A Smart Traffic Congestion Control Method

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Abstract
With the turn of the century, there occurred an explosion of population across the globe. According to the United Nation's Department of Economic and Social Affairs, Population Division of the world was 7.3 billion as of July 1, 2015. This directly led to more number of peoples living in cities. In this 21st century day by day more and more people are dwelling in cities and towns. This has resulted in outburst of traffic in cities. However, not much attention has been paid towards reduction of the traffic congestion. Hence we came up with a proposed model which can minimize the traffic congestion for normal traffic flow. Keeping in mind the modern Indian road, our proposed model would be able to solve the problem of traffic congestion on the junction much more efficiently than conventional traffic system. The whole system is efficient as well as cost effective, and can easily be installed in Indian roadways. The method is quite simple; it senses the load on the road for certain minute at predefined distance and takes the best fitted decision automatically on priority basis, where the priority is defined by the load on the road.
A prototype of the idea has been designed using Proteus software. The prototype has been demonstrated by Hardware which has AT89S52 microcontroller, IR Sensor, counter 74LS390, 7 segment display and LED's(Light Emitting Diode).

Keywords
Traffic System, Microcontroller, IR Sensors, Counter

I. Introduction

In India like country where the total population is approximately 1.27 billion, which is the 17.5% of the world population [1] probability of traffic congestion is very high. In 2011-12 India was the largest manufacturer of tractor, around 1/3 of global output with a total estimated production of 605,000 units. In the same year India was the largest manufacturer of tractor ,around 1/3 of global output with a total estimated production of 605,000 units and also the Construction vehicle production was approx. 48000 in the that year. In 2013 India was the sixth in position in case of motor/vehicle manufacturer. In 2014-15 (Apr-Mar) Indian auto manufacturers produced 23.4 million motor vehicles which was a record. India is the largest manufacturer of three-wheelers i.e. 949000 in 2014-15, the eighth largest commercial vehicle producer (697000 in 2014-15), while the production of two-wheeler reached 18.5 m units in the same year. In 2014-15, 1.88 million Passengers cars were sold in India. In 2014-15 the domestic motor vehicle sales is recorded as [2].

- Passenger Vehicles: 2.60 million units.
- Commercial Vehicles: 0.61 m.
- Two-wheelers: 16.0 m.
- Three-wheelers: 0.53 m.
- TOTAL: 19.75 million units.

From these data we can imagine that the sales of motor vehicle increasing day by day. Also with the increase in number of vehicles in a city causes probability of congestion more. During rush time i.e. morning and afternoon the traffic on the road is highest, which in turn cause the traffic jam/congestion for long period. Many methods have been developed to minimize the congestion level on the road but most of them either costly or less efficiency. Mostly used traffic system are static traffic light and vehicle actuated lights [4]. Some of the existing control system are [5].

- Vehicle actuated control, the drawback in this system is the control algorithm does not take consideration of the number of vehicle waiting at red, only consider the vehicle on green.
- Manual controlling which need manpower i.e. traffic police to control the traffic.
- Edge detection technique, which has disadvantage like in Gaussian based edge detection technique is sensitive to noise, also other drawbacks of edge detection is it required high computation time.
- Automatic traffic light, which is sensor based system. The lights are automatic depending on the predefined time that is set for ON or OFF. In this method waste of time is more due to predefined procedure of how traffic light will work.

Our model is also an automatic control traffic light which overcomes the above mentioned drawbacks. At present the traffic light signal in India works in a process of certain time for each road in a four way junction irrespective of the number of vehicles in different road, which is not the optimum solution to the traffic congestion. . It has been often noticed; inspite of heavy traffic or vehicles on a particular road the light is still red whereas the light on the other road is green with minimum traffic or vehicles. So, seeing the present condition we are motivated to develop a smart traffic control system which sense the load on the road for certain duration of time and takes the best fitted decision according to the highest traffic on the road. In this paper we propose a design of a smart and fully automatic system which detect traffic congestion in real time and Management of the congestion efficiently to ensure smooth traffic flow with the use of active optical detection technology. Our designed traffic system, acts according to the traffic load on each side of the four way junction. The system act on priority basic to decide which side need to be green depending on the side having more traffic with the help of IR sensors.
We have successfully implemented our system in software as well as hardware. We also install a camera in the junction to monitor the violation of traffic rule, violence, traffic load etc.

