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Intelligent Traffic Signal Control System Using Embedded System

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Abstract

A development of an intelligent traffic signal control (ITSC) system needed because present traffic light controllers are based on old microcontroller such as AT89C51 which has very less internal memory and no in-built ADC. These systems have limitation because they will use the predefined program that does not have the flexibility of modification on real time application. The present traffic system have fixed time interval for green and red signal which does not provide the flexibility to the system. The ITSC system consist of high-performance, low power AVR_32 microcontroller with 32kbytes of in-system programmable flash memory and in-built 8-channel, 10-bit ADC which is required to process the IR input from sensor network. The ITSC system will able to deal two basic problem of traditional traffic light system: i) Detection of traffic volume by using genetic algorithm. ii) Emergence vehicle detection such as ambulance, police etc by using wireless sensor network (IR) embedded at the signal intersection.

Keywords: Traffic Volume Estimation, Genetic Algorithm, wireless sensor network, Vehicle detection, Intelligent Traffic Signal Controller, embedded system.

1. Introduction

A steady increase in metro-city population, the number of automobiles and cars increases rapidly and metro traffic is growing crowded which leads to the traffic jam problem. This proposed system will have effective role to avoid the traffic jam.

Under ordinary conditions, traffic signals control mainly has two defects:

1. When the traffic lane waits until the green light, time setting is almost same and fixed. A-road was always crowded with vehicles and go-ahead time is short. So, vehicles can't pass through in the time allowed. But sublane has few vehicles and go-ahead time is relatively long.

2. Emergency cars are not considered. (For example, fire engines and ambulances have priority over other traffic. The two lanes should both wait them to pass through.) Because the traffic light control system is lack of emergency measures, the crossroads always meets a traffic jam and leads to unnecessary economic losses[1]. The author Zhang Yuye et.al. [1] System use AT89C51 and CAN BUS controller which leads to complicated design and cost of the system more because of CAN BUS controller. Also power requirement will be more in case of AT89C51 but the proposed ITSC system will used low power AVR-32 microcontroller.

The author Manoj Kanta Mainali et.al.[2] proposed a genetic algorithm approach to estimate the traffic volume in road sections without the traffic information of road sections. This method can estimate the unknown traffic volume using only the known traffic volumes. So, proposed ITSC system use the advantage of [1][2] to design very efficient system that use the combination of AVR-32 and genetic algorithm.

The author Cai Bai-gen et.al.[3] design a vehicle detection system based on magneto-resistive sensor is composed by wireless traffic information collection nodes which are set on two sides of road to detect vehicle signal. The magneto-resistive sensor is costly and maintenance cost of the system will be more if the system fails. This system is lack of emergence measures and proposed ITSC system will able to solve this problem effectively.

The author S.L.Toral et.al.[4] design will provide good result for vehicle detection where ARM-based video processor not only deals with the video processing algorithms but again the cost of system design will be more

because camera will be required to capture video .

The author Shilpa S.Chavan et.al.[5] design of traffic light controller handles major problem of conventional traffic signal. At certain junction, sometimes even if there is no traffic but people have to wait because the traffic light remains red for the preset time and road users waits until the light turn to green. They try to solve this problem effectively by using GSM but system will leads to complications. The proposed ITSC system solves this problem by using genetic algorithm.

The author Ahmed S. Salamaet.al.[6] provide integrated intelligent traffic light system using photoelectric sensors distributed on long range before and after traffic light on roads. Emergency cases such as , the passing president car and ambulance that require immediate opening of traffic signal. The system has the ability to open a complete path for such emergency cases until reaching the target but this system does not operate wells when more than one emergence Vehicles come on the signal from two sides.

The proposed ITSC system solves this problem in most effective way. The rest of the paper is organized as follows. Section 2 presents the definition and problem description. Section 3 described the proposed method and design. Section 4 gives the experimental results and finally, Section 5 concludes the paper.

2. Definitions and Problem Description

The problems of typical conventional traffic light Controller are mentioned below:

2.1. Heavy Traffic Jams:

With increasing number of vehicles on road, heavy traffic congestion has substantially increased in major cities. This happened usually at the main junctions commonly in the morning, before office hour and in the evening, after office hours. The main effect of this matter is increased time wasting of the people on the road. The solution for this problem is by developing the program which different setting delays for different junctions. The delay for junctions that have high volume of traffic should be setting longer than the delay for the junction that has low of traffic. This operation is calling Normal Mode [7].

