

# Traffic Density Measurement based On-road Traffic Control using Ultrasonic Sensors and GSM Technology

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**Abstract-** In this paper we have proposed the optimization of traffic light controller in a City using ultrasonic sensor and microcontroller with fault detection technique and reporting them to authority using GSM.

**Index Terms-**Ultrasonic sensors, microcontrollers, GSM module.

## I.INTRODUCTION

In the present scenario the vehicle problem is increasing and Traffic congestion is a severe problem in many modern cities all over the world. To overcome the problem, we have come up with an exclusive idea for a dynamic and automatic traffic light control expert system combined with a simulation mode.

Traffic research has the goal to optimize traffic flow ,as the roads have become overloaded with increasing number of vehicles and resources are limited. However, still there are some limitations in existing traffic control which are not environmental and economical. There are several models which give solutions for traffic simulation. In our research we have focussed on optimization of traffic light controller in a city using wireless sensor[1]-[4].

Traffic light optimization is a big problem. Even for single junction there is no optimal solution. The problem becomes even more complex with multiple junctions, as the state of one light is responsible for the flow of traffic of that road only. Another complication is that the flow of traffic density frequently changes, depending on the time of day, the day of the week, and the time of year[5].

In this paper, we propose three approaches. In the first approach - to take data/input/ from ultrasonic receivers. In the second approach - to process the input data using Microcontroller and finally display it on the traffic light signal to control the Closed Loop System. In the third approach whenever any fault arises in the whole system like damaging of sensors or microcontrollers or any other problem due to weather , than it will send a message to the authority of that traffic light and traffic police, about the fault on that particular traffic light in the city.

## II. IMPORTANT NOTIFICATIONS USEFUL IN PAPER

### A. Ultrasonic Sensors

The principle of ultra sonic sensors is similar to that of radar or sonar which evaluate attributes of a target by interpreting the echoes from radio or sound waves respectively.

An ultrasonic transducer is a device that converts energy into ultrasound(above 40khz) , or sound waves

above the normal range of human hearing(20hz - 20khz). While technically a dog whistle is an ultrasonic transducer that converts mechanical energy in the form of air pressure into ultrasonic sound waves, like piezoelectric transducers that convert electrical energy into sound. This property of Piezoelectric crystals where the size changes when a voltage is applied, thus applying an alternating current (ac) across them causes them to oscillate at very high frequencies, thus very high frequency ultrasonic sound waves are produced[6].

When physical force is applied to them the piezoelectric crystals generate a voltage, the same crystal is used as an ultrasonic detector.

In this proposed system we use transmitter and receiver components separately instead of placing them together which is commonly used to measure distance.

### B. Range Of Ultrasonic Sensor

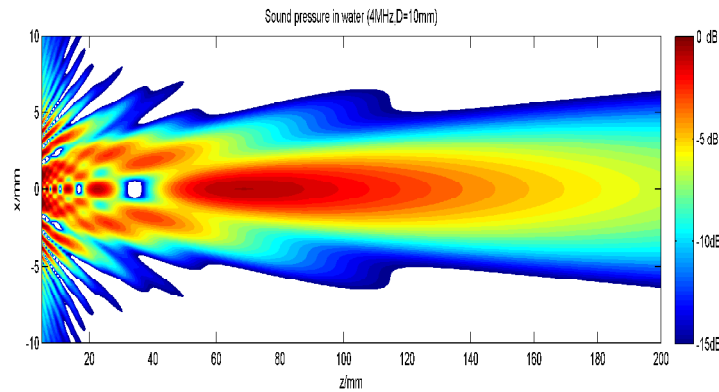


Figure 1. The plot shows the sound pressure at a logarithmic db-scale

Figure no. [1] shows the range of sound pressure in water for ultrasonic sensor. Sound field of a non focusing 4 MHz ultrasonic transducer with a near field length of  $N = 67$  mm in water.

## III SYSTEM MODELLING

In this section, we focus on the use of ULTRASONIC SENSOR and wireless N/W in traffic control. A lot of scope can be gained in this idea, and intelligent traffic control attracted several governments and commercial companies. Our main aim is to provide more secure roads with less travel time. Such improvements will lead to health benefits, economy, and the environment.

Figure no. 2 shows the model of the traffic light.