II. Traffic System

Modern traffic controller assumes equal traffic density on each side of a four way junction road. These days, traffic lights are typically pre-programmed, but traffic is variable, and unforeseen events like congestion can through that off. Our ultimate goal is to minimize congestion for smooth running of traffic with low cost and high efficiency. In a four way junction the traffic lights works on circular fashion. For e.g.: suppose traffic light is green first for west side for certain duration of time then the green light of north – south – east respectively will be on. The duration for green and red light to be on is same for all the side. There may be many situation arise which prove that conventional traffic is not efficient to handle the traffic congestion. Suppose south side's

green light is on and all other side red light is on. Now there may be a situation as shown in Fig.1 that in South Side there is less traffic but green light is on and in the other two side suppose east and west side there is heavy traffic but red light is on. North side normal traffic, red light is on. But due to the predefined rule the east side vehicles have to wait until South Side does not become red i.e. the duration of South Side green light and West Side have to wait duration of south side plus East Side.

Thus the vehicle which are on the east and west side are have to wait inspite in those side traffic is high, which is waste of time and also shows the disadvantage of the conventional traffic system. . We have made a system which overcome this drawback and act according to the load on priority basis.

III. Proposed Model

In normal traffic condition we have taken that the green light will on in a fashion West – North – South – East - West. For our convenient we have taken that the duration of green light, red light will on for 30 seconds as shown in Fig.2. It can be understood that at first the West Side green light is on and in all other side's red light is on for duration of 30 seconds. After 20 sec the green light of West Side and the yellow light of North Side will start blinking for 10 seconds to indicate the drives that next within 10 seconds

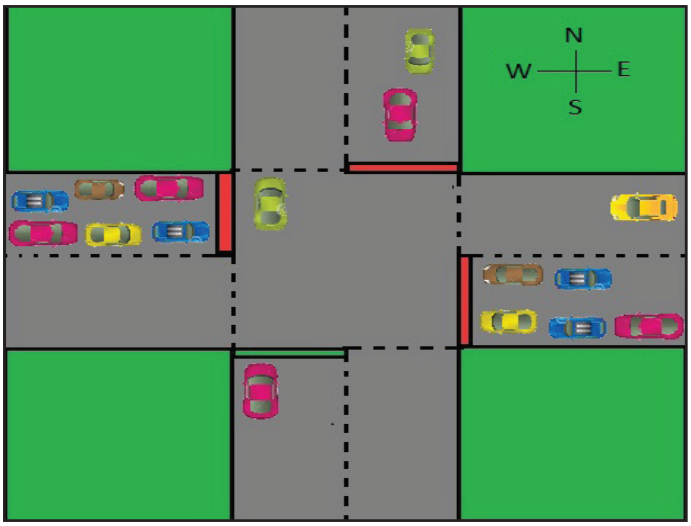

Fig. 1: Situation of Having Heavy Traffic

West Side road is going to be closed and North Side road is going to be open. In this case the driver know which road is going to be open or closed and according to that they can stop or start engine before certain time which save the fuel and also the environment from pollution. After compilation of 30 sec the green light of West Side go off, red light will on, in North Side red and yellow light will off & green light will on and rest of the side remain same as earlier. Same procedures will flow for rest of the side i.e. South and East and again West side and this way the traffic will flow in normal condition. To solve the earlier said problem in conventional traffic system in our proposed model we have used microcontroller, counter, seven segment display and IR sensors. The microcontroller is programmed to perform the entire task on the basis of the data that it has got from the IR sensor. Fig.3 shows the block diagram of our proposed model.

Directions ---------->		WEST SIDE			NORTH SIDE			SOUTH SIDE			EAST		
No.	Time	WR	WY	WG	NR	NY	NG	SR	SY	SG	ER	EY	EG
1	For 20 seconds			G	R			R			R		
	For 10 seconds blinking of green and yellow			G		Y		R			R		
2	20 seconds	R					G	R			R		
	For 10 seconds blinking of green and yellow	R					G		Y		R		
3	For 20 seconds	R			R					G	R		
	For 10 seconds blinking of green and yellow	R			R					G		Y	
4	For 20 seconds	R			R			R					G
	For 10 seconds blinking of green and yellow		Y		R			R					G

Fig. 2: Working in Normal Condition of Proposed Systrm in Normal Conditionl

From the block diagram it can be seen that IR sensors send information directly to the microcontroller and microcontroller initiate the counter and the output of the counter is again feedback to microcontroller to initiate the traffic signal which is best fitted. Fig. 4 shows the deployment model of our system.We have placed a IR sensor at a certain distance say 100 m from the junction on both side of a road i.e. transmitter in one side and receiver in other side to all the road means North, East, West, South Side road.