2.2. No traffic, but still need to wait:

At certain junctions, sometimes even if there is no traffic, people have to wait. Because the traffic light remains red for the preset time period, the road users should wait until the light turn to green. If they run the red light, they have to pay fine. The solution of this problem is by developing a system which detects traffic flow on each road and set timings of signals accordingly. Moreover, synchronization of traffic signals in adjacent junctions is also necessary [8].

2.3. Emergency car stuck in traffic jam:

Usually, during traffic jam, the emergency vehicle, such as ambulance, fire brigade and police will be stuck especially at the traffic light junction. This is because the road users waiting for the traffic light turn to green. This is very critical problem because it can cause the emergency case become complicated and involving life [5].

2.4. When more than one emergency car came:

The proposed ITSC system solves this problem in most effective way. When more than one emergency car came then most of the system fails. They give green signal to both which lead to traffic conjunction problem and also leads to accidents. In ITSC system, this problem solve by giving red signal to all traffic. So only emergency cars will pass the signal for particular time period.

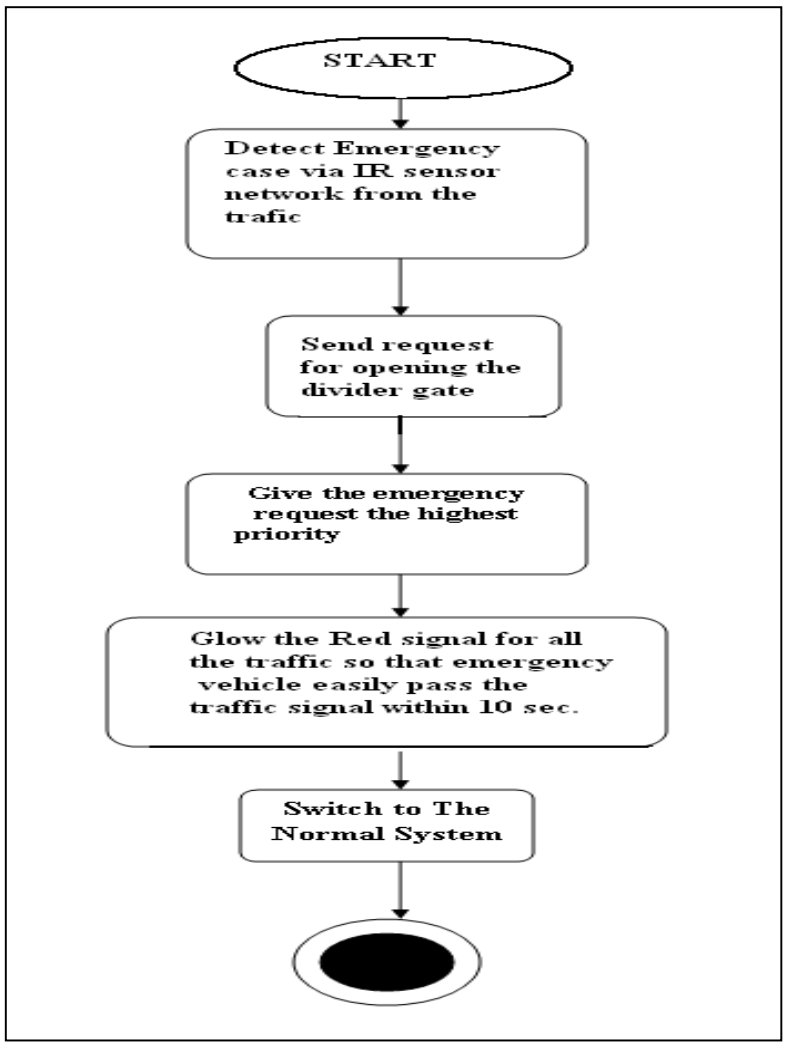


Figure1. Emergency Cases Activity Diagram

3. Proposed Method and Design

The proposed ITSC system consist of high-performance, low power AVR-32 microcontroller with 32kbytes of in-system programmable flash memory and in-built 8-channel ADC which required to process the IR input from sensor network. So complexity of system reduces as no additional ADC required.

