ISSN (Online) 2394-6849

International Journal of Engineering Research in Electronic and Communication Engineering (IJERECE) Vol 3, Issue 6, June 2016

Remote Override of Traffic Signal in an Emergency

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***Abstract*- Traffic congestion is a severe problem in many major cities across the world, it is very imperative to provide priority to important vehicles. The project is designed to develop a density based dynamic traffic signal system having remote override facilities. During normal time the signal timing changes automatically on sensing the traffic density at the junction but in the event of any emergency vehicle like ambulance, fire brigade etc requiring priority are built in with RF remote control to override the set timing by providing instantaneous green signal in the desired direction while blocking the other lanes by red signal for some time. The proposed system using a microcontroller of 8051 family duly interfaced with sensors, changes the junction timing automatically to accommodate movement of vehicles smoothly avoiding unnecessary waiting time at the junction. The density of the vehicles is measured in three zones i.e., low, medium, high based on which timings are allotted accordingly**

***Keywords* – Override, Microcontroller AT89S52, Traffic control system, Radio Frequency (RF), Infrared (IR) sensing, Density based zones,**

I. INTRODUCTION

Traffic signals are installed when traffic at an intersection becomes too heavy for motorists to efficiently or safely assign their own right of way. Because a traffic signal removes the motorist's ability to coordinate his turn at an intersection, it is considered a more restrictive form of control than uncontrolled or stop-controlled intersections. For this reason, traffic signals are generally regarded as a last resort for intersection traffic control.

1.1 Existing Traffic Control System

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.

Many countries in the world are facing the problem at traffic light intersection that causes accident between emergency vehicle and other public vehicle. The traffic control system in some developing countries is specifically has not been equipped with appropriate method when emergency case occurs. This will cause the emergency vehicles such as ambulances difficult to reach the destination on time because of the traffic congestion. Moreover, the situation is getting worse when emergency vehicles have to wait for other vehicles to give way at intersections with traffic lights. This causes a delay of time and may affect the emergency case.

Besides, the collisions with other vehicles from other direction might occur at intersections when emergency vehicles had to override the red traffic lights. All these difficulties faced by emergency vehicles can be avoided using this traffic light control system based on radio frequency.

Assume the traffic scenario in which only one lane consists of vehicles and other lanes being empty, but still the vehicles need to wait for the signal to turn green. The delay for the vehicles waiting for the signal to turn green is very large, so the solution to this problem is to re-time the green signal if the density on the other lanes is very low. If this solution is not provided to the signals then the tendencies of road disasters may occur such as accidents because if by chance a vehicle arrives from one lane and the vehicles on the other lane don't hesitate to wait for a long time and moves forward, then there is a chance of a disaster. Maximum density of traffic will allow traffic with maximum default timing assigned. It explains that if the traffic density of the lane increases, then the green timing increases accordingly.

Before a traffic control signal is designed it must be determined if the signal is warranted and needed through a review of the volumes, sight lines, accident experience, turning movements, geometry and input from local officials. Once it is determined that a traffic control signal will be installed, it is necessary to perform preliminary analysis to determine geometry, lane arrangement and phasing. The geometric design of an intersection involves several critical decisions about the number and use of lanes to be provided on each approach. Factors to be considered include but are not limited to the functional classification of the roadway; the proximity of nearby signals. Traffic signal control systems benefit the public with improved traffic flow by optimizing available capacity on surface streets. They

achieve this by providing control of traffic by adjusting and coordinating traffic signals at intersections; surveillance by monitoring traffic conditions with vehicle detectors and cameras; and maintenance of equipment by monitoring for equipment failures. However there are certain fundamental steps that are fairly common across these processes. These basic steps include:

1) Identification of transportation needs or problems
2) Identification of potential solutions to the problem
3) Planning and design of solutions to the problem
4) Funding, procurement, and implementation of the solution to the problem

Each step of this development process is briefly described below as it relates to transportation issues that agencies or public works departments involved with traffic signal control may experience.

1.2 Advanced Traffic Control System

Advanced traffic signal control systems provide traffic control through traffic management strategies that are responsive to changing traffic demand and benefit the public with improved traffic flow. Additionally, they are easy to maintain, expand, upgrade, and coordinate with other transportation systems in their region.