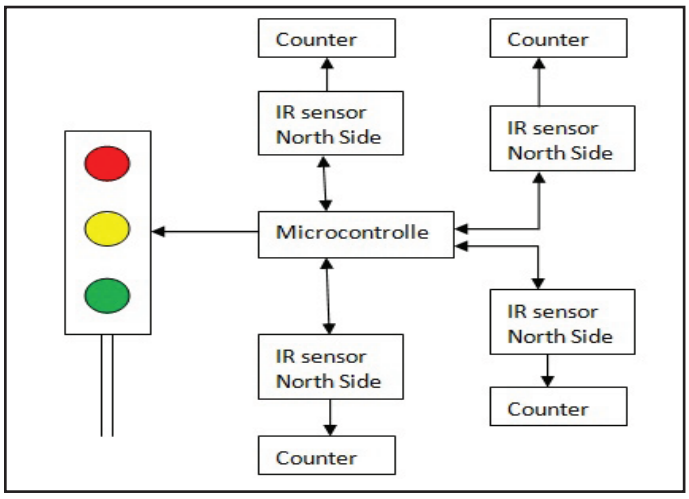

Fig. 3: Block Diagram of Proposed Model

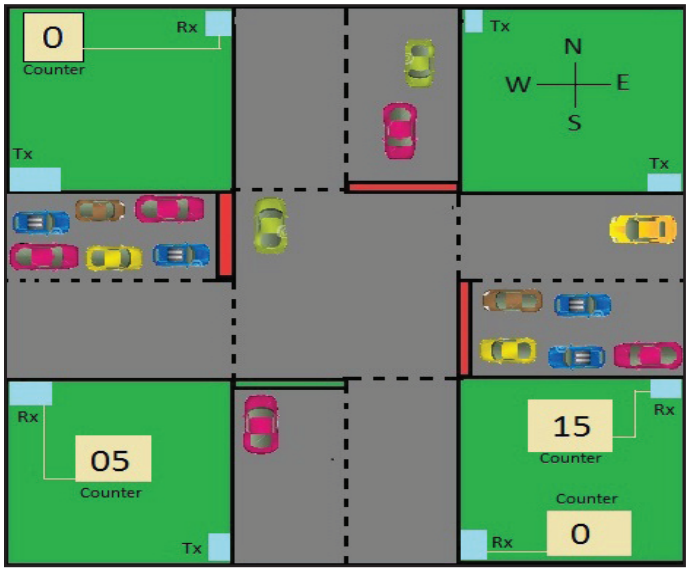

Fig. 4: Deployment Model

We have used four pair of IR sensors i.e. one pair for each side. We have connected one counter to each IR sensor i.e. four counter for four IR sensors.

IV. Description of Our Model

When there is no obstacle (vehicle) between IR transmitter and receiver, they are continuously transmitting and receiving signal. In this case the traffic works as per the normal condition. But when there is obstacle between the IR transmitter and receiver, the counter starts counting. For our convenient we have taken that the counter will count up to 30 sec and stop counting. When the counter counts 30 sec than the green light of the side in which the counter belongs will on and all other sides red light will on, also when the counter counts 20 sec the yellow light of the side that belongs the counter and the green light of the current road that is open start blinking to indicate within 10 sec this side road will be open and closed respectively. Fig.5 shows the flowchart of our model.

In our system we have considered some special case to make sure that the traffic goes smoothly without any congestion.

The special cases that we have considered in our proposed model are:

1. What will happen when at the same time two or more IR sensors encounter obstacle and two or more sides' counter starts counting at the same time?
2. What will happen when any one side of the road is green and the duration of green light and the side which is to be green starts blinking its yellow light but in the mean time in some other side the counter finish its count up to defined time?
3. What will happen when a vehicle stops in between IR sensor or when the speed of the vehicle is low and it passes through the IR sensors and the counter start counting?
4. What will happen when a Vehicle intentionally stops between IR sensors?