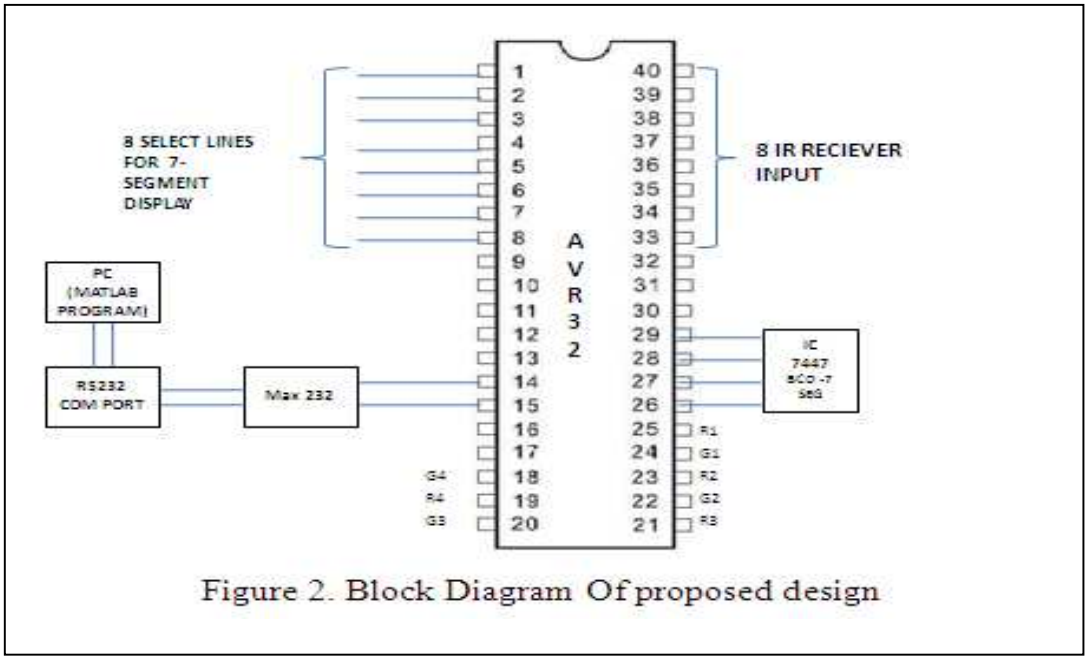
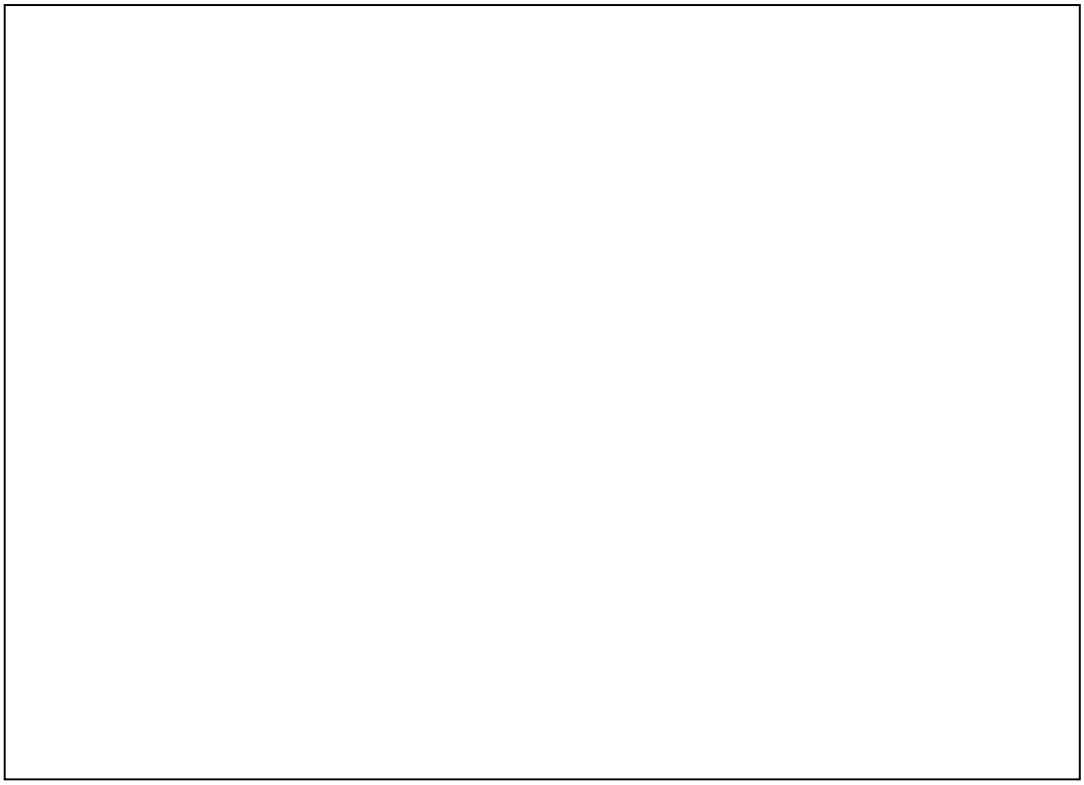
