Design and Implementation of Portable Traffic Light Control System

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Abstract—The idea behind this project is to design and implement a Portable Traffic Light Controller using embedded system platform. Nowadays, due to increase in the population in cities, the number of automobiles have also increased rapidly. Also, due to large time delays between the traffic lights, the problem of traffic congestion is rising. In addition to this all smart traffic light projects require expensive sensors and are not practically effective in implementation as in high density country like India most of the cities and towns are unplanned. In order to overcome these problems and for smooth traffic flow, a practical traffic controller is required. The standard traffic light systems follow a set amount of time for all the lights, i.e. red, green, and yellow. However, in case of emergency or high traffic density from one side, the duration of these lights pose a great hindrance in the smooth flow of traffic thus causing highly crowded traffic on the road with very less go ahead time. In order to remove these problems, a smart control system has been designed in order to switch the lights from automatic to manual mode where light delays could be changed as per the traffic density on the roads. This traffic light control system is portable, easy to implement, cost effective and field deployable as compared to other bulky controllers.

Keywords—Traffic Congestion; Microcontroller; Density based Traffic; Safety and Convenience

I. INTRODUCTION

Due to rapid increase in the number of transport and personal vehicles in a country like India, the roads have become more crowded and resulting in more traffic congestion. The exploitation of new trends and technologies requires fast transportation of goods, machinery and manpower for various reasons [1]. The goal of every person is to reach at destination without wasting time and money. But due to limited number of resources provided by current infrastructures, this is not possible.

Also, the traditional traffic control signals fails in time management, because it allocates equal time intervals to each road it is managing. This creates unnecessary waiting for the drivers, which could not be endurable in every case, as being in time, is important to everyone [2]. Nowadays one of the major problems faced in any metro city is traffic congestion [3]. Getting stuck in between heavy traffic is a problem for each and every person driving the vehicles and even to the traffic police controlling the traffic [4, 5]. In case of high traffic, generally, the traffic is generally controlled by a traffic policeman standing in the middle of the road and such traffic police is deployed in all the junctions along the road and controls the flow of traffic through hand signals.

However this was quite cumbersome and after this came the requirement for a different type of control - using Traffic Light Control Signals [6]. Conventional Traffic signal with same time slots started playing important role in cities, but as time passed, due to increase in population in cities and thus the road traffic, this system became lesser efficient in managing the traffic. This called the need of traffic control signal which works more efficiently [7, 8]. This led to the design and development of smart traffic light control systems based on density of traffic. In these smart traffic light systems, the time is allocated for each road depending on the density of traffic on it [9].
Also, in case of emergency through a signal override as compared to the conventional timing cycle. This part is used basically when there is an emergency situation like ambulance, fire brigade stuck in the traffic [10].

In this project, a Smart traffic light control system has been designed and implemented to tackle the problem of traffic congestion due to high density traffic on a road and also to give "go ahead" signal to emergency vehicles like an ambulance or a fire brigade. This smart traffic light control system incorporates the following features:

- Simple and easy to implement
- Cost effective
- Portable design
- Easily deployable
- Robust

This smart traffic light control system uses a microcontroller for making the decisions when input is taken from the user. It then generates a control signal to increase the time of a particular side of traffic lights for passing the complete traffic and then simultaneously stopping the traffic on other sides of the road. This is called the manual mode where a control person sitting in the area switches the controller on manual mode to vary the timings of the road traffic lights based on high density traffic or emergency vehicles and then turns it back to automatic mode with standard equally placed time slots for each light when the traffic reduces.

