Assembly Language Programmed Automatic Railway Gate Control

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Abstract

As we are aware that the number of accidents at railway crossing has been increasing lately, more precautionary measures are being undertaken. Accidents take place either due to the absence of crossing gates, or due to impatience and carelessness of pedestrians. There are many places where the railroad crossings are open, without any gates. This becomes an open threat to the people or vehicles who wish to cross the railroad. Whereas, there are places where the crossing gates at railroad is being controlled and managed by a guard. In such cases, threat may arise due to carelessness of the guard. So, our project aims at automating this process. Automatic Railway Gate Control (ARGC) is managed and controlled by microcontroller 8051 and is more reliable since there is no human intervention in the process. Our model, most primarily, is different from others in terms of the programming method and considering various possibilities that the actually railroad crossing system encounters. We have programmed 8051 using assembly language program (.asm). Infrared (IR) sensors are used which senses the presence of train and conveys the information to 8051. 8051 is programmed accordingly to open or close the gate whenever required. Also, the steps for creating hex file from the program are elaborated. Keil uvision3 is being used to create the hex file.
Keywords: Hex File, Keil, L293D Driver IC, Microcontroller 8051, Proteus6

I. INTRODUCTION

This system is designed to manage the control system of railway gate using the microcontroller. The main purpose of this paper is to propose an idea to make the process automated so that the probability of accidents reduces drastically. This system is designed using 8051 microcontroller to avoid railway accidents happening at railroad crossings. 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 informs the microcontroller about it [1]. This signal is used to trigger the microcontroller for opening or closing of gates. The abstraction of this system is to provide the advanced control system available to everywhere.

II. PROJECT OBJECTIVE

This system is to manage the control system of railway gate using the microcontroller. 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 to road users by reducing the accidents that usually occur due to carelessness of road users and errors made by the gatekeepers. Railways are the preferred cheapest mode of transportation over all the other means. Also, it is evident from the experimental results that accidents at railroad crossings with the gate control are far less than those crossings that are devoid of gates.

III. RESEARCH METHODOLOGY

The main idea of this model is to sense the presence of locomotive and take necessary actions to open or close the gates. IR sensors are used to sense the presence of locomotive and these signals are being sent to microcontroller 8051. 8051 is efficiently programmed to take proper actions.

A. Hardware

1) Model Diagram

Model diagram of ARGC is shown above. Basically the circuit consists of four IR LED-Photodiode pairs arranged in such a way that each pair is on either side of the track as shown in the figure above. The rail crossing, gates, train, and two rails are also explicitly mentioned in the above diagram.

When the train cuts the IR Sensor 1, the sensor senses its presence and notifies the 8051 microcontroller by sending an electrical signal. Usually, crossing gates are closed when train interrupts IR sensor 1 and are opened only when the train passes by the IR sensor 2. This is the basic principle of operation but there exists few other possibilities too. All the possibilities are taken under consideration while programming 8051 [2]. Various possibilities are as follows –