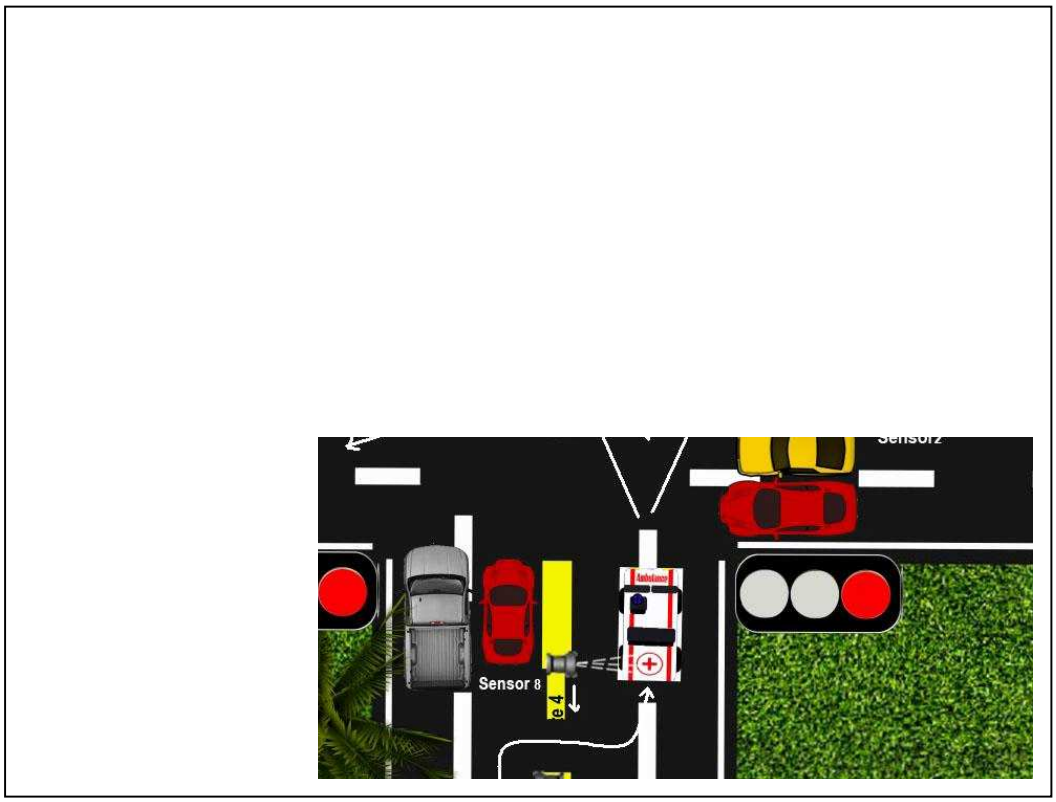


