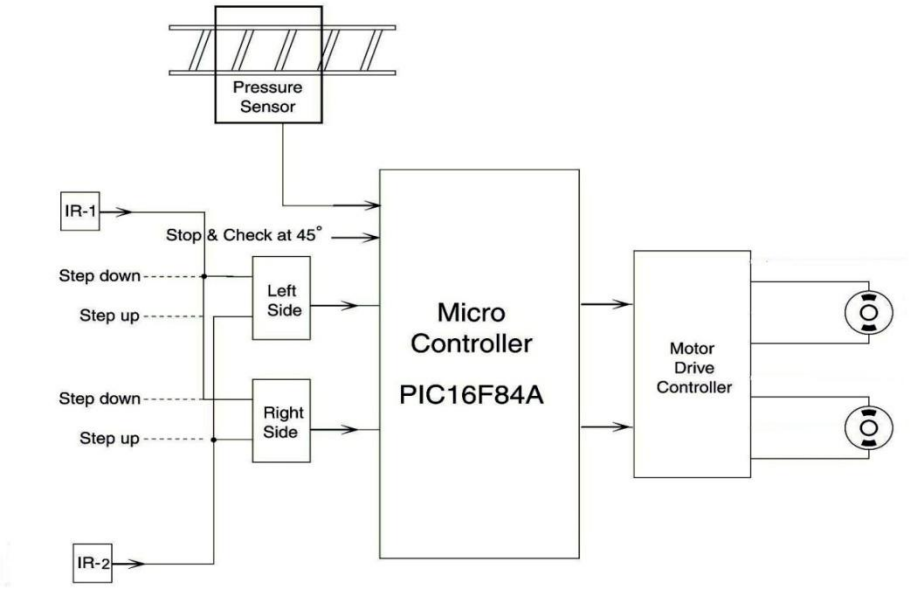

Fig. 2. Proposed technical block diagram

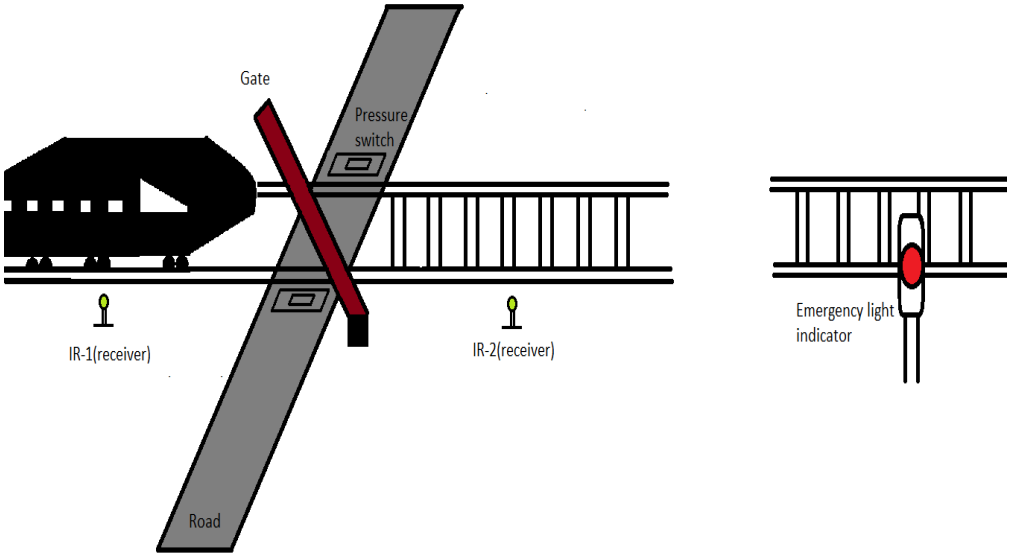

Fig. 3. Proposed implementation planning

To describe the whole operation of the project, we need to explain the two block diagrams in Fig. 2 and Fig. 3. We are placing the IR transmitter in the train so that it would only be activated when it would be closer to the receiver. We need to select the side from which the train is coming. If we consider the train is coming from the left side of the track (Fig. 3) then if the train touches the IR-1 (Receiver) it will send the signal to the Microcontroller and the microcontroller pass this signal to the motor driver controller. It will drive the motor in its way. In our project it will rotate at anti-clock wise position if it gets signal from the IR-1 in Fig. 2.