- ❖ Basically in our proposed system on one side of a single lane road, the ultrasonic sound transmitters are placed which produces ultrasonic waves and these ultrasonic transmitters are placed at a distance ( approx 10- 15 meter gap). On the opposite side of same road the ultrasonic receivers are placed at the same gap as that of ultrasonic transmitters which receives the waves .
- ❖ This system will keep track of the road and whenever the series of ultrasonic receivers does not receive the sound than it indicates the microcontroller about the density of traffic jam
- ❖ In our proposed system ultrasonic sensors are placed on the road. When their transmittance is disturbed by the moving vehicles they convey that message to the microcontroller for generating results. Which will be described below in upcoming topics.
- ❖ Unlike all others system for measuring traffic density where sensors are placed on the road here we are installing ultrasonic sensors above the road on the foot-path and railings in between the roads. The advantage of this technique is that the ultrasound will not pass below the vehicles and conveying a wrong message to controller is be avoided.

- ❖ After that this system will also work when there is excess of water flowing on road during rain or also above the sensors , because ultrasound can also travel in water or we say travels faster in water according to science.
- ❖ The chances of failing this technique is very less because this system overcomes all the possibilities that affects a signalling system

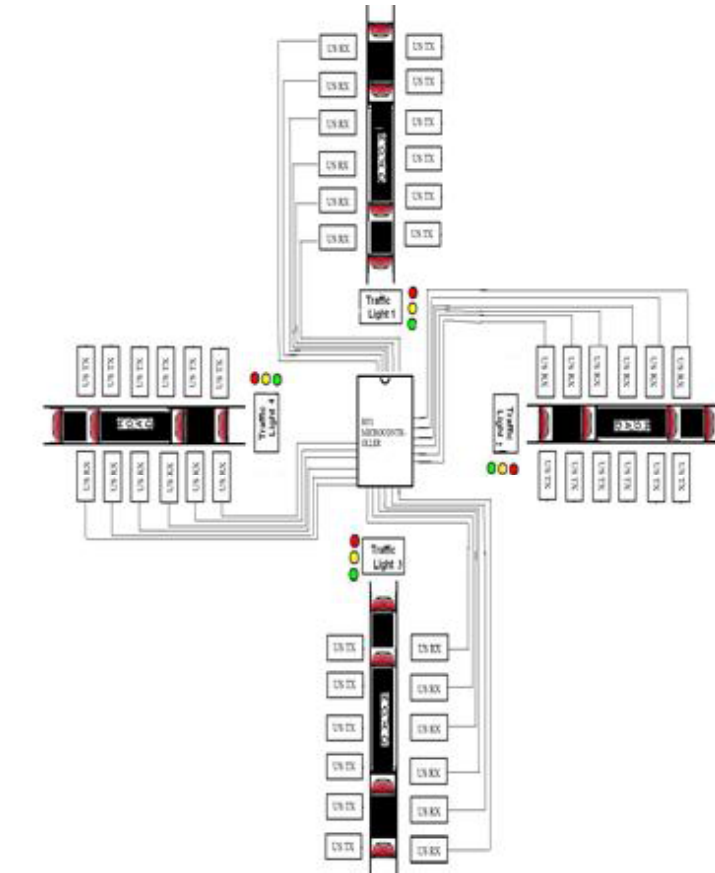


Figure 2: Prototype Of Road

#### IV. BLOCK DIAGRAM

- ❖ In this paper we are mainly interested in the optimization of traffic flow, thus effectively minimizing the Average travelling time of cars. A common tool for analyzing traffic is the traffic simulator. In this section we will first describe block diagram as shown in the figure [3] to model traffic controllers. We will then describe how this models can be used to obtain real-time traffic information or predict traffic conditions. After that in this paper we describe how information is communicated as a means of controlling traffic, and what is the effect of the communicated data on traffic conditions will be.

##### A. Power Supply

As per the power requirement of the hardware of the intelligent traffic light control and monitoring system, supply of +5V w.r.t GND is developed as shown in Figure [4].

The complete circuitry is operated with TTL logic, '1' or '0' i.e. 1.7volt for '0' and 5 volt for '1'. It comprise of 0V to 9V transformer to step down the 220V AC supply to 9V AC. Further a bridge rectifier converts the 9V into  $9V\sqrt{2}$  DC. It is further filtered through a 1000uF capacitor and then regulated using 7805 to get +5V. To isolate the output voltage of +5V from noise further filtering 220uF capacitor is done.