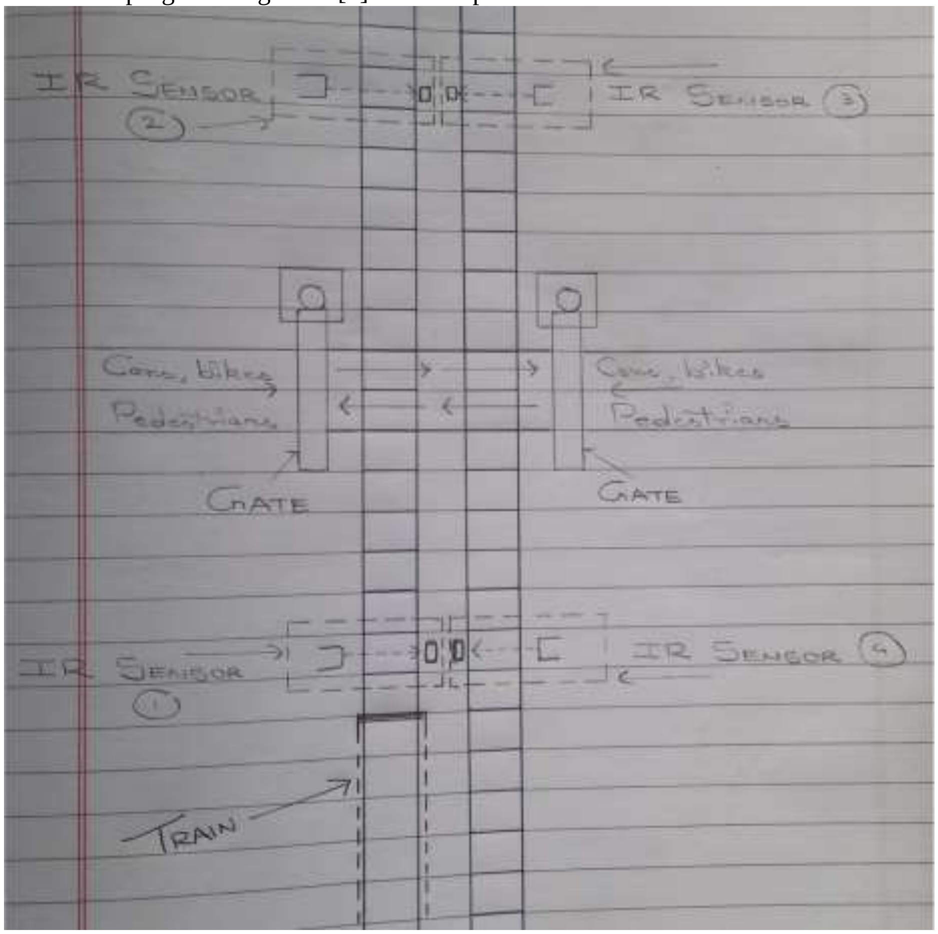


Fig. 1: Model Diagram of ARGC

- Case 1: Assuming the length of train is very long, the train cuts IR sensor 1 and gates are closed. Then it travels and interrupts IR sensor 2. Now both IR sensors are being blocked. As train passes further, IR sensor 1 is no longer blocked by the train but IR sensor 2 is still being blocked. Eventually train moves further and IR sensor 2 is no more interrupted and the gates are closed. Therefore, the gates will be opened only when both IR sensors are not blocked.
- Case 2: There is a possibility that train passes IR sensor 1 and waits in between. So in such cases, the gates must remain close and open only when the train completely passes through IR sensor 2.
- Case 3: There is a possibility that there is only single engine passing through the sensors. When it blocks IR sensor 1 and moves a little further, IR sensor 1 is again unblocked. Now, the engine is somewhere between IR sensors 1 and 2 but both sensors are unblocked. As per case 1, when both IR sensors are open, the gates shall be opened. That logic is very dangerous in this case because the engine is running somewhere between the two sensor pairs but the gates are open. In order to tackle this issue, a new algorithm is designed. In the new algorithm, the gates will be opened only when there is a block-unblock transition in IR sensor 2 equivalent a similar transition in IR sensor 1.

2) *Circuit Diagram*

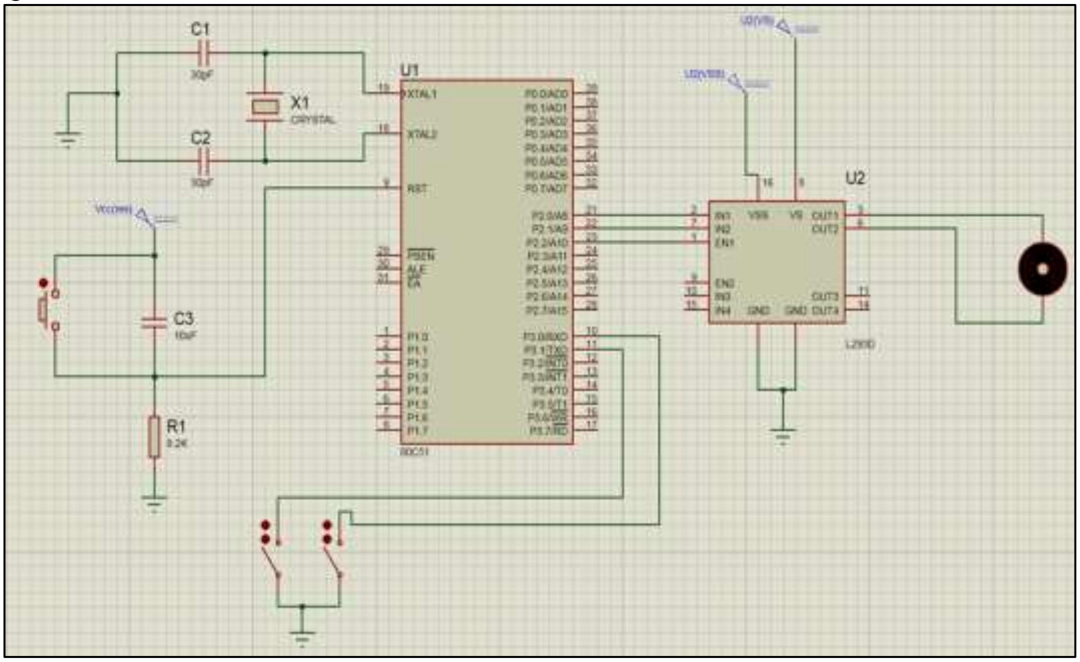
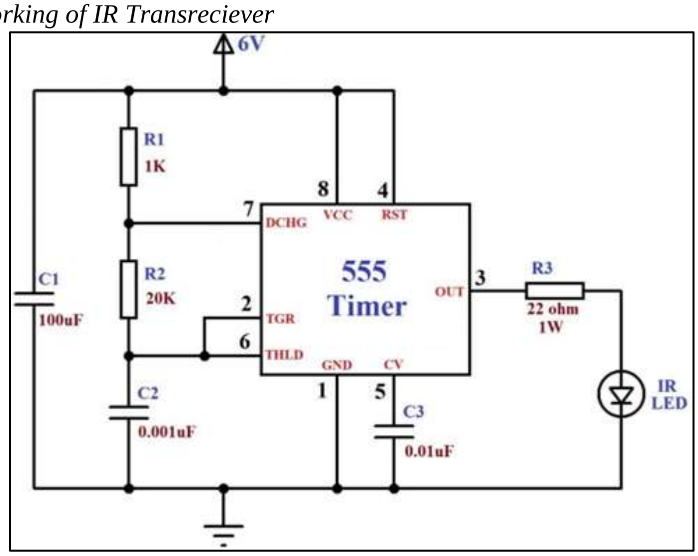


