Webology (ISSN: 1735-188X)
Volume 16, Number 1, 2019

Smart Traffic Signal Control System: Design And Implementation

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Abstract- Currently used microcontroller and microprocessor-based traffic light controllers (TLC). Because it operates in accordance with a programme that lacks the flexibility of adjustment in real time, this TLC has limits. The waiting time is longer and the car uses more fuel as a result of the predetermined time intervals between green, orange, and red signals. There is a new method called "Smart Traffic Signal Control" to make controlling traffic lights more effective. This novel method combines embedded technology with sensor networks. Red and Green light timings at each intersection will be intelligently chosen based on the volume of traffic on all nearby roads. As a result, optimising traffic light switching boosts road capacity and traffic flow and helps avoid traffic jams.

Keywords- Embedded System, Micro-controller, IR sensors, RFID, Traffic Control, Blockage.

1. INTRODUCTION

The current transportation system must be improved in terms of traffic flow and road safety, so we must use automation and clever construction techniques on the infrastructure along the roadways. Smart traffic control will become an essential issue in the near future due to the limited resources offered by the current infrastructure. The current transportation system has issues like heavy traffic jams and fixed signal timings that require waiting even when there is no traffic.

The objective of traffic study is to maximise the flow of both people and products. Intelligent traffic control will become a crucial issue in the future as resources given by current infrastructures are constrained and the number of road users continues to rise. However, there are some restrictions on the application of intelligent traffic control. For instance, avoiding traffic congestion is regarded to be good for the environment and the economy, but improved traffic flow may also raise demand. There are numerous models for simulating traffic. Our study focuses on the optimization of a city's traffic light controller employing an IR sensor and controller 16F877A for monitoring. Optimization of traffic lights is a challenging issue. There might not even be an evident best solution for single junctions. When there are several junctions, the issue is made even

more difficult since the status of one light affects how traffic moves towards numerous other lights. The fact that traffic flow is always variable based on the time of day, the day of the week, and the season is another challenge. Complexity and performance are further impacted by roadwork and accidents. In this paper, we propose two methods: the first method involves calculating the controller/vehicle density and changing the signal timings accordingly; the second method involves collecting data from objects, subjects, and vehicles, processing it using a computer and a microcontroller, and then displaying the results on a traffic light signal to operate the system.
The problems of typical conventional traffic light Controller are mentioned below

- **Heavy Traffic Jams with increasing number of vehicles on road:** Major cities now experience significantly more severe traffic congestion. This typically occurred at the major intersections early in the morning before business hours and late at night after business hours. The primary outcome of this issue is an increase in the amount of time drivers waste. The programme with varied setting delays for different junctions is the solution to this issue. The delay for intersections with heavy traffic should be configured to be longer than the delay for intersections with light traffic. Normal Model is being called by this operation.
- **No traffic, but still need to wait:** People may have to wait at particular intersections even when there is no traffic. Road users should wait until the light turns to green because the traffic signal will remain red for the predetermined amount of time. They must pay a fine if they run a red light. The development of a system that tracks traffic flow on each route and establishes timetables is the answer to this issue.
- **Rules followed, to avoid accidents:** When a car violates traffic regulations, such as by crossing a red light, it is photographed, its number plate is read using optical character recognition technology, the owner's mobile phone information is collected, and a warning message is sent. The technology will analyze the vehicle's number plate and send it to the nearby police control room if, for example, the same vehicle is detected and identified the following time.

The issue of traffic congestion has had a significant negative influence on the nation's transportation system. This leads to a lot of issues, particularly when there are emergencies at major crossroads with traffic lights. To address these issues, a traffic light controller system has been developed. Drivers, pilots, railway engineers, and ship captains depend on traffic control to construct a system of rules and instructions that help them avoid collisions and other dangers. Motorists depend on traffic control equipment to avoid collisions and proceed safely to their destinations. For highway travel, traffic control devices may be placed on, over, beside, or even under the roadway. These include signs, signal lights, pavement markings, and various other objects. Probably the most recognisable traffic management equipment is the signal light. A traffic signal may manage the movements of more than 100,000 vehicles each day at a busy intersection in a big city. Less than 30% of all annual kilometres travelled are on roads with traffic signals in

place. Traffic signs indicate to moving traffic and pedestrians when to go, halt, or move carefully. The majority of crossroads can handle more traffic thanks to the lights. They may connect to a computer-controlled system that runs over multiple intersections or operate independently on timers. Traffic detectors are positioned at various points—typically in the pavement—in a computerized system.

2. Literature Review

"In 'Dynamic Traffic Signal Timing Optimization Strategy Incorporating Various Vehicle Fuel Consumption Characteristics' paper proposes a dynamic traffic signal timing optimization strategy (DTSTOS) based on various vehicle fuel consumption and dynamic characteristics to minimize the combined total energy consumption and traffic delay for vehicles passing through an intersection. The proposed timing plan was compared with consistent results were obtained" [1].