1.2.1 Traffic Signl Control System

Effective traffic signal control systems provide control, surveillance, and maintenance functions: control of traffic by adjusting and coordinating traffic signals at intersections; surveillance by monitoring traffic conditions with vehicle detectors and cameras; and maintenance of equipment by monitoring for equipment failures. These functions allow a traffic management agency to service traffic demand, share traffic status with other agencies and with the traveling public, and operate and maintain the traffic signal control system.

1.2.2 Control And Coordination

Traffic signal control systems control signal timing at individual signal controllers to coordinate surface traffic flow. In the most advanced systems, traffic flow information is used as input data by algorithms in traffic control programs which automatically adjust signal timing plans in response to current traffic demand.

1.2.3 Survellience And Monitoring

The most common type of detection device used today is the inductive loop vehicle sensor. An emerging trend in traffic signal control systems is the use of closed-circuit television (CCTV) cameras, possibly with image processing to derive traffic flow data, to enable traffic managers to monitor the video. Information collected in this fashion is used to determine road Developing Traffic Signal Control Systems Using the National ITS Architecture1-4 conditions, identify and verify incidents, and verify traffic information collected through other methods.

1.2.4 Monitor Faults And Malfunctions

An effective traffic signal control system monitors equipment for faults or malfunctions that may affect the system's ability to properly control traffic flow. The objective is to identify system and equipment operational problems and quickly initiate corrective actions and repair responses to return the equipment to its proper operating condition in order to keep traffic flow interruptions to a minimum.

1.3 Proposed Work

As per the proposed assessment the first objective is to calculate the density of vehicle on the road for flow traffic smoothly without congestion. Second objective is, developing Priority Based Signaling which helps to give the priority to the emergency vehicles. This approach is used to control the traffic smoothly. It is also helpful to overcome the traffic jam problem in reducing the delay problem and avoiding congestion. It also helps in providing the emergency services like Fire Brigade Vehicle, Ambulance or Police on pursuit at right time. Traffic Signal Management when properly designed, operated and maintained yields significant benefits like less congestion, saving fuel consumption. Vehicle emissions are also reduced and it also improves the air quality.

1.4 Advantages

- The system is an adaptive real time based design with low budget electricity production.
- It also avoids the unnecessary waiting time at the junction during emergency.
- Reliable design which is easy to install and inexpensive.
- The Hardware components and Software tools are easily available and components can be easily replaced once they are worn out
- The programming on 8051 Microcontroller which is based on CISC architecture is advanced and precise. Hence the length of the code is comparatively reduced [4].
- Memory can be easily accessed directly which is not possible in PIC 16F877A [4].

1.5 Applications

- Implemented on Rail Road pre-emption.
- Ambulance, Fire extinguisher services and VIP control vehicles.
- Airport junction ring roads. .

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II. LITERATURE SURVEY

The literature review will provide information on the technology available and methodologies used by other research counterparts around the world on this topic.
In general, each traffic signal control system is designed to meet the specific social and political objectives of each community. Fundamentally, however, traffic signal control systems strive to achieve the following:

1. Maximize traffic flow efficiency and public safety.
2. Accurately monitor traffic flows and make appropriate traffic control decisions in a timely manner.
3. Moderate fuel consumption and environmental impact of stop-and-go traffic through improvements to traffic flow efficiency.

Advanced traffic signal control systems have demonstrated benefits in several areas including travel time, speeds, vehicle stops, delays, energy consumption, and environmental impacts. In addition, they have been shown to reduce congestion and the number of accidents on roadways. III.

A traffic signal control system can provide traffic signal preemption to emergency vehicles. An emergency management center can track vehicles with automated vehicle location equipment and coordinate the signal preemption with a traffic management center. Alternatively, the emergency vehicle can communicate directly with a traffic signal controller and coordinate the preemption locally. Similarly, route guidance, using Global Positioning System (GPS) and map technology, allows safe and efficient routing of emergency vehicles to the site of the emergency, and from the emergency to a medical facility.