When the gate is closing down it will stop and check at 45° for any presence of the vehicle from the pressure sensor. If no vehicle gets stuck at the level crossing, then our Microcontroller will allow the gate to be closed at 90°.If the microcontroller could sense any presence of the vehicle at the level crossing it will send signal to the motor and it will stop at 45°. It will also give an emergency signal to train driver so that the driver of the train could take necessary actions to avoid the collision in Fig. 2 and Fig. 3. At the time of departure of the train, it will touch the sensor IR-2 and it will send signal to the Microcontroller and our Microcontroller will

allow the gate to rotate at clock wise direction. And that's how the gate could come in its initial position.
In practical case, the IR receiver will be placed 1 km away from the level crossing and so that the train could reduce its speed when an object gets stuck at the level crossing.

2.2 Flow Chart

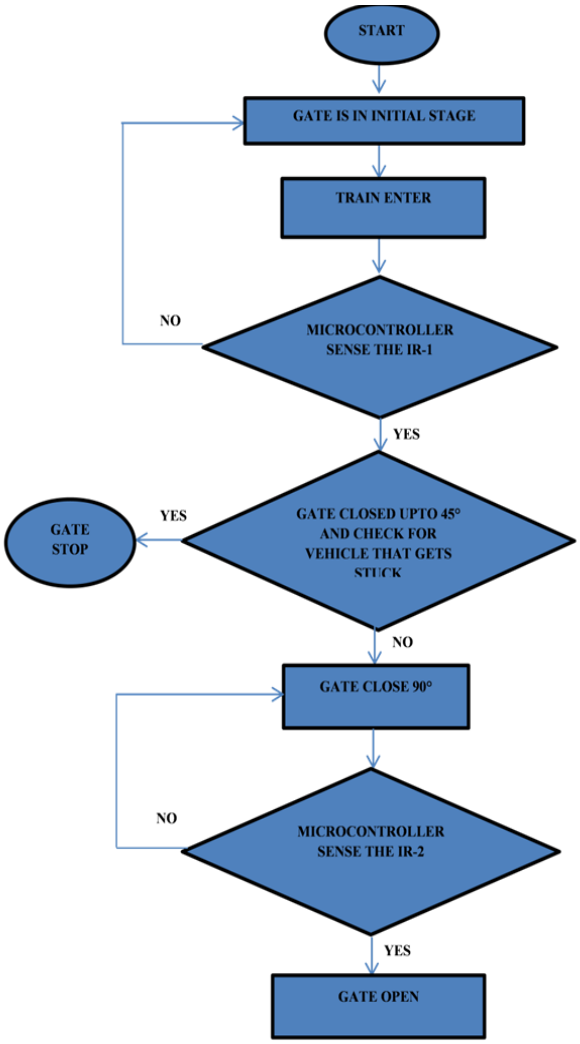

Fig. 4. Flow Chart

2.3 Algorithm

The algorithms used in the flow chart in Fig. 4 are described in steps.

⇒ Start.
⇒ Set the variables.
⇒ Make initial settings for the signal of the train.
⇒ Check the arrivals of the train in either direction by the IR-1 sensor. If train is sensed then go step-5 otherwise go the step-2.
⇒ If the arrival of the train is sensed then the gate is closed up to 45° and check for the vehicle that gets stuck. If any vehicle gets stuck it would be Stop otherwise go to Step- 6.
⇒ Close the gate.
⇒ The departures of the train are sensed then go to Step-8 otherwise goes to Step-6.
⇒ Open the gate.