### B. Ultrasonic Transmitter

In our proposed system ultrasonic sensor is going to play a very vital role. This sensor will help us to recognize the traffic jam density and work accordingly. This sensor is going to initiate the whole working of the system.

An ultrasonic transmitter transmits the ultrasonic waves of frequency above 20khz in the air towards the ultrasonic receiver.

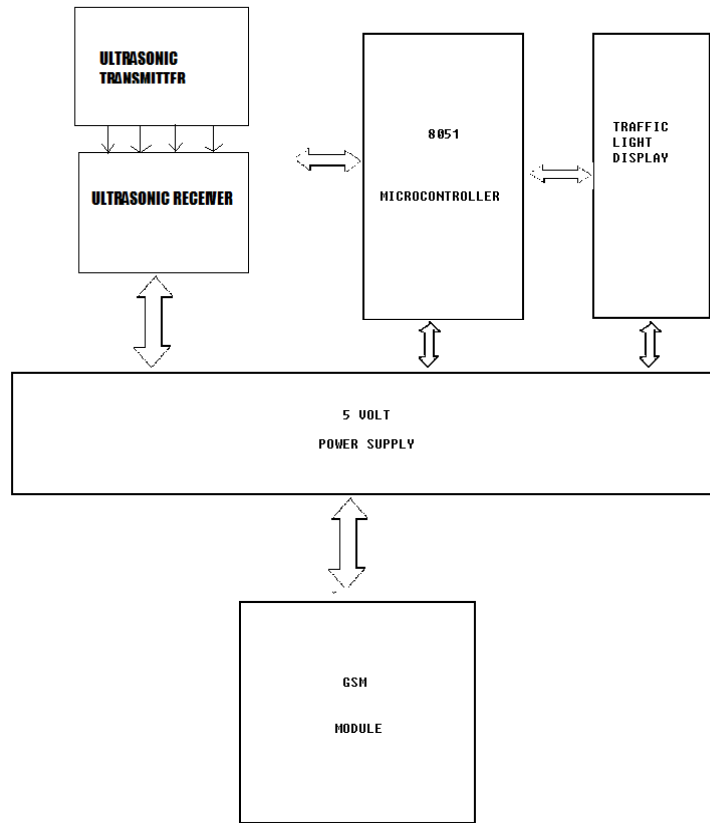


Figure 3. Block Diagram

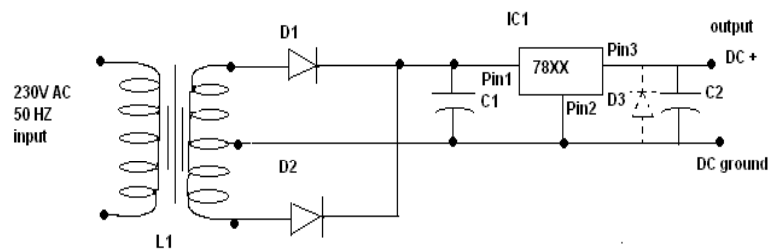


Figure 4 Circuit Diagram of Power Supply

### C. Ultrasonic Receiver

Now the ultrasonic receiver will receive the ultrasonic waves transmitted by the transmitter. As we are using digital ultrasonic receiver ( *US 18* ) so the output pulse would be in the form of either '0' or '1'. If we are receiving a pulse then it will result in "1" else "0". The resulting output pulse will be sent to the microcontroller.

#### D. Microcontroller

A microcontroller is an economical computer-on-a-chip built for dealing with several specific tasks, such as receiving information through PORTs or remote controlled devices and processing it further to give appropriate result for which it is programmed. **8051 Microcontrollers** are the most preferred and used microcontrollers for a vast community of hobbyists and professionals. **8051**, is the most revolutionary product of INTEL which gained lots of popularity and is used till date where more innovative microcontrollers have been launched after it.

- ❖ In this system ATMEL AT89S52 is used which is 8 bit microcontroller. This system is an intelligent traffic light control and monitoring system which shows the interfacing of some peripherals and ICs with the microcontroller. As the power is switched on the microcontroller will come in to action it will activate all the sensors for 5 sec and then turn them off. Sensors which are available on all the four roads will supervise the traffic density on the individual basis. And the pulses received by the sensors will be sent to microcontroller and the comparator is going to compare the data of individual four road given by the sensor and the road with the maximum value of traffic will