II. LITERATURE REVIEW

[1] Vishakha S. Thakre et.al has proposed the design of a smart traffic light controller using embedded system that could provide dynamic time interval for traffic lights according to the length of vehicles present at each lane. It also handles the occurrence of emergency vehicles by making the all the signals red other than the one from where the emergency vehicle is approaching. Also, the proposed system also facilitates user with the GSM technology by sending the information of traffic congestion as an SMS on the mobile phone network. [2] Prathmesh Nikam et.al has proposed a density based traffic control signal, which allocates different time slots to each road according to vehicle density on it and therefore doing time management function. This system also comes with RF signal override control in case of emergency vehicles such as fire brigade, ambulance, etc. So this is also a priority based system and offers various advantages over existing conventional traffic light system. [3] Saiba P A et.al have used IR sensors for measuring the traffic density on the road with three IR sensors on each road having variable distance between them proportional to the amount of traffic. Based on the signals received by these sensors, the PIC microcontroller sets up the delay for the lights. The existing traffic signal system is implemented with delays where the signal transition time slots are fixed and do not depend on current traffic flow. The existing traffic system needs to be upgraded to solve the severe traffic congestion problems. Also, they have proposed a simple, low-cost, and real time traffic signal system that aims to overcome many problems and improves the traffic system. The system is based on PIC microcontroller that evaluates the traffic density using IR sensors mounted on either sides of each road and dynamic timing slots with different levels. [4] K. Vidhya et.al have also presented a density based traffic light control system. In this system, the signal timing changes automatically on sensing the traffic density at the junction using image processing technique. Conventional traffic light system is based on fixed time concept allotted to each side of the junction which cannot be varied as per varying traffic density. Junction timings allotted are fixed. Sometimes higher traffic density at one side of the junction demands longer green time as compared to standard allotted time. The image captured in the traffic signal is processed and converted into grayscale image then its threshold is calculated based on which the contour has been drawn in order to calculate the number of vehicles present in the image. After calculating the number
of vehicles, it is estimated that which side the density is high based on which signals will be allotted for a particular side. Raspberry pi has been used as a microcontroller which provides the signal timing based on the traffic density. [5] Faruk Bin Poyen et.al has designed a density based dynamic traffic signal system where the timing of signal will change automatically on sensing the traffic density at any junction. Traffic congestion is a severe problem in most cities across the world and therefore it is time to shift more manual mode or fixed timer mode to an automated system with decision making capabilities. Present day traffic signaling system is fixed time based which may render inefficient if one lane is operational than the others. To optimize this problem, a framework for an intelligent traffic control system has been proposed. This is achieved by using proximity Infrared (PIR) sensors. Once the density is calculated, the glowing time of green light is assigned by the help of the Arduino microcontroller. The sensors which are present on sides of the road will detect the presence of the vehicles and sends the information to the microcontroller where it will decide how long a flank will be open or when to change over the signal lights. [6] Bilal Ghazal et.al has designed a traffic light control system to realize smooth motion of the cars on the roads. The proposed system evaluates the traffic density and calculates the appropriate time slots for each traffic lights in order to overcome the problems of the mutual interference between adjacent traffic light systems, the disparity of cars flow with time, the accidents, the passage of emergency vehicles, and the pedestrian crossing are not implemented in the existing traffic system.

III. MOTIVATION

The rising problem of traffic congestion on the roads due to increasing number of vehicles have led to a chaos condition on roads especially at the peak hours of working days. This problem also creates a headache in the mind of the people driving the automobiles who are stuck in a traffic jam due to high density traffic on roads and lesser outflow of the vehicles. This problem has been raised due to conventional fixed time slots between various traffic lights. It is highly required that today's traffic system needs to be smart enough to tackle these problems and ensure a smooth flow of traffic on the roads with even lesser congestion at the peak hours. This could be achieved only by implemented more flexible and smart controllers with the traffic lights and a fast and accurate means of determining the traffic. Also, most of the presented traffic light control systems in the literature review are complex and based on sensors. They usually miss the amount of traffic present or give a wrong reading due to limitations of the range of operation and low accuracy. Further, highly accurate and long range sensors are generally very costly and difficult to implement on all the roads. So, this proposed design of manually switching the control system to manual or automatic mode by means of a traffic policeman seems more economical and easy to implement. It also does not removes the requirement of traffic police at most of the junctions thereby not effecting the employment of traffic policeman that was otherwise not required in sensor based designs. Thus, it is required to come up with the design that is socially and economically viable to implement in a nation like India.

IV. PROBLEM FORMULATION AND OBJECTIVES

The problem was to design and implement a smart traffic light control system to overcome the problems of traffic contestation due to high traffic density on one side and remove the situations generating traffic jams.