Fig. 2: Overall Circuit Diagram

3) *Working of IR Transreciever*



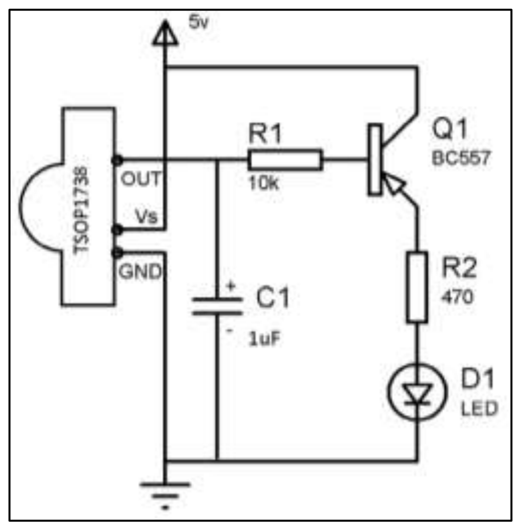


Fig. 3: IR Transmitter Circuit

Fig. 4: IR Receiver Circuit

In the above circuit, 555 Timer is operated as an ‘A stable Multivibrator.’ The 100µF capacitor (C1) is used to reduce ripples in the power supply. 1st and 8th pins of 555 are used to give power Vcc and GND respectively. 4th pin is the reset pin which is active low input, hence it is connected to Vcc. 5th pin is the Control Voltage pin which is not used in this application, and hence it is grounded via a capacitor to avoid high frequency noises through that pin. Capacitor C2, Resistors R1, R2 determines the time period of oscillation. Capacitor C2 charges to Vcc via resistors R1 and R2. It discharges through Resistor R2 and 7th pin of 555. The voltage across capacitor C2 is connected to the internal comparators via 2nd and 6th pins of 555. Output is taken from the 3rd pin of the IC. Charging time constant of the capacitor (output HIGH period) is determined by the expression 0.693(R1+R2)C2 and discharging time constant (output LOW period) is determined by 0.693R2C2. They are approximately equal.

We have used BC557 PNP transistor here, to reverse the effect of TSOP, means whenever the output is HIGH LED will be OFF and whenever it detects IR and output is low, LED will be ON. PNP transistor behaves opposite to the NPN transistor; it acts as open switch when a voltage applied to its base and acts as closed switch when there is no voltage at its base. So normally TSOP output remains HIGH and Transistor behaves as open switch and LED will be OFF. As soon as TSOP detects Infrared, its output becomes low and transistor behaves as closed switch and LED will be ON. A 10k resistor is used for provide proper biasing to transistor and a 470ohm resistor is used at LED for limiting the current. So whenever we press the Button at IR transmitter, it is detected by TSOP1738 and LED will glow.