III. SOFTWARE INTERFACING

Compiling the code for microcontroller, MPLAB IDE is the best solution. For burning the code to the microcontroller PICkit2 is very efficient. For showing the circuits and simulation virtually Proteus is perfect for this job.

3.1 MPLAB Integrated Development Environment

MPLAB Integrated Development Environment (IDE) is a full-featured compiler for PIC devices from Microchip. It is called an Integrated Development Environment, or IDE, because it provides a single integrated environment to develop code for embedded microcontrollers. It is the best solution for developing code for PIC devices. It includes a host of free software components for fast application development and supercharged debugging. MPLAB IDE also serves as a single, unified graphical user interface. [5]

3.2 Working with MPLAB IDE

Starting with MPLAB at first we need to create a project from project wizard. From there a language tool needs to select which is shown in Fig. 5. Then have to create a project with a valid name. After that others file or work can be included from there. Then new file should be created for writing the code. For assembly language file name should be "filename.asm" format. From source that assembly file should be include.

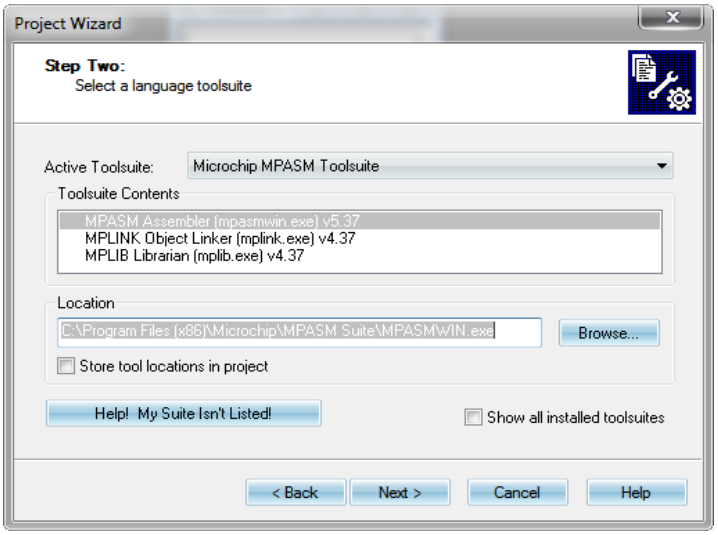

Fig. 5. Selecting compiler language

3.3 Features of MPLAB IDE

Some features of MPLAB IDE is given below:

⇒ It assembles, compile and link the source code.
⇒ It debugs the executable logic by watching program flow with the built-in.
⇒ Simulator or in real time with in-circuit emulators or in-circuit debuggers.
⇒ It makes timing measurements with the simulator or emulator.
⇒ It views variables in watch windows.
⇒ Program firmware into devices with device programmers.
⇒ These are the features of MPLAB IDE. [5]

3.4 Proteus

Proteus software is renowned to all for software simulation. Proteus is the software of "LABCENTER" Electronics. It is even possible to connect Proteus VSM with third party software debugger, and watch animated schematic diagram at work as if it was real hardware. [6] This software has a library. From this library any components can be include in the circuit for simulation. It has thousands of components that use in real life

which is shown in Fig. 6 and for a certain period of time library can be updated by internet. It is the professional software for embedded designers. It helps a designer to complete the work.