According to the Emergency vehicle detector designed by Ehren Bendler [1], the EMV system uses a radio. The device will be connected to a radio's power supply and to the LED output system. A siren recording will be played near the microphone of the EMV Detector. The device is functional if it cuts power to the radio, activates the LED output system, and plays a prerecorded message alerting the driver of vehicle near by the emergency vehicle, stating that the path has to be cleared to make way to the emergency vehicle. But, this is not effective when there is a traffic jam hence the work expects an override traffic signals

As per Emergency Vehicle alert system designed by Jeffrey F. Paniati [2], In countries like Virginia, the sound based protocols are used as sensors in Emergency vehicle. In such systems Sirens are used as emitter. The signals generated by these sirens are loaded into the detection and processing equipment such that directional microphones mounted on the signal arm present on the Traffic signal board, can detect the siren that meets the mandated decibel level. Once detected, a pre-emption request is generated by the phase selector and send to the signal controller. But, this system is quiet time consuming, and the equipments are expensive too. Therefore this system cannot be adapted in busy traffic environment.

The traffic light system designed by M. R. Smith et al [3] provided early warning of the approaching an emergency vehicle to find a way out from traffic congestion and lead the emergency vehicle to the destination. The emergency vehicle also may take control of traffic light at an intersection. A transmitter placed on an emergency vehicle transmits a signal to the receivers positioned at the traffic lights whenever it is on emergency mode. The received signal is then processed by a master controller which in turn pre-empts the sequence of the traffic light to control the traffic flow at the intersection which is taken by the emergency vehicle. The master controller also provides an output which display signs to indicate that there is an emergency vehicle to the other road users from other direction at the traffic light intersection. On the darker note the resuming of normal state after the override during emergency is difficult.

Further, the Traffic light system designed by N. M. Z. Hashim [4] which uses the radio frequency of 434 MHz compared to the range of about 3 kHz to 300 GHz of frequency which have been reserved for the RF theoretically. The system was successful in achieving 3 main objectives, first the system would implement a wireless communication based on analysing the transmission of Radio Frequency (RF) in traffic light control system for emergency vehicles. Further, the system automatically generates a traffic light sequence for emergency mode when receive signal from emergency vehicles. Finally, the system successfully switched back to its normal traffic light sequence as it was before the triggering of emergency mode. This project have been developed using the microcontroller PIC 16F877A. The length of the program will be big since it is based on RISC architecture and the program memory is not accessible since it has only single accumulator. Hence the work expects a prototype system that can be improved by controlling the real traffic situation and the study can be done by investigating the length, reception and transmission issue for the system to be operated with this traffic light system.

ISSN (Online) 2394-6849

International Journal of Engineering Research in Electronic and Communication Engineering (IJERECE) Vol 3, Issue 6, June 2016

III. DESIGN METHODOLOGY

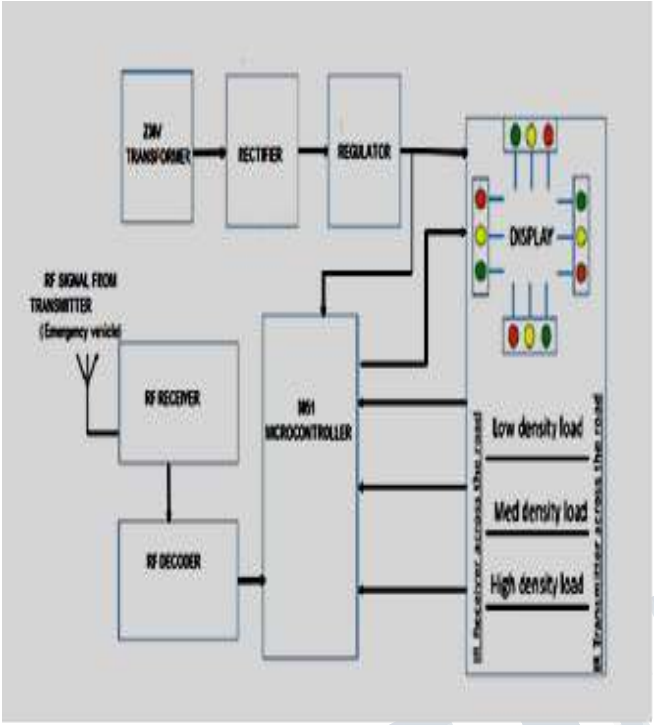

Fig.3.1 Block diagram of density based remote overriding traffic control system

3.1 Remote Override during Emergency

The proposed system using a Microcontroller of 8051 family duly interfaced with sensors. The emergency vehicle has the RF transmitter circuit with switches, based on the path where it reaches, the corresponding switch activates. This information pulse is encoded to a RF signal and transmitted out.

