A Novel Approach for Emergency Vehicle Detection and Traffic Light Control System

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Abstract: **The main objective of this paper is to design and implement an efficient and accurate way to detect emergency vehicle at the traffic signal and their direction of approach towards the traffic signal, so as to clear the traffic of that lane by turning the traffic signal green. When an emergency vehicles like ambulance, fire brigade vehicle is detected in stopping conflicting traffic signal, signal light is turned green color if it is red automatically, thereby allowing the emergency vehicle to pass through that lane. The main feature of this system is to minimize long waiting time in traffic congestion for emergency vehicles, also it is provides accurate detection of emergency vehicle as it is based on both Infrared ray for lane detection and Doppler effect which is used for siren detection.**

Keywords: Doppler effect, Infrared Waves, Op-amp, RFID, 8051 Microcontroller.

Introduction

The monitoring and control of city traffic is becoming a major problem in many developed and under developing countries. With the increasing number of vehicles on the road, growing numbers of road users and the limited resources provided by current infrastructures lead to ever increasing traveling times. One way to improve traffic flow and safety of the current transportation system is to apply automation and intelligent control methods to roadside infrastructure and vehicles. The goal of Transportation research is to optimize transportation flow of people and goods[15]. The unique approach presented in paper which is very useful to drivers and patients, fire brigade vehicle and other emergency vehicles in cities where there is traffic congestion. This solution focus to make the emergency vehicle to reach the destination in the right time, proposed system makes use of infrared transmitter, receiver and Doppler effect for more accurate detection. As the emergency vehicle's siren emit sound in a defined frequency range and follow peculiar, yet recognizable ,auditory patterns ,MIC is placed in the direction such that it is facing the road ,such that it will collect sound signals of all frequencies including noise from all the paths connected to traffic junction .This signal received by mic is passed through amplifying and filtering circuit to get the desired frequency of siren (by filtering other frequencies such as noise) ,the path by which the emergency vehicle is approaching the traffic signal ,that side will get the maximum amplitude than the rest.

Amplitude comparator is used to determine the way by which emergency vehicle is approaching the traffic junction. For more accurate detection of emergency vehicle infrared trans-receivers are used to determine the direction of approach towards junction. Both the signals(IR output and Comparator output) are passed through logical and gate, if the output of the and gate IC is turned out to be logical true(+5v) then that lane is made green automatically using microcontroller , so as to make way for emergency vehicle approaching from that direction, else the traffic light is not manipulated. Our proposed system is programmed in assembly level language and code is burnt on 8051 microcontroller .

Related Works

The work proposed by Faisal A. Al- Nasser, Hosam Rowaihy on smart traffic control system[3] based on the wireless sensor network and an alerting system for red light crossing scenario to alert the drivers on other sides to save their lives. This technique is based on the queue length of the vehicles on the traffic lights. They also depict the simulation of four models which are used in the different parts of the world and shows competing results in the terms of waiting time and number of vehicles not served first time. Research efforts in traffic engineering studies yielded the queue traffic light model in which vehicles arrive at an intersection controlled by a traffic light and form a queue. Researchers have developed different techniques tailored towards the evaluation of the lengths of the queue in each lane on street width and the number of vehicles that are expected at a given time of day. The efficiency of the traffic light in the queue model however, was affected by the occurrence of unexpected events such as the break-down of a vehicle or road traffic accidents thereby causing disruption to the flow of vehicles. Among those techniques based on the queue model was a

queue detection algorithm proposed by [4]. Chattarajet al. (2008) proposed a novel architecture for creating Intelligent Systems for controlling road traffic. Their system was based on the principle of the use of Radio Frequency Identification (RFID) tracking of vehicles. This architecture can be used in places where RFID tagging of vehicles is compulsory and the efficiency of the system lied in the fact that it operated traffic signals based on the current situation of vehicular volume in different directions of a road crossing and not on pre-assigned times [4].The proposed method by Sarika B. Kale, Gajanan P. Dhok [1] on design of intelligent ambulance and traffic control makes use of RFID technology and makes the shortest possible route from source to destination for emergency vehicles since it makes use of Radio Frequency, it is affected from physical size ,environmental conditions and from other RF devices in the vicinity and there is a range restriction, their method is not applicable for under developed countries and developing countries like India , as the shorted route computed may be shortest route but it may be under construction or repair .Heart beat sensor which is used in their proposed method[1] is not efficient and accurate way of monitoring person's health as heart beat rate varies from person to person based on their health habits ,heart beat of a patient is checked accurately for one minute or for half a minute the system proposed in [1] doesn't through light on how and where heart beat counts are storing for 30 seconds or 60 seconds, and there may be a delay caused because of GSM messages since it is a queue based technique.