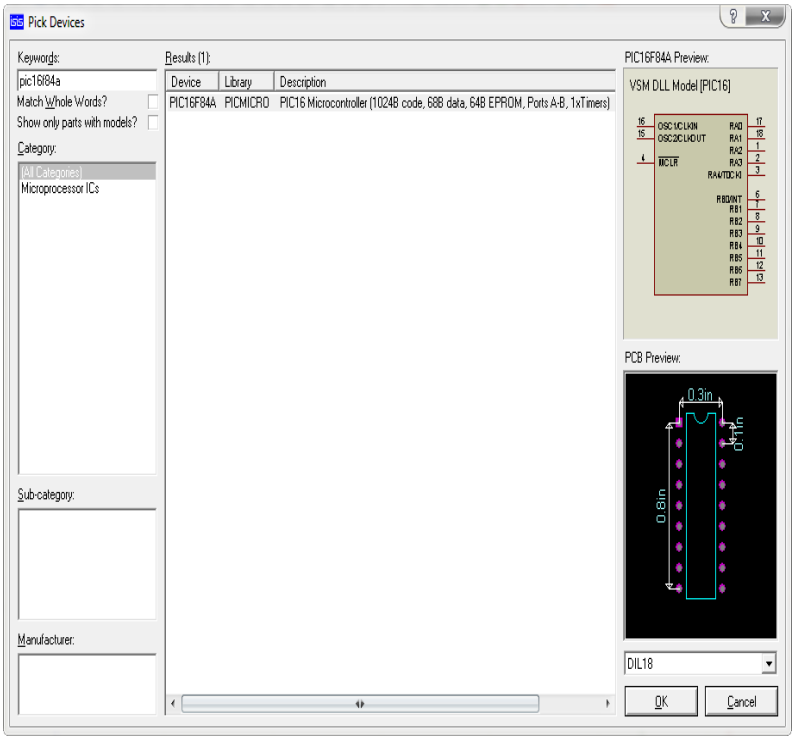

Fig. 6. Picking up devices from Proteus Library

3.5 Working with Proteus

The Proteus is the simple and most essential software with latest technology for circuit implementation and simulation. It has ISIS which is for circuit design and simulation and ARES which is for PCB designing. Starting the software there is a library for including the components. Including necessary components it can be simulate after building the circuit. It is necessary to give corresponding information to the components and microcontroller needs to include the hex file for its necessary work.

3.6 Applications of Proteus software

Microcontrollers are widely applied in the field of industry to solve engineering control problems. A new simulation software package for microcontroller, Proteus virtual system modeling (VSM), is introduced for industrial and educational use. Proteus combines circuit simulation, animated components and microprocessor models to facilitate co-simulation of complete microcontroller based designs. Proteus makes it possible to develop and test designs before a physical prototype is constructed. Proteus is very suited for teaching students about the design and operation of microcontroller-based systems. [7] – [8].

IV. SIMULATION AND RESULT ANALYSIS

This project is about the implementation of a smart anti-collision system as well as to control the railway gate automatically. By studying the rate of accidents in our country we are trying to reduce or minimize the accidents by using an automatic system. This is a system which is designed using Microcontroller 16F84A.

4.1 Proposed Circuit Design

We have built the circuit to simulate our project using Proteus v7.8 which is shown in Fig. 7. We are using this software because this is very much user friendly to design and simulate any circuits instead of using other software's. The design of the circuit in Proteus is given below.

As IR sensor is not available in Proteus we are using push button here. Here two push buttons are used to instead of using IR-1 and IR-2 and that stands for closing and opening the gate. Another button is used for checking at 45° and other stands for giving the presence of vehicle if that gets stuck. We are using four more push buttons directly connected with the motors as we are using DC motor. It will work as a trip switch. LED D1 is used to give signal to the train if any vehicle or living object gets stuck at the level crossing of rail-line. We can explain the whole operation and its results using the following figure.