Figure 2. Block Diagram Of proposed design

The emergency vehicle detection system based on wireless IR sensor network is shown below to solve two basic problem related to emergency case:



Case1: When single emergency car comes on the signal and no. of vehicles will be available in front of the emergency vehicle. In this situation, IR sensor network detect the emergency car and then open divider gate to pass the car. As the signal will be red for other vehicles, so no possibility of accident.



Case 2: When two emergency cars come on the signal and no. of vehicles will be available in front of the emergency vehicle. In this situation, IR sensor network detect the emergency cars and then open divider gate to pass the cars. Arrows will indicate the possible direction. The sensor network is used to open and close the divider gate when emergency vehicles pass through gate.

The proposed ITSC system combines the advantages of hardware and software and we can easily control the traffic system through central computer system.

4. Experiment Analyses

The ITSC system consist of AVR-32 microcontroller with inbuilt 8-channel ADC to receive IR-input from IR-transmitter which is embedded in the emergence vehicle. The 8-IR sensors are used to detect the emergence vehicle and open the divider gate to pass emergence car and then immediately closed the gate. This system used the genetic algorithm to find the traffic flow information at signalized intersection using previous data. Genetic algorithm calculates the green light time for signal depending on the three factor's demands, densities, and flow. The formula to calculate the green light time is given below:

Total time = (Demands) + (Densities) + (flows)
Where,
Demands- Past dada of signalized intersection
Densities- No. Of present vehicle on the signal after red signal
Flows- Approximate no. Of vehicle comes from previous signal.

The following result shows the estimation of unknown traffic volumes to vary the time of green signal light:

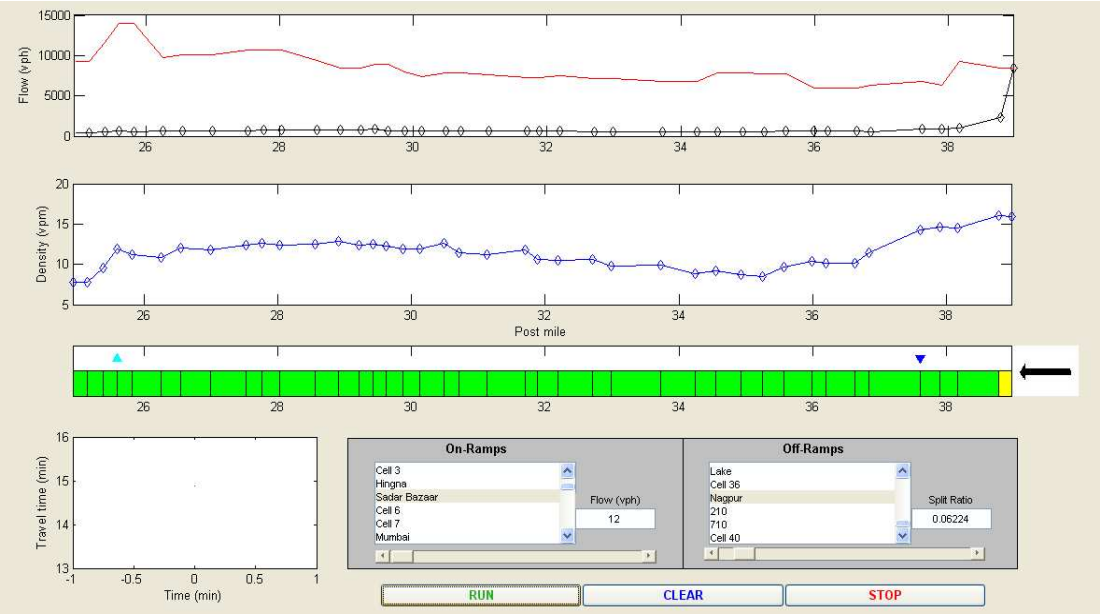


Figure3.Waveform of density and flow for flow =12(vph), split ratio = 0.06224

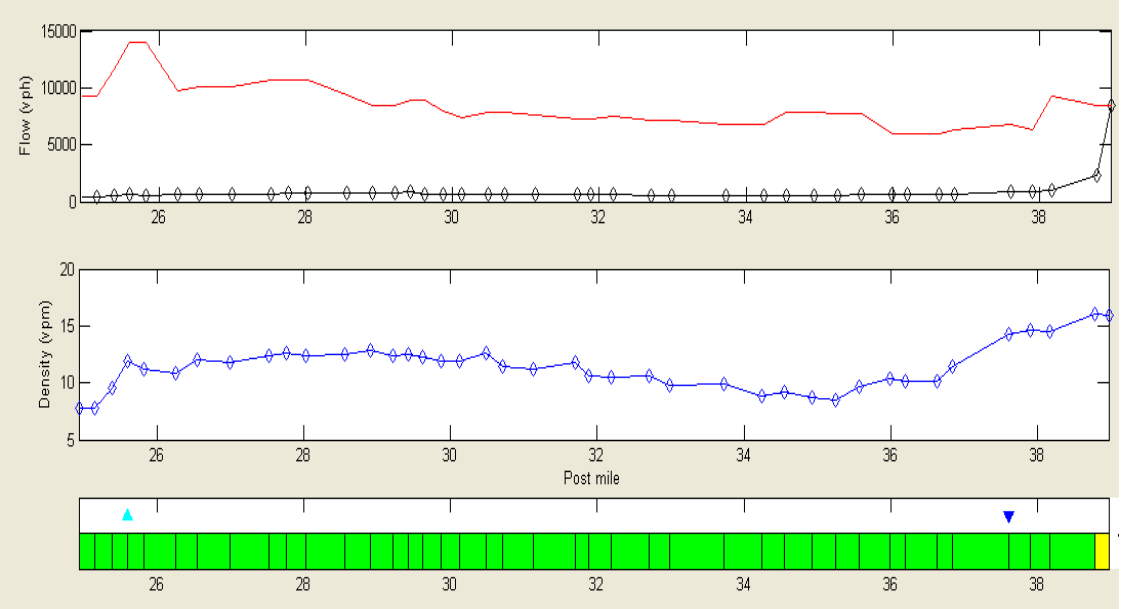


Figure4.Waveform of density and flow for flow =108(vph), split ratio = 0.16224

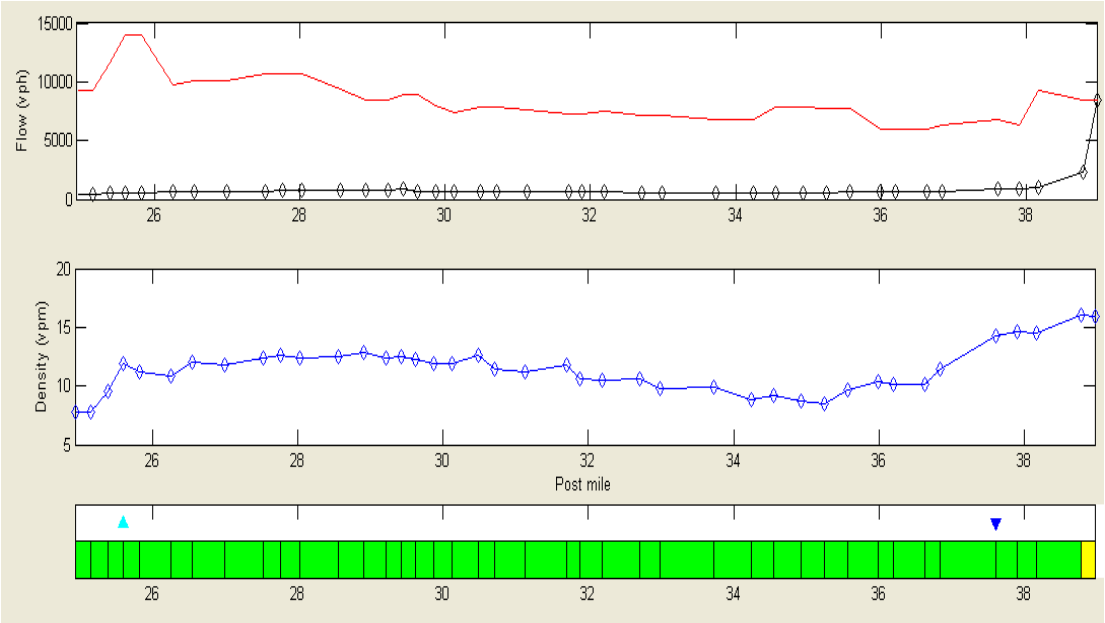


Figure5.Waveform of density and flow for flow =132(vph), split ratio = 0.25224

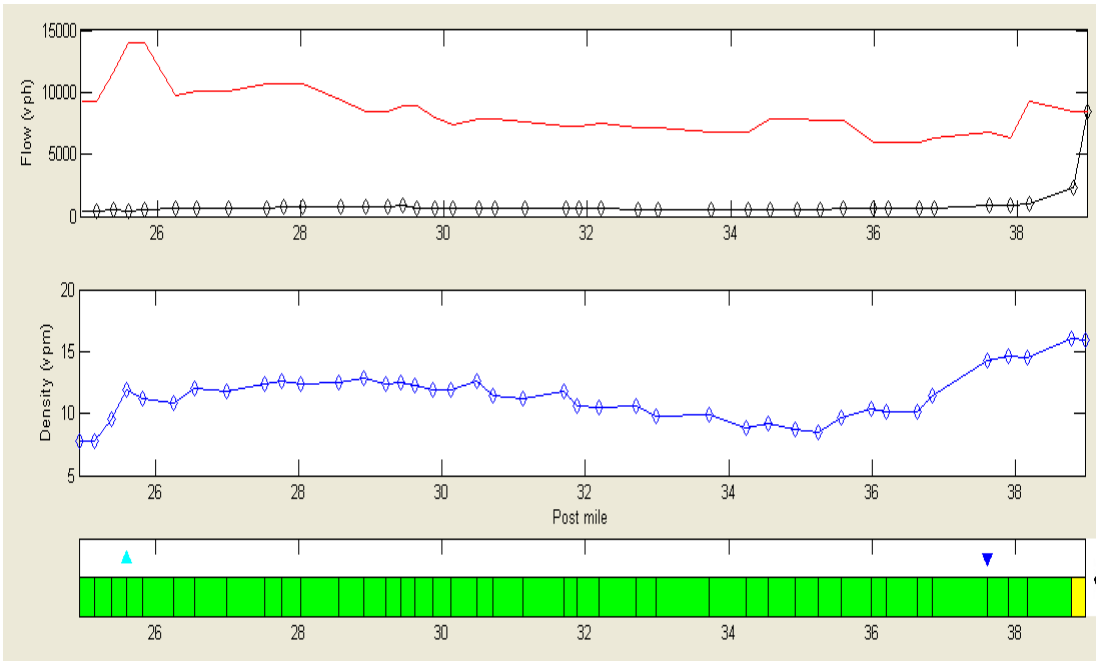


Figure6.Waveform of density and flow for flow =132(vph), split ratio = 0.50224

All the above waveform will shows that when density and flow parameter will change then that will change the green signal time. Only single parameter is also capable of changing the green signal time depending on the traffic flow and density at present time.

So we will get the following result by fixing traffic flow and changing the value of split ratio in the range 0 to 1:

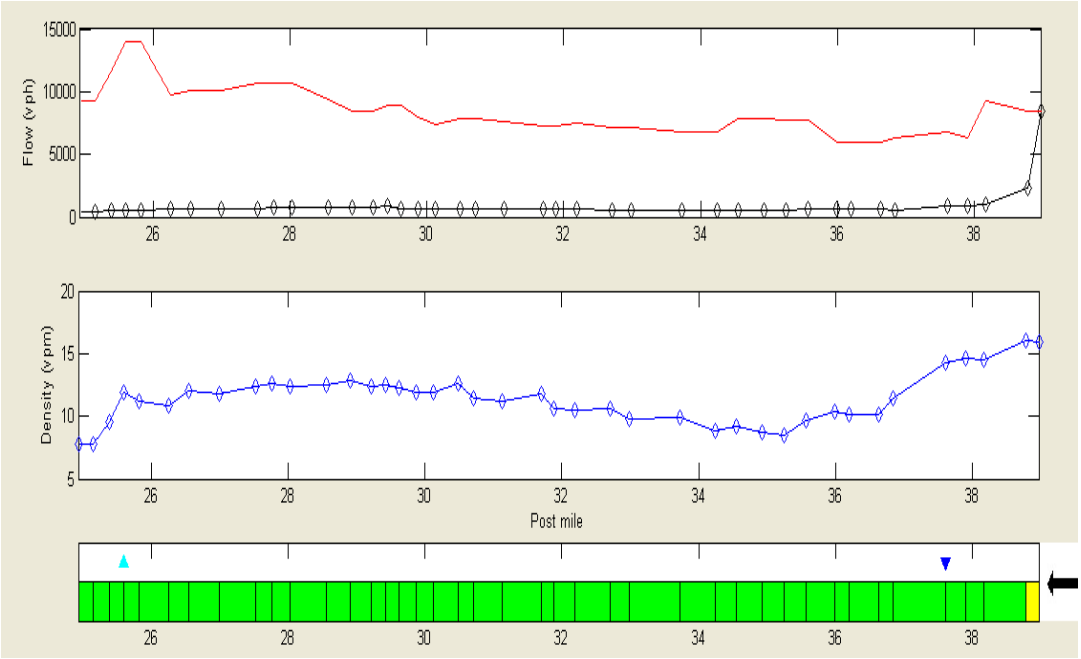


Figure7.Waveform of density and flow for flow =60(vph), split ratio = 0.25224

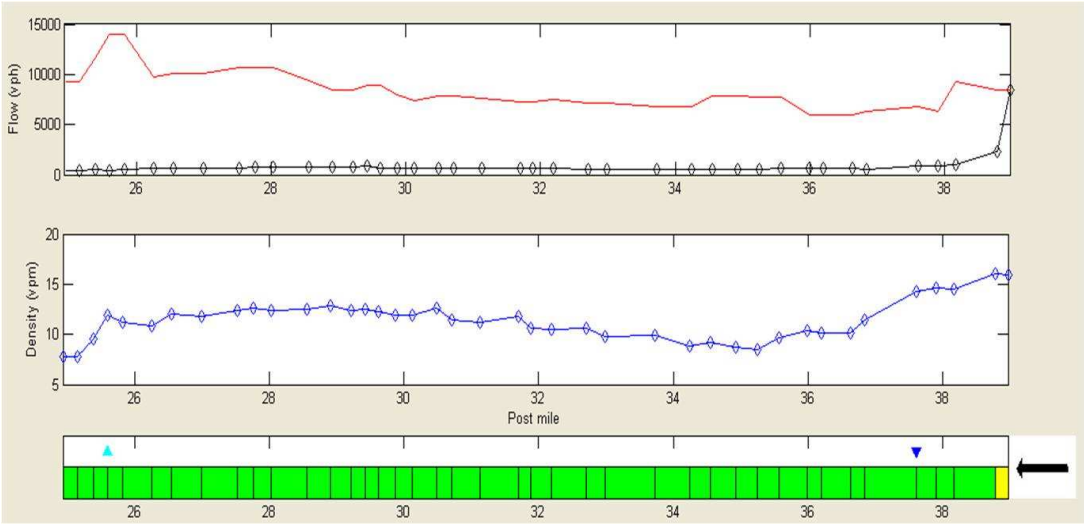


Figure8.Waveform of density and flow for flow =60(vph), split ratio = 0.50224

Snapshot of Hardware:

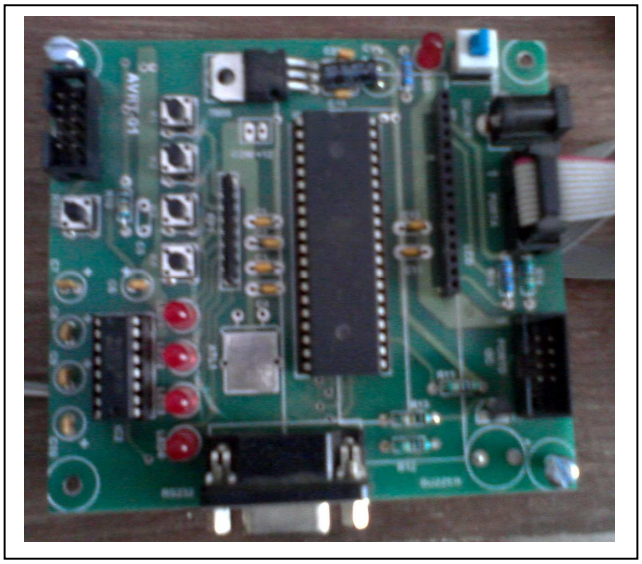


Figure9. AVR 32 Microcontroller Kit

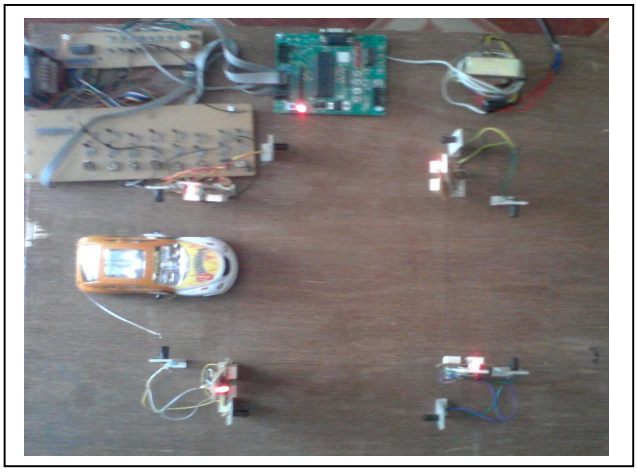


Figure10. ITSC system (Upper view)

Figure11. ITSC system (Side view)

5. Conclusions and Future Work

In this paper, an evolutionary approach to estimate the traffic volumes of road networks has been proposed, in which real time traffic information is not provided. Genetic algorithm was used to estimate the unknown traffic volumes for such road section whose traffic information not available. Present work considered a simple road sections under static environments.

In future work, we will use real dynamic road section to estimate the unknown traffic volumes and apply to real traffic. When more than one emergency car came then most of the system fails. They give green signal to both which lead to traffic conjunction problem and also leads to accidents. In ITSC system, this problem solve by giving red signal to all traffic and only emergency cars will pass the signal for particular time period.

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