4) Interfacing of IC L293D with 8051

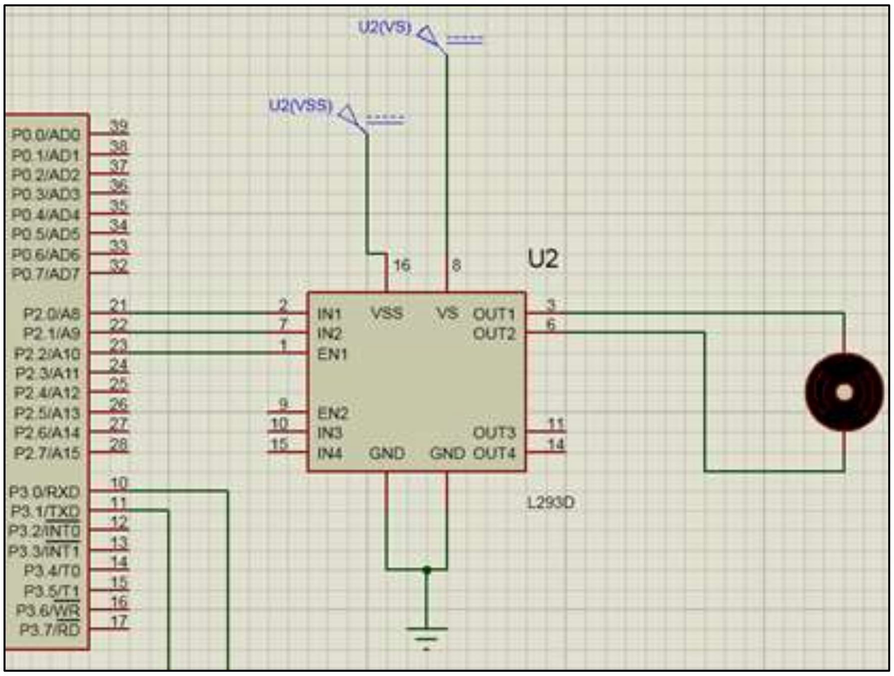


Fig. 5: Interfacing of L293D driver IC with 8051

LM293D is a motor driver IC which is interfaced to the 8051 IC. The DC Motor is connected to the first pair of drivers and it is enabled by connecting EN1 to logic HIGH (5V). VSS pin is used to provide logic voltage to L293D. Here 8051 microcontroller, which works at 5v is used to control L293D, hence the logic voltage is 5. The motor supply is given to Vs pin of the L293D [3].

The function of IN1 and IN2 pins is show below –

Table – 1
Function of IN1 and IN2 pins

IN1 / P2.0	*IN2 / P2.1*	*Motor Status*
Low	*Low*	*Stops*
Low	*High*	*Clockwise*
High	*Low*	*Anti - Clockwise*
High	*High*	*Stops*

5) List of Components

The materials and components that are used in automatic railway gate control system is mentioned below. As in normal control design, system can be roughly divided as input, output and processing sections. The main components of system are:

a) Microcontroller IC 8051
- Reset circuit
- Oscillator circuit

b) Motor Driver IC L293D

c) IR Transceiver circuit
- Infrared Sensor (IR LED and TSOP IC)
- IC 555 (Timer IC)
- LM7805 (Voltage Regulator)
- Resistors
- Capacitors