Some of the main objectives of the design are as follows:

- To make the design simple and easy to implement in real time.
- To improve the flexibility of working and easy adaptability to the present situation of traffic.
- To make the controller robust and more accurate.
- To make the design portable and field deployable.
- Finally, to reduce the overall cost of the design.
V. DESIGN METHODOLOGY AND EXPERIMENTAL SETUP

The system was designed to be simple and the experimental setup included the prototype model of traffic lights showing lights from the four sides of a junction. The model included a pole with three traffic lights each on the four sides; depicting red, yellow and green colours. These are designed using colored bulbs of red, yellow and green colour. The input signal was given through four different switches to control the timings of four directions. The experimental setup is depicted in figure 1.

![Figure 1: Experimental setup for smart traffic light control system](image)

The picture in figure 1 represents the designed experimental setup for the implementation of traffic light control system. It shows various coloured bulbs (red, yellow and green) used as the traffic lights. The mechanical framework included the fabrication of a long pole fixed on a stable based both made of mild steel. The connections to the bulbs was made with the help of ribbon wires from a circuit placed separately on the board with the designed PCB's of various parts of the project. The circuit used in the project is depicted in figure 2.

![Figure 2: Circuit of the Smart Traffic light control system](image)
The circuit was designed on different printed circuit boards placed on a wooden board as depicted in figure 2. It incorporates a Transformer to step down the power supply. The output of the transformer is connected to a rectifier and voltage regulator circuit thus making the power supply. This power supply is regulated in terms that it removes any fluctuations in the output in case of changes in the mains voltage.

The output of the power supply is around 5 V DC and that of the rectifier circuit is 12 V DC. The rectifier output drives the microcontroller circuit that is 8051 microcontroller fitted with the crystal oscillator circuit and reset circuit. There is a Max232 circuit also for serial interfacing with the 8051 microcontroller while programming. There is also a circuit for input using four tactical switches. These switches could be pressed by the traffic policeman in case of emergency situation or in case of high density traffic on a particular side that will generate a longer duration "on" signal by turning on the green light for more time and turning all the other direction signals red simultaneously.

When the traffic density reduces or when emergency vehicle passes on, the system converts back to normal mode that is run automatically with equally spaced time intervals for all the traffic lights. The output of the microcontroller is given to the relay driver unit that increases the current in the output to drive high voltage relays in the output. The circuit uses a total of 12 relays for the 12 traffic lights. The circuit diagram of the system is depicted in figure 3 and block diagram of the system is depicted in figure 4.

![Figure 3: Schematic diagram on Proteus Workbench](image-url)
As depicted in figure 4, the power supply unit drives the power to the entire circuit. Microcontroller unit receives the signal from input switches about the traffic density for a particular direction and then generates a sequence of commands to increase the output of that particular direction while keeping the others stop. After the circuit is triggered to automatic mode, it works normally with equal time slots.

VI. RESULTS AND DISCUSSIONS
The simplicity of this portable traffic light control system gives us the opportunity for direct implementation.

Case 1-Normal operation.

During normal operation, portable traffic light controller works as conventional traffic lights. First lights on side 1 turn green for 30 seconds (can be programmed as desired) and all other sides are red. Vehicle coming from side 1 can either go straight or turn right. After 30 seconds green light on side 1 turns OFF and yellow lights on side 1 and 2 turn ON respectively. On side 3 and 4 red lights

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**Figure 4: Block Diagram of smart traffic light control system**

**Figure 5: Portable traffic light controller during normal operation**
continue to remain ON. After 5 seconds (can be programmed as desired) the yellow lights on side 1 and 2 turn OFF. Simultaneously green light on side 2 turns ON and red light on side 1 turns ON. Vehicles coming from side 2 can now either go straight or turn right. Hence this process goes on and on.

**Case 2**-Manual input mode.
Suppose an ambulance is coming from side 1 but lights are red on side 1. Then a traffic policeman can clear ambulance’s path by turning the green light on side 1 ON. This can be achieved just by pressing switch 1. As soon as the policeman presses switch 1, instantly the yellow lights on all sides turn ON. In 5 seconds (programmable as desired) green light on side 1 turns ON. Simultaneously all yellow lights and red lights on remaining three sides turn OFF and ON respectively. After 20 seconds (programmable as desired) green light on side 1 turns OFF and the portable traffic light controller goes back to normal mode as before. Policeman can click same switch multiple times to give more time to ambulance. Similarly same can be done for sides 2, 3 and 4. Manual input can also be used when there is heavy traffic on either of the sides.

![Portable traffic light controller during manual input mode](image)

**REFERENCES**


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