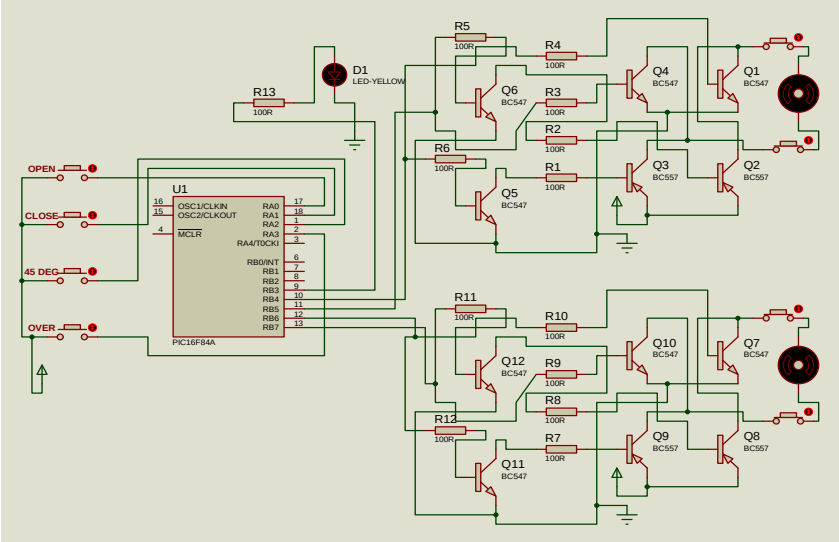

Fig. 7. Circuit design using Proteus

4.2 Results in Three Different Cases

Result part presents three important cases here. Those are:

⇒ When the train arrives

⇒ When the train leaves

⇒ When any vehicle gets stuck

4.2.1 Train Arrival Detections

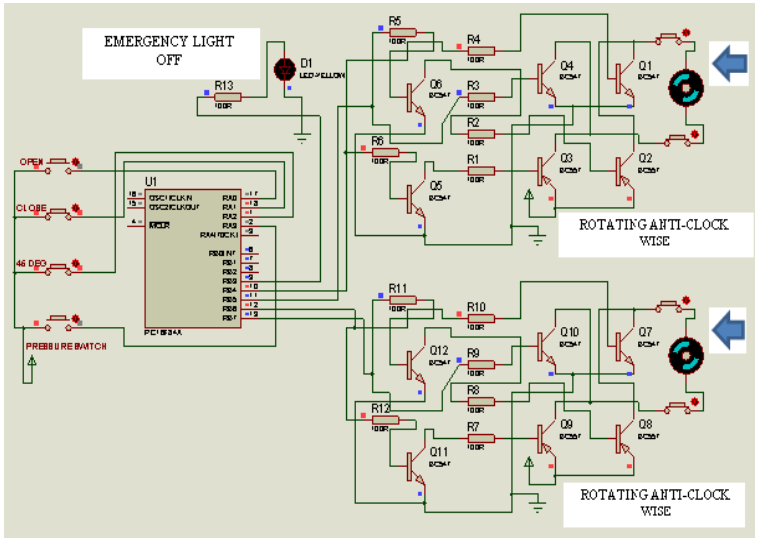

Fig. 8. Arrival of the train detections

As the gate will always check at 45° it would always be closed as we can see from the figure. When the train is coming we need to close the push button named as Close. So the gate will be closing down and at 45° it will check for the presence of any vehicle that gets stuck. If any object is not found then the gate it is closed properly. That's why it is rotating in anti-clock wise direction shown in Fig. 8.
As it is not sensing any living object at the level crossing so the emergency light D1 will remain off.