We have considered these special cases and developed our system to overcome these types of situation. when at the same time two or more IR sensors encounter obstacle and as a result counter starts counting then the microcontroller check in conventional way which side suppose to get next green light between or among the roads that have encountered obstacle that side's green light will be made on and all the counter is set to zero and start counting again. If same case again occurs then same procedure is followed.

In second type of special case the microcontroller stops the blinking of yellow and green light as soon as the counter of ay side counts up to specific limit and the microcontroller made that side open and all other roads closed. Also in this case the microcontroller reset all the counter and starts counting again so that this type of situation can be avoided again in queue.

In third case whenever a vehicle stops between IR sensors for 1 second then the counter start counting but when the vehicles goes forward or backward from the line of sight of IR sensors then the counter automatically reset to zero.

Now for the fourth case generally car stops at the beginning of a junction and other vehicles comes one after another and form a queue and reached up to the IR sensors then the counter starts counting and the whole process works.

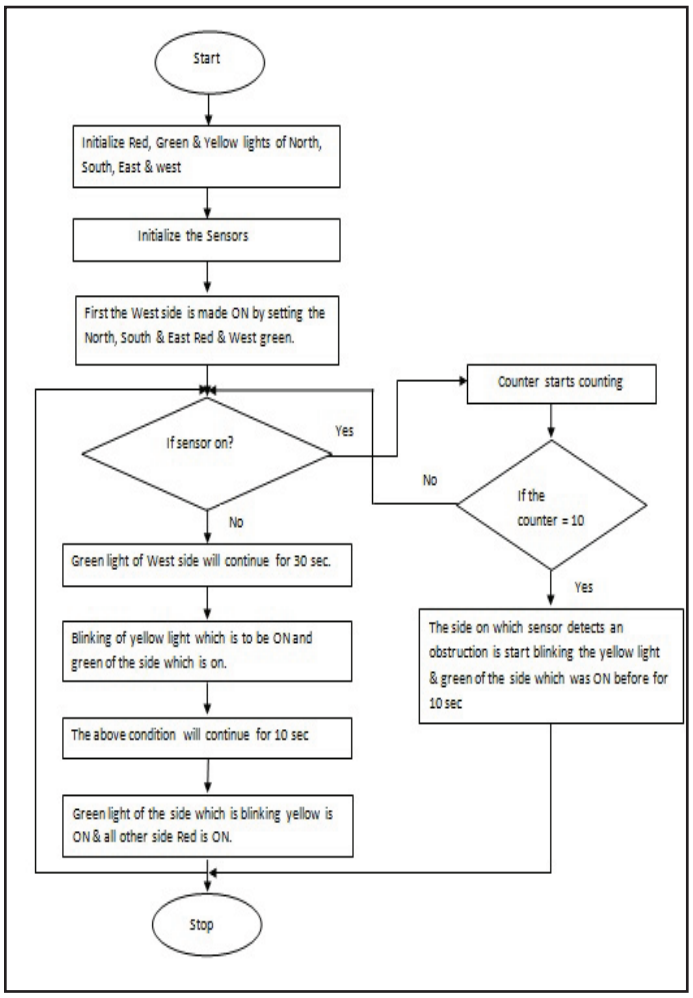

Fig. 5: Flowchart of Proposed System

But in a case as mentioned in number 4 to avoid such type of scenario we have installed security camera in the junction. The camera can act as an eye to monitor the activity on the roads, smooth flow of traffic, violence, accident and also some unusual activity.

V. System Design

We have implemented the design both in hardware and software. We have used AT89S52 Microcontroller, IR sensors, Counter, LEDs (Red, Green & Yellow color). We have first write the code then convert it into hex file then we have design hardware part in simulation software, burn the code in microcontroller, run the system successfully and then implemented in hardware.

A. Software Simulation

The simulation of the code is done in KEIL Software. Keil MicroVision is an integrated development environment used to create software to be run on embedded systems (like a microcontroller).We have written the code in c. In Keil software we can check the output in input/output ports which are available in microcontroller. We can directly create the Hex code file for the code that is written. In the Fig.6 port 1.0, 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 3.0, 3.1, 3.2, 3.3 are the ports which are connected to the traffic lights. And the port 2.0, 2.1, 2.2, 2.3 are ports which are connected to the sensors.