Proposed Work

Our proposed method has the following advantages I. Minimize long waiting time in traffic congestion during emergency II. Controls traffic signals automatically without human intervention III. Provides priority to emergency vehicles. The mic, pre-amplifier and the IR receiver is placed at all four direction's of road that meet the traffic light junction. The pre-amplifier circuit consists of Mic which receives all types of sound (consisting of wide range of frequencies and noise) and an op-amp. Mic will convert vibrations (sound) into corresponding electrical pulses, op-amp will amplify the strength of the received signal from mic which are necessary for further processing. The emergency vehicle's siren emits a peculiar sound at frequency about 700Hz [16]. All the sound and noise received by the microphone's from all four direction is amplified by pre-amplifier circuit as shown in figure 1, and is passed through a band pass filter as shown in figure 4 which will only allow frequency range between 745Hz-760Hz to pass through it suppresses all other sound[12]. When the emergency vehicle is approaching towards the traffic signal from one particular side ,all the four traffic junction's Mic will receive that siren signal along with other sound and noise ,this signal is amplified at all the four junctions ,these amplified.
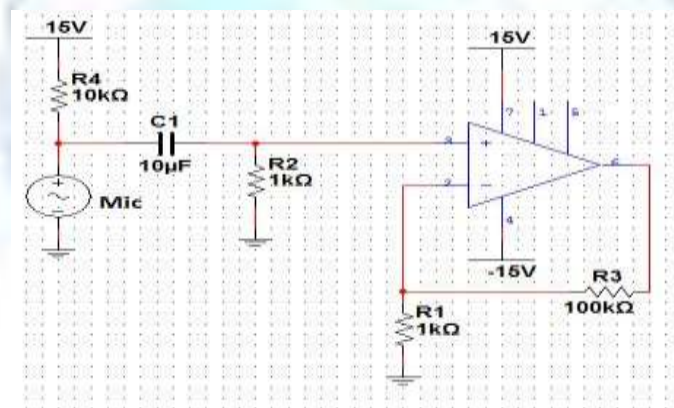

Figure 1:Pre-amplifier circuit to increase the strength of the received signal using MIC .
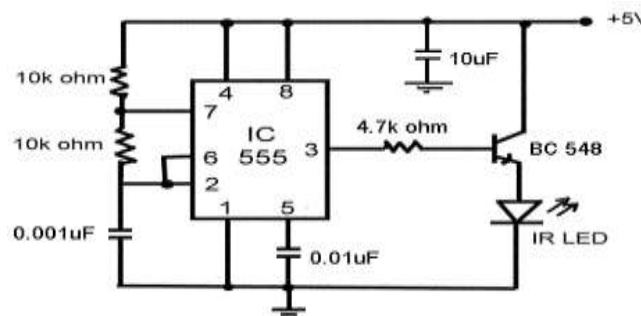

Figure 2: Infrared transmitter which is placed on top of emergency vehicle

signals are sent through filtering circuit as shown in figure 4 ,after filtering the signal consists of frequency band 745Hz-760Hz these signal from all the four junction is given to comparator . Comparator compares amplitude for every 10 seconds from all the four direction's signal and gives the output[+5v]for that side from where emergency vehicle is approaching towards the traffic junction. This is based on Doppler effect, emergency vehicle approaching side(direction) will have maximum frequency and signal strength increases as maximum sound of siren is absorbed by that side microphone, hence the amplitude of signal for that direction is more when compared to other sides.

IR Transmitter and receiver is calibrated to work at 34KHz for more precision . Infrared transmitter is placed on top of the emergency vehicle which will transmit the Infrared rays at 34Khz the circuit for the same is as shown in figure 2.
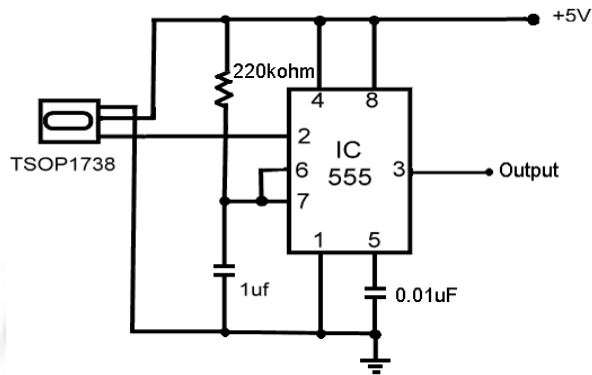