4.2.2 Departure of the Train Detections

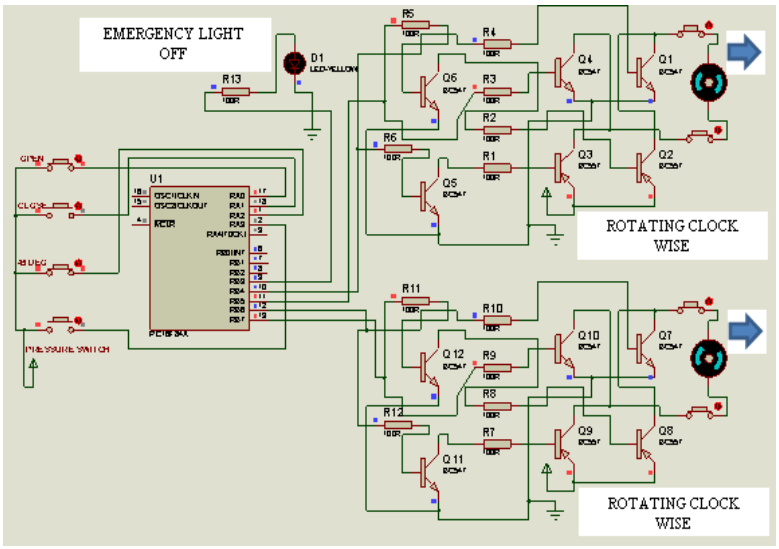

Fig. 9. Departure of the train detections

Fig. 10.

To show the departure of the train from the level crossing shown in Fig. 9 we need to open the CLOSE button and close the OPEN button. As soon as we close this button, it will send signal to the Microcontroller and motor will rotate in clock wise position so that the gate can open and allow the vehicle to pass through the level crossing.
As our Microcontroller is not getting any signal from the pressure switch emergency light indicator D1 will remain off.

4.2.3 When a Vehicle Gets Stuck

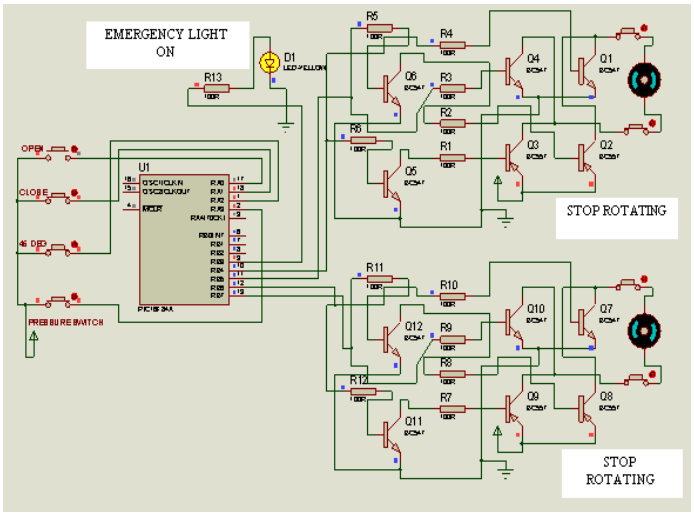

Fig. 11. Pressure switch is activated

For this operation in Fig. 10 we need to activate the pressure switch as well as to CLOSE button. So the gate is closing down it will check at 45° and it will get a signal of any living object that gets stuck at the level crossing of the rail-line. So our Microcontroller will give signal to the motor to Stop and send this emergency signal to the train driver making the emergency light ON. As we can see from the figure D1 is activated and that's how train driver will take necessary actions to reduce the accident.

V. DESIGN PROTOTYPE

We have designed the PCB layout after implementing the whole circuit on the bread board to check whether it works properly or not.