"In 'SmartRoad: Smartphone-Based Crowd Sensing for Traffic Regulator Detection and Identification' article they present Smart Road, a crowd-sourced road sensing system that detects and identifies traffic regulators, traffic lights, and stop signs. The resulting traffic regulator information can be used for many assisted-driving or navigation systems but limitation is the mobile crowd sensing paradigm is quickly raising interests and funds" [2].

"There's a huge increase in car user's day by day, Traffic blockings and traffic jams have become very common these days. In this paper, an arrangement for the traffic in highways is estimated by image processing method has been proposed. This Paper will be implemented by Mat lab software and it aims to anticipate abundant traffic in highways" [3].

3. Proposed System

Fig. 1 depicts the Smart Traffic Light Controller's activities. Vehicles are found using infrared sensors. This serves as the TLC unit's input. Red, Green, and Orange output signals are produced by the ITLC unit. This traffic controller's fundamental functions are carried out by an embedded device. It benefits greatly from simplicity, user friendliness, and ease of programming. This model uses the Microcontroller89c51AT to carry out its fundamental activities. The microcontroller has an adequate number of input and output lines, acceptable RAM and ROM sizes, and a straightforward architecture. The microcontroller AT89c51 serves as the system's brain in our concept. Additional ports and multiplexers are employed to communicate with the external signals. Application programmes make advantage of additional RAM and ROM.

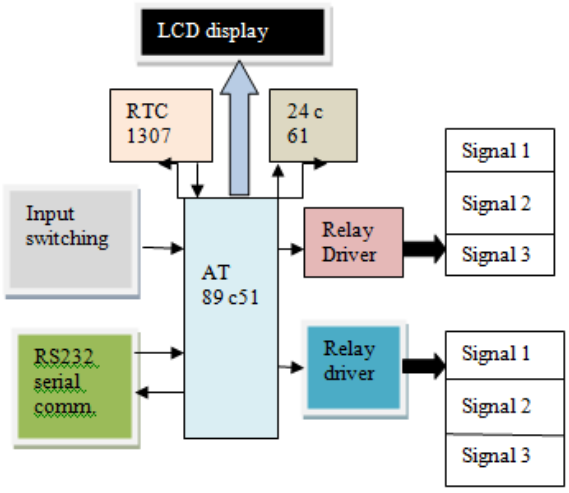

Fig. 1: Block Diagram of Smart Traffic Light Signal

The microprocessor, input switching matrix, serial communication interface, Real Time Clock 1307, clock circuit, Relay Driver ULN 2003, and LED interfacing circuit are all shown in the traffic controller's block diagram. The input switching circuit will receive the signals from the sensor. Digital signals will be used as these input signals. These signals indicate whether a vehicle is present or not. These digital signals will be supplied to the microcontroller's input port, which will use them to calculate the volume of traffic in each lane. The microcontroller will choose the timing signals based on this information. To reduce waiting time, the microcontroller will calculate the on and off times of the four junctions. Two relay drivers will receive these signals. At each junction, Red, Green, and Orange LED are affected by the relay driver's output. I2C is interfaced using IC 24C61. Each signal will come with a single LCD display. A vehicle must wait at a certain intersection for a predetermined amount of time, which is displayed on an LCD display.

Due to the vast amount of data kept in a database, analysis, interpretation, and best use of the data are all exceedingly challenging tasks. As a result, data mining seems to be a very potent method for accessing the data. Data extraction for specific purposes is all that data mining is. One of the many places where vital information about the welfare of society is recorded and stored is the traffic control system. The transportation system is equipped with sensors that gather vast amounts of data in order to support and enhance signal timing operations.

4. Advantages of traffic controller

- Average time of a vehicle waiting

Each car must wait at a certain intersection, however it appears that the smart traffic controller's average waiting time is lower during busy and non-busy hours since it can detect a vehicle's physical presence and adjust the signal timings accordingly. Consequently, there will be less time wasted.

- An increase in signal switching frequency

As opposed to fixed traffic controller systems, smart traffic controllers will switch signals more often. It is a dynamic system because, as signal timings are updated continuously, switching frequency is altered in response to traffic.

Conclusion

A practical and affordable microcontroller-based traffic light system for road intersection control has been successfully shown in this study. The power section, crystal oscillator, light-emitting diode, and programmable integrated circuit (PIC) microcontroller are used to build the traffic light system (LED). The PIC is then implemented for efficient traffic control by an IC programmer using a mikrobasic programme created in Basic language. By building a prototype that resembles the actual application, the designed traffic light control system is put to the test. The prototype's functionality demonstrates that the created system may be utilised to control traffic at a road intersection in the real world. Additionally, the created system can be used as a training tool for understanding traffic light control systems.

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