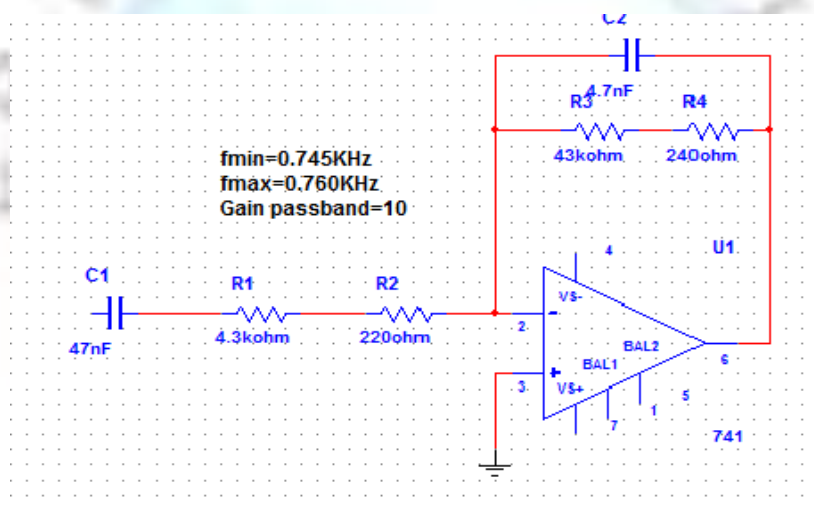Figure 3: Infrared receiver using TS01738

Figure 4: Band-pass filter circuit for detecting siren frequency

The output of IR receiver is active low and it gives +5Volts in off state. And Whenever IR waves, from a source, with a frequency of 38 kHz incident on it, its output goes low. Receiver module (as shown in figure 3) has an inbuilt control circuit for amplifying the coded pulses from the IR transmitter. A signal is generated when photodiode receives the signals, this input signal is received by an automatic gain control. For a range of inputs, the output is fed back in order to adjust the gain to a suitable level[11]. The signal is passed to a band pass filter to filter unwanted frequencies. After this, the signal goes to a demodulator and this demodulated signal drives an NPN transistor [9] as shown in figure 3.

IR receiver is placed on top of the traffic signal (in all the four direction, so that receiver will receive signal from emergency vehicle's transmitter only when it is approaching from that side.

Whenever the emergency vehicle is approaching ,that direction's IR receiver will be activated and the output of the comparator for that particular side will be high (because that side will have maximum amplitude after it passed through filter circuit), on comparing these two parameter that signal light is turned to green automatically for that particular direction without human intervention[8].

Hardware Implementation

Microcontrollers are usually dedicated devices embedded within an application. For example, microcontrollers are used as engine controllers in automobiles and as exposure and focus controllers in cameras [7]. In order to serve these applications, they have a high concentration of on-chip facilities such as serial ports, parallel input output ports, timers, counters, interrupt control, analog-to-digital converters, random access memory, read only memory, etc[13].

The Microcontroller can function as a compiler with the addition of no external digital parts(without external RAM). Modules vary in data size 4 to 32 bits. For four bit units in huge volume for very simple, and 8 bit units are most versatile.16 and 32 bits are used in high-speed control and signal processing applications.
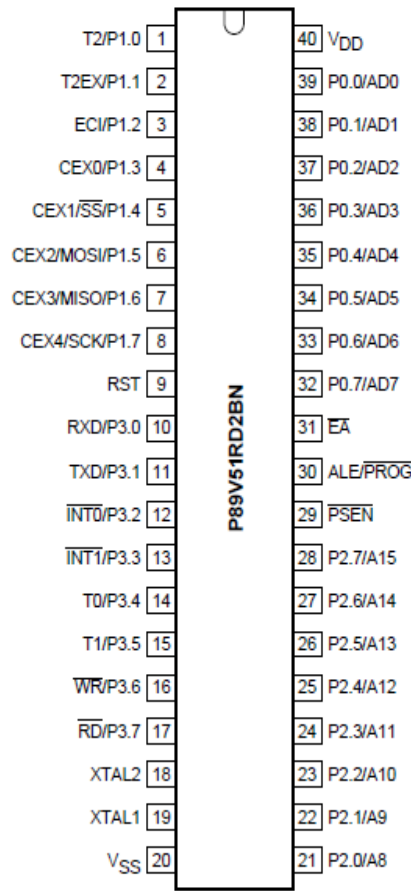

Figure 5: Pin diagram of PV89V51RD2BN microcontroller IC

Many modules feature a programmable pin that allows external memory to be addressed with the loss of I\O capability. We have used 'PV89V51RD2BN' Micro Controller chip as shown in figure 5, which belongs to 8051 family of integrated chips by Phillips company for the above proposed method. In 44 pins version, there are four 8-bit I/O ports and in 64 pins or 68 pins version, there are six 8-bit I/O ports[10].We are using 40 pins version of 8051 Integrated Chip IC. 32 I/O pins arranged as four 8 bit ports (P0 – P3). PV89V51RD2BN operates at 11.0592 MHz frequency. Green signal will only be turned on for that direction, if and only if both Infrared receiver and comparator gives logic high for that direction. Both IR and comparator signals are passed through logical and gate (using IC 7408).The output of the AND gate will drive the green led for that direction when emergency vehicle is approaching.