5.1 PCB Design (Front and Back)

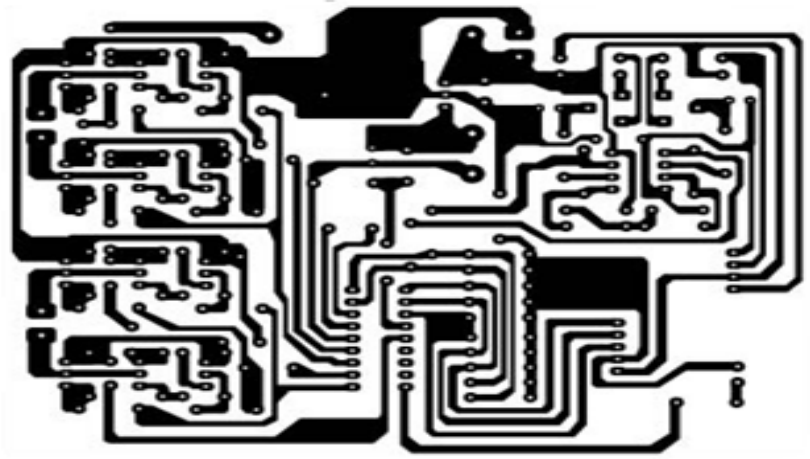

Fig. 12. Back part of the PCB layout

As we are making a model of the whole project, it would not be possible to test its functionality with the practical railway system. That's why using a demo train we had observe its functionality. When every function of the project runs properly then the PCB layout has been designed which is shown is Fig. 11 and Fig. 12 and implemented the circuit on the PCB.