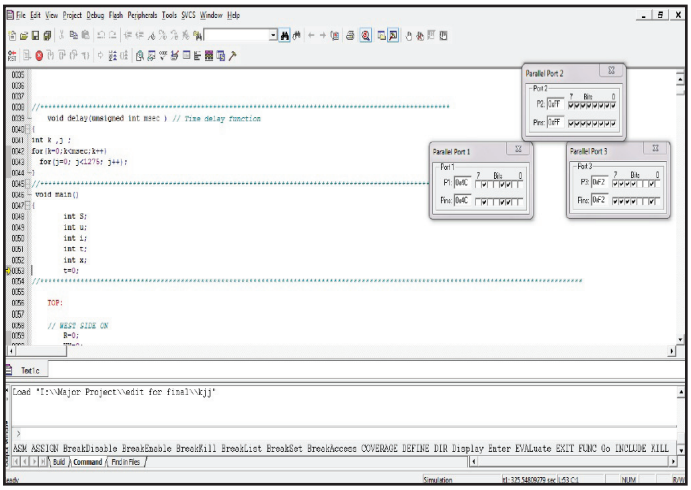

Fig. 6: Coding in Keil Software

We used Proteus software to visualize the working of the hardware in software. In which we have connected all the necessary hardware part with the microcontroller such as traffic lights, counter, IR sensors and all necessary hardware that is needed to work the model.

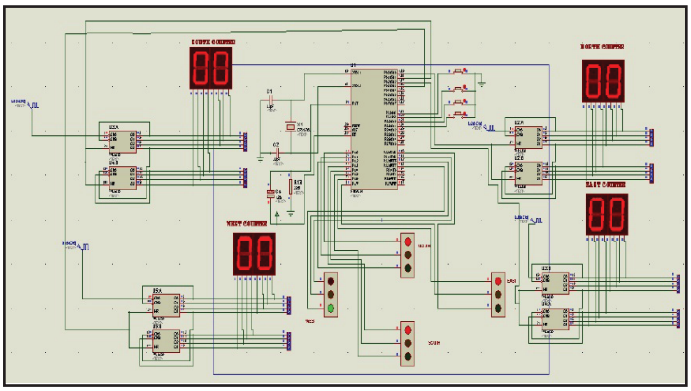

Fig. 7: Full Hardware Implementation in Proteus

Fig.7 gives the Proteus design part of hardware of our system. In the Proteus software and Fig.8 shows when there is obstacle between sensor counter starts counting, we burn the hex code file that is generated in the Keil software to the microcontroller and the total system performs as per the code written and exactly same behavior with hardware.

B. Hardware Implementation

As per the design that are implemented in Proteus software we design the same way in the hardware in a digital kit with microcontroller AT89S52,& segment display, led lights (red, green and yellow), IR sensors, amplifier. We have demonstrated the system and the hardware part performs perfectly. The smoothness of the system is very good and the cost involved in hardware part is very less.

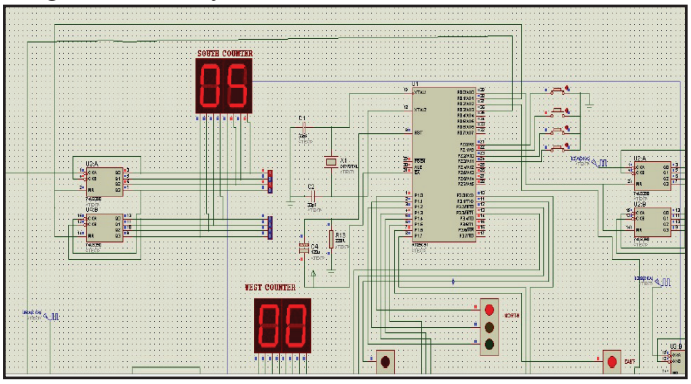

Fig. 8: Counter Starts counting when there is obstacle beetween sensor

VI. Conclusion

We have implemented the system both in software as well as hardware. The hardware simulation has been carried out in Proteus to validate the performance of the proposed system. The system has been implemented in real hardware with low cost and high efficiency to control the traffic congestion in Indian roadways. A security camera has also been installed at the junction. However there can be further more up-gradation in this system which would minimize the traffic congestion further. Some of the possible ways are video data analysis of cars which pass through that junction, use of wireless sensor network, radio frequency identification.

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