Proposed System solves the test below cases or scenarios efficiently and accurately as it makes use of both Infrared sensor and Doppler effect

Case1: When only one emergency vehicle comes near   the signal and number of vehicles will be available in front of the
emergency vehicle. In this situation, IR sensor network and mic(with filtering comparator circuit) detects emergency vehicle and signal is turned to green for that side. As the signal will be red for other vehicles(other 3 lanes), so no possibility of accident.
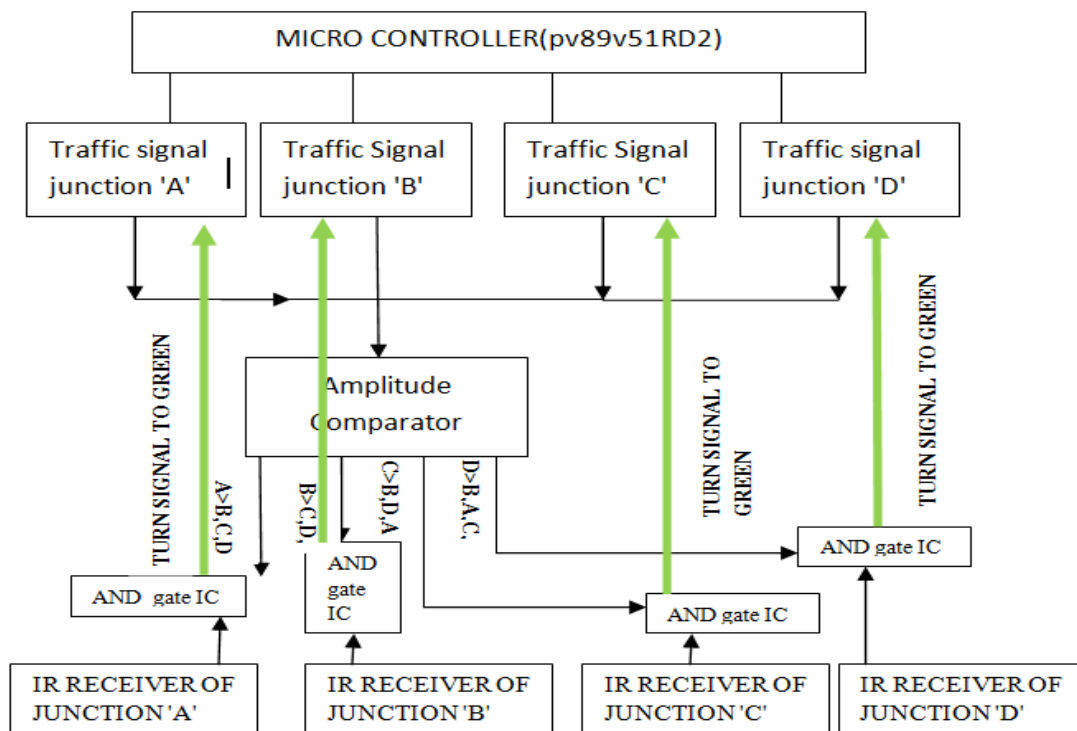
Figure 6: Data flow design for the proposed method

Case 2: When two emergency cars is arrived on the signal and number of vehicles will be available in front of the emergency vehicle. In this situation, IR sensor network detects emergency vehicle in two different lanes/sides of the junction .Since the amplitude comparator is used the emergency vehicle which is ahead towards the junction ,that side will be made green first because comparator gives output to that side where more signals are received, so the priority for two emergency vehicle is based on the distance from the traffic junction , emergency vehicle which is close to the junction that side's signal is made green first and then the second emergency vehicle's side is turned green.

Acknowledgment

Conclusion/Results

A novel approach of automated lane clearance system paper may reduce the risk of loss of life because of the delayed treatment of the patients due to traffic. This work can be designed on digital signal processors for filter design and also on FPGA(Field Programmable Gate Array) or PSOC (Programmable System On Chip) for adding new feature to our proposed technology .By using FPGA chip[14] , the comparator ,temporary storage(RAM) can be designed on a single chip ,as well as the speed of computation can be increases up to 250Mhz.The above system can be designed using ASIC (Application Specific Integrated Circuit) to increase the speed of computation . This approach can be used for ambulances ,fire brigade vehicle and any other emergency vehicle .

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