The triggered RF signal is captured by RF receiver at the traffic signal system at the junction. The signal is decoded to original pulse information and sent to microcontroller.

A 230V transformer is connected to the microcontroller via a rectifier and regulator. The rectifier provides suitable DC voltage to the components connected to the microcontroller whereas, Regulator is used for switching of Microcontroller as well as the traffic signal (LEDs).

As per the path information, Microcontroller switches that particular path where the emergency vehicle arrives to Green (go state) and remaining to Red (stop). The duration of the green signal would be as per the time slot allotted according to the design. After the emergency override the normal routine is resumed.

3.2 Traffic Signal Control Based On Density

The project uses the IR interruption concept for providing logic state change to the input of the MC as explained above. The project uses a number of IR diodes facings photodiodes. Thus the transistors Q1, Q2, Q3, Q4, Q5 are in conducting state. As the collector of those transistors are connected to corresponding port pins form as an input for the program to the executed based on change of logic state.

Twelve number of LEDs representing as signal lights are connected to the output of the MC in sink mode to port ‘o’, port 1 & port 2. While all the input coming from Q1 to Q5 are in logic low state, the output LED’s i.e., 3 per junction that is Red, Amber & Green of each side way of a four traffic junction follow switch ON green timing in fixed intervals in a sequential clockwise direction. Thus during low traffic density in one of the way, fixed green timing for each way in a junction are provided. While any one of the way is blocked with more no.of vehicles the IR blocking happens. There are three zones with three set of IR sensing arrangement In this project the transistors Q1 to Q5 goes high because of IR interruption while the vehicle comes in between the photodiode & the IR diode.

When the logic high sensed at the MC input changes the green ON time to a higher value for allowing more vehicles to pass through. After sometime similarly any other way gets more traffic, the sequential timing gets automatically increased for that way. Each way is divided into 3 active zones, each zone representing some specific length. Based on the IR interruption the green ON time increases, thus more the vehicle longer will be the green signal time. Thus dynamic time control is achieved based on the traffic density.

3.2.1 The Density Based Zones

There are 3 major zones categorized based on the number on vehicles sensed on the path . These are as follows

Low density Zone- When there are least number of vehicles

Medium density zone- When the IR sensing has moderate interruption that is, there are comparatively more number of vehicles.

High density zone- When the IR sensing has continuous interruption that is there is highest number of vehicles waiting.

Based on the above criteria the signal timing is changed accordingly.

IV. RESULTS

4.1 Emergency Override

Fig 4.1.1 RF module

The RF module (emergency vehicle) consists of 4 switches which indicate the 4 individual paths as shown in fig. 4.1. As soon as the RF module reaches the junction the switch corresponding the path through which the emergency vehicle has to pass has to be activated

Fig. 4.1.2 Traffic signal system

With reference to fig 4.2, switch 4 is activated hence path 4 signal status is overridden to green state while rest all other paths are switched to red state. This continues until the RF module turns off the activated switch.

Density based traffic signal control

Here the green state of the current path continues until the Photo diode senses the IR with no or least interruption.

V. CONCLUSION & FUTURE SCOPE

This Proposed system controls the change of traffic lights at intersection points giving high priority to emergency vehicles, which avoids the congestion and allows the smooth movement during an emergency situation.

Even though today's methods are robust and work well when the traffic load is distributed evenly across the lanes in the intersection, In this case, This system also allocates the traffic signal timing based on the density of the vehicles in each path. Unnecessary waiting time in the signal can be avoided by determining in which side the green signal should be large during the traffic.

As the proposed system is designed for single emergency override, further one can try for multiple interruption that will enhance the idea and contribute more to the real time application

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