6) Hardware Prototype

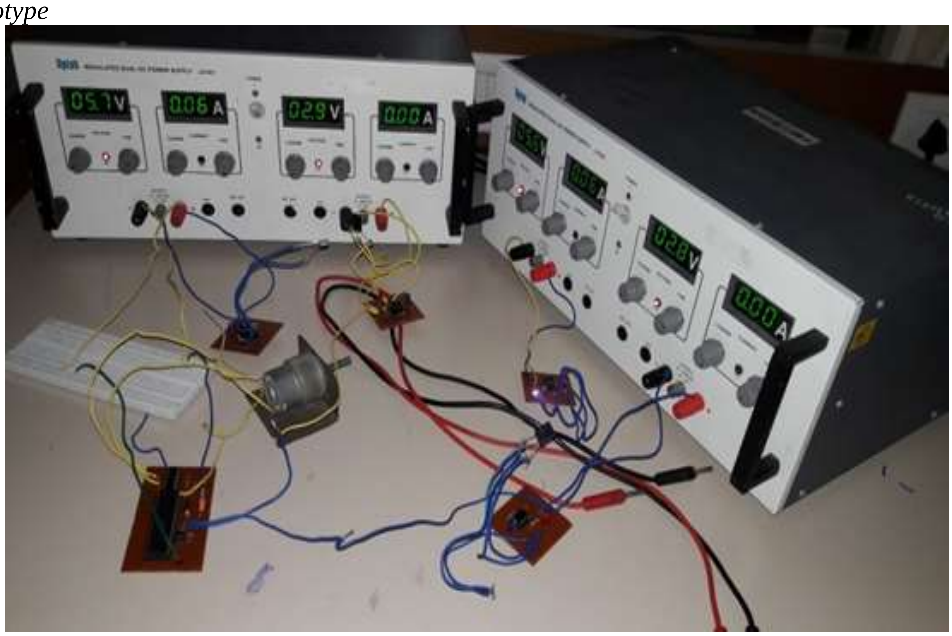


Fig. 6: Prototype of ARGC

B. Software

1) Program (Assembly Language)

```
Start: MOV P3, #0FFH; IR connected to Port3. No block, IR's output is logic1. (Only for software simulation purpose)
CLR P2.0                              ;connected to IN1 of L293D
CLR P2.1                              ;connected to IN2 of L293D
CheckIR: ACALL DELAY
MOV R7, P3                            ;IR (1) read.
MOV A, R7
RRC A
JNC MotorForward;                     ;Jump when CY=0 i.e. IR is blocked.
SJMP CheckIR
BACK1: MOV R7, P3                     ;IR(2) read.
MOV A, R7
RRC A
RRC A
JNC SecondIRDetected
SJMP BACK1
MotorForward:SETB P2.0                ;This loop closes the gate.
CLR P2.1
ACALL DELAY1
ACALL DELAY1
ACALL DELAY
CLR P2.0
SJMP BACK1
SecondIRDetected:MOV R6,P3            ;Train is cutting IR(2) and is going to pass through it.
MOV A, R6
RRC A
RRC A
JC MotorReverse_Check_FirstIR         ; Check IR (1) when train crosses IR (2)
SJMP SecondIRDetected                 ; Wait till train crosses IR (2)
MotorReverse_Check_FirstIR:MOV R5,P3
MOV A,R5
RRC A
JNC MotorReverse_Check_FirstIR        ;Keep looping when IR (1) is cut. Go down once train crosses IR (1)
SecondIR_Check:MOV R4,P3              ;Check IR (2) after making sure that train has crossed IR(1)
MOV A,R4
```



```
RRC A
RRC A
JNC SecondIR_Check          ;Keep looping when IR(2) is cut. Go down when train crosses IR(2)
CLR P2.0                    ;This loop opens the gate.
SETB P2.1
ACALL DELAY1
ACALL DELAY1
ACALL DELAY
CLR P2.1
SJMP Start
DELAY:MOV R7,#0FFH          ;Delay program 1
TOP:MOV R6,#0FFH
MOV R5,#0FFH
BACK:DJNZ R5,BACK
UP:DJNZ R6,UP
DJNZ R7,TOP
RET
DELAY1:MOV R4,#14H          ;Delay program 2
OneSec:MOV TMOD,#01H
MOV TL0,#0AFH
MOV TH0,#3CH
SETB TR0
WAIT:JNB TF0,WAIT
CLR TR0
CLR TF0
DJNZ R4,OneSec
RET
END
```

2) Procedure of generating hex file

One of the software that can used to generate hex file is 'Keil uvision 3' [4]. The steps of generating hex file is as follows –

– Step1: Creating a project file.

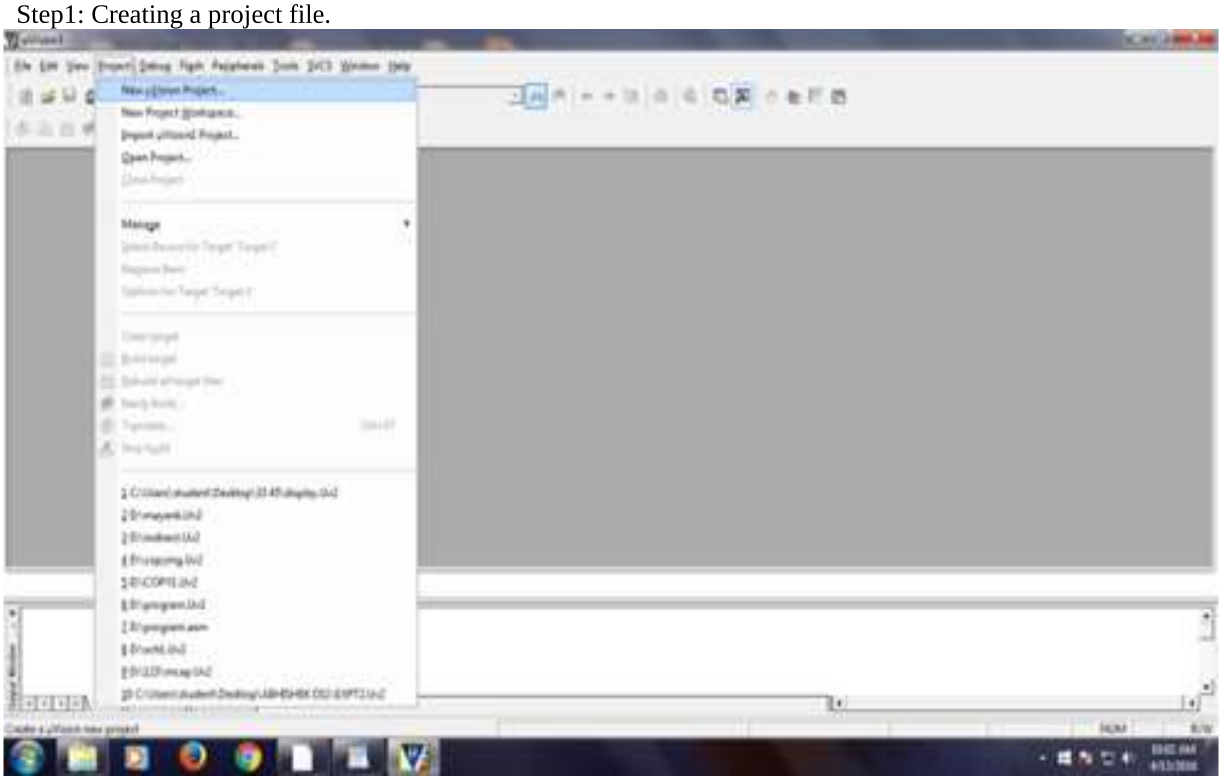


Fig. 7: Step 1

– Step2: Choosing your desired microcontroller name in the pop-up box.