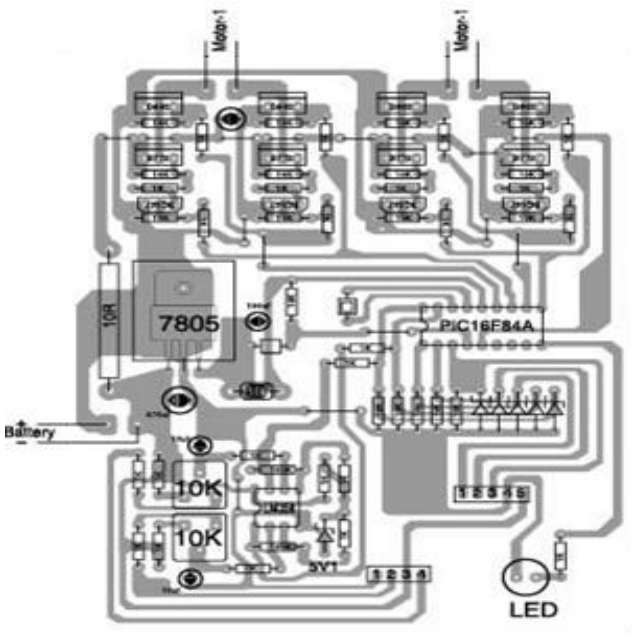

Fig. 13. Front part of the PCB layout

5.2 Physical Construction

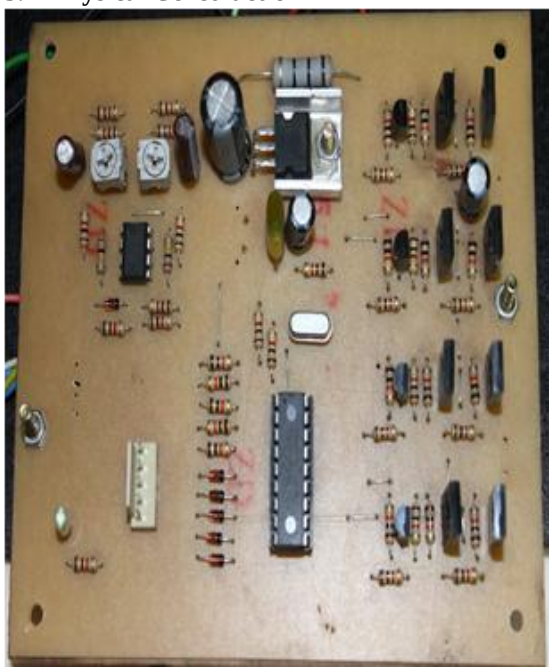

Fig. 14. Physical construction

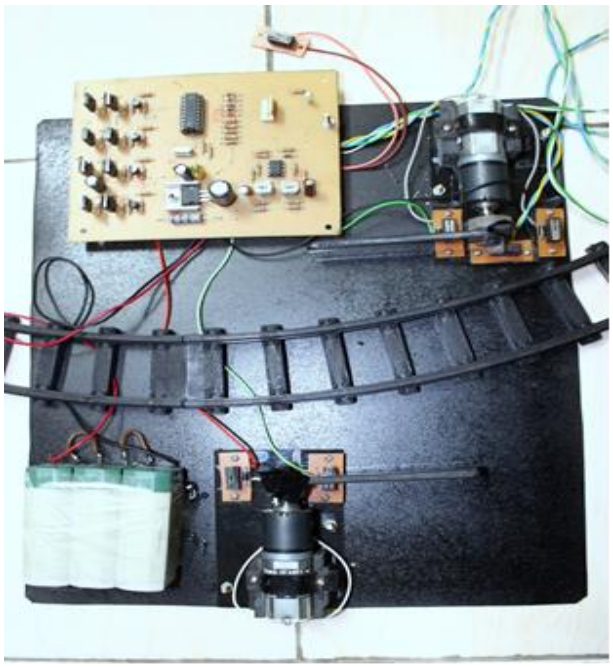

Fig. 15. Physical construction

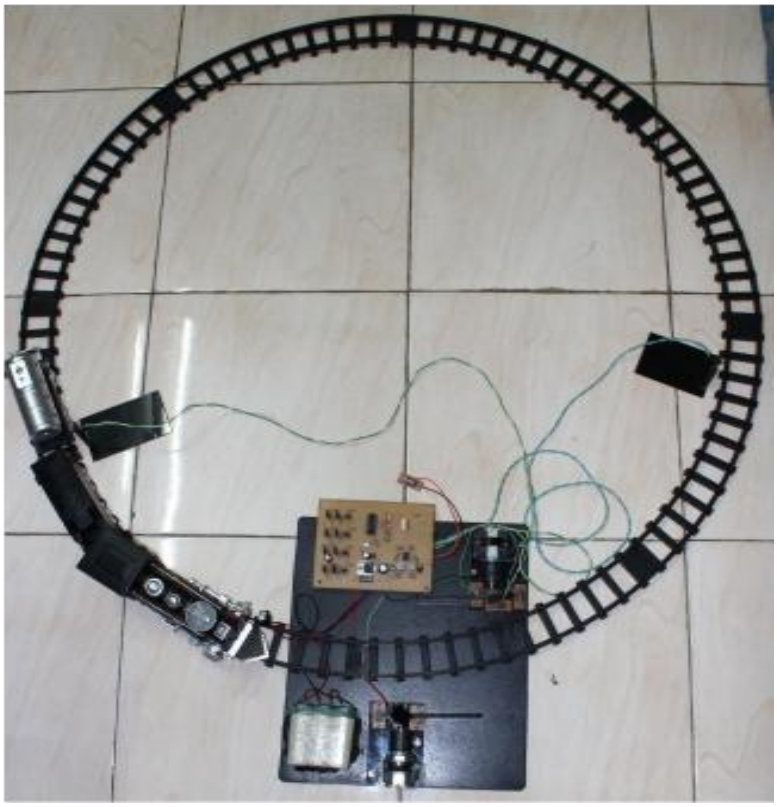

Fig. 15. An automatic railway gate control

The above Fig. 13 and Fig.14 present the physical of the actual implemented hardware. Fig. 15 is the total design prototype and it also shows how the pressure sensed automatic gate control system will be placed.

VI. CONCLUSION

The pressure sensed anti-collision system for an automatic railway gate control is developed to reduce the loss of death and injuries for the human at the level crossing of the rail-line. An automatic system is more reliable than a manual system. That's why this project is very much effective and efficient considering the safety of the human life. In this project, all the apparatus were handled safely to avoid unexpected short circuit. The novelty of this project is the safety of the human life at the level crossing of the railway.

VII. FUTURE WORK

There are many scopes to improve this project in future. If we overlook the whole project we can get the idea of using RF module instead of using wire for the transmission of signal. Another improvement of this project could be the sector of pressure switch. Instead of using this, a high-tech load sensor could be used so that it could give the actual rating of the vehicle that gets stuck at the level crossing. So, it is expected that more works will be done on relevant project in near future.

VIII. ACKNOWLEDGEMENTS

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APPENDIX

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