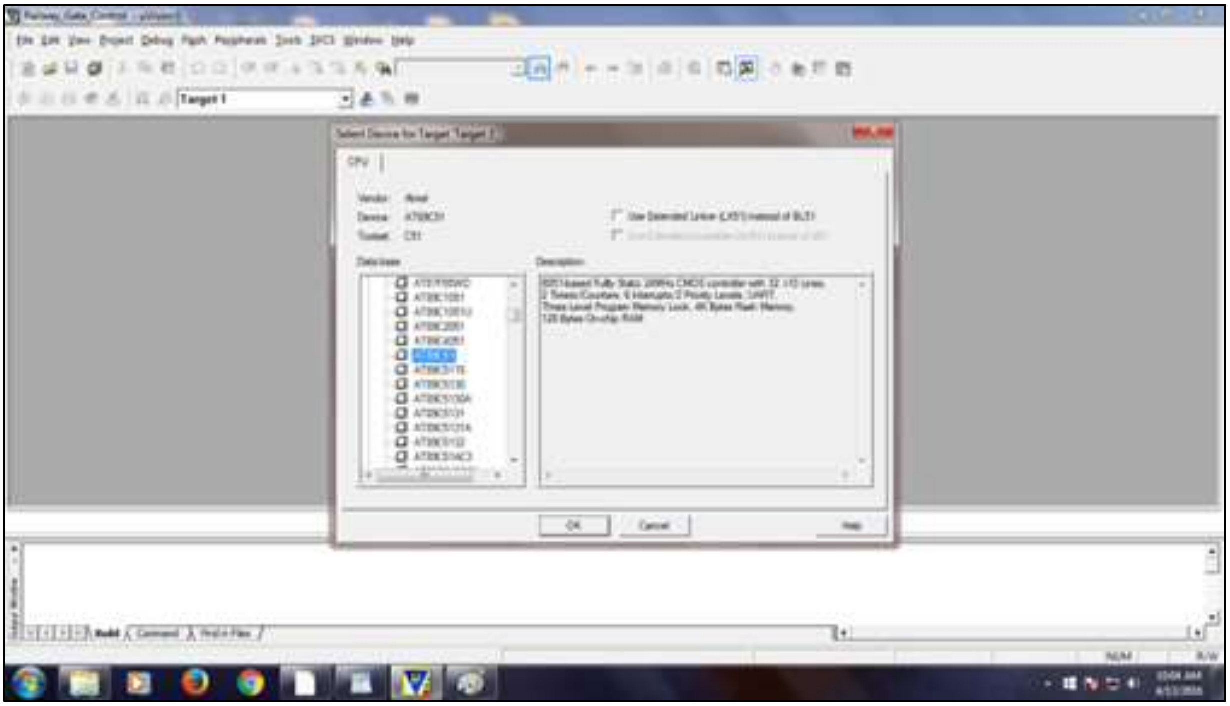


Fig. 8: Step 2

– Step3: Writing your program in Keil and save it as '.asm' file.

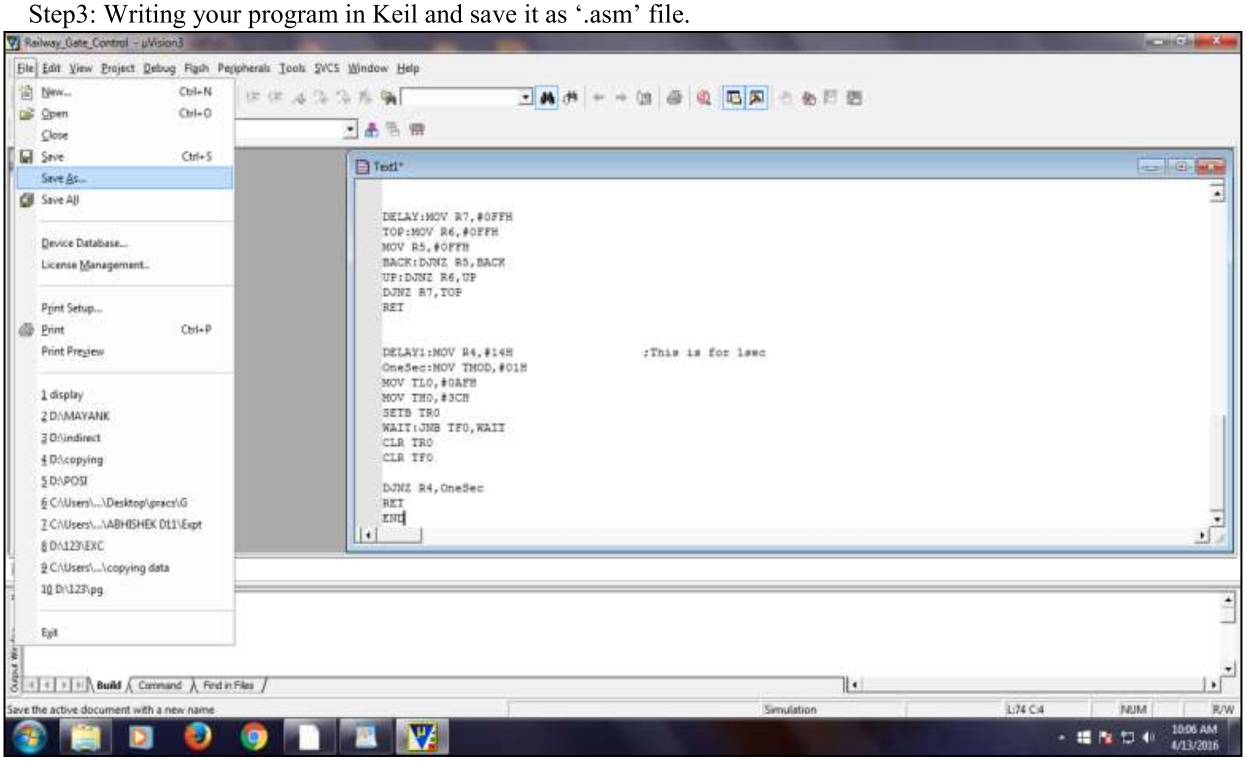


Fig. 9: Step 3

– Step4: Add the '.asm' file in the source group.

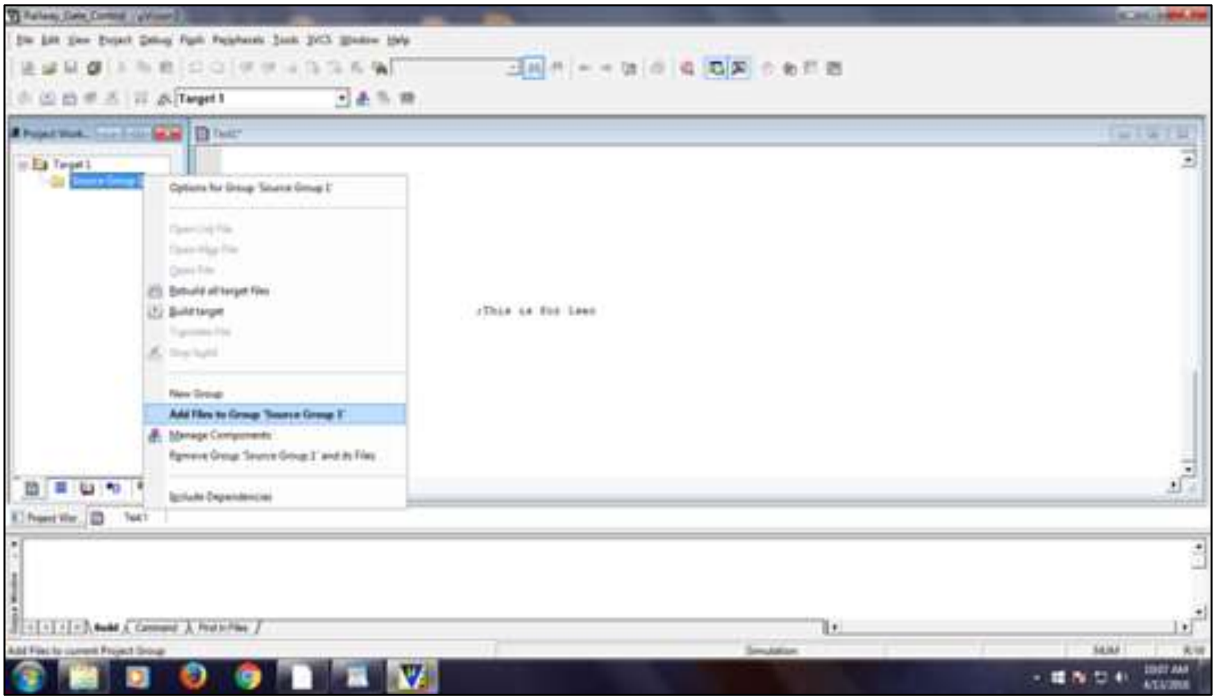


Fig. 10: Step 4

– Step5: Right click on Target for this window to pop-up. Go to output tab and tick on 'create .hex file'

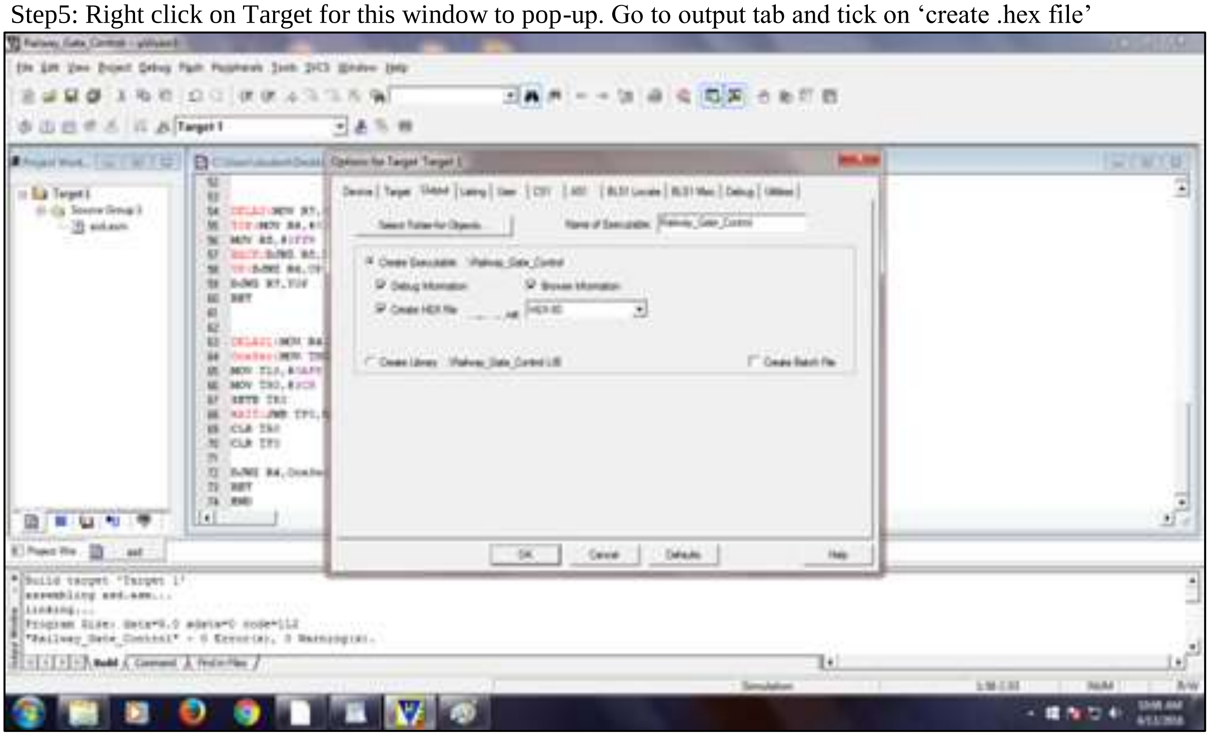


Fig. 11: Step 5

IV. EXPERIMENTAL RESULTS

In the past 20 years, there have been a total of 21 collisions between vehicles and trains at crossings on the New Haven Line, with safeguards at the crossings ranging from the higher level of protection of drop arm gates to as little as stop signs and cross buck crossing signs at private crossings. The accidents caused 15 injuries and two fatalities, according to the statistics [5].

In 1980, there were only 16,291 public railroad-crossings equipped with automated gates and lights, compared with 34,296 such crossings in 2000 [6]. This 111% increase in the number of gated crossings could explain at least 50% of the reduction in railroad-crossing accidents. This is because gates tend to be installed at the most densely-traveled crossings, and on a unit-of-traffic basis, numerous studies have shown gates to be 85-90% more effective than passive devices in saving lives [7].

There are two broad types of protective devices installed at grade crossings. First, the safest type of safety device is a barrier -- more precisely, an automated crossing gate -- which is always accompanied by lights. Automated gates are installed on railroad property, and must be maintained by the owners. While accidents occur at gated crossings, studies show them to be 85-90 percent more effective than non-gated crossings. This is largely because, when properly operating, gates preclude accidents which might otherwise have happened. Incredibly, although countless billions of dollars of public funds have been expended on grade-crossing safety, and many crossings have been eliminated by an aggressive public campaign and railroad downsizing, only 20 percent of the crossings in this country are equipped with automated gates. The majority of the other crossings have cross bucks -- that is, an "x" sign with the word "railroad" printed on one diagonal and the word "crossing" printed on the other. The cross buck is supposed to warn motorists that they are approaching a train track. If they remember the contents of their state driver's handbook, motorists would be expected to slow down and look both ways before entering the crossing. Cross bucks are located on publicly-owned highways and maintained by the road authority. [8]

V. Conclusion

Automatic gate control system offer an effective way to reduce the occurrence of railway accidents. This system can contribute a lot of benefit either to the road users or to the railway management. Since the design is completely automated it can be used in remote villages where no station master or line man is present. Railway sensors are placed at two sides of gate. It is used to sense the arrival and departure of the train. This system uses the DC motor to open and close the gates automatically when it is rotated clockwise or anticlockwise direction. Now a day’s automatic system occupies each and every sector of applications as it is reliable and accurate.

- We demonstrate that it is possible to improve the overall safety of the railway system in India.
- The proposed system provide the means for real time inspection, review and data collection for the purpose of maintenance on the movable and fixed facilities for the guarantee of operation safety and maintenance efficiency as well as the safety appraisal decision-making system based on the share of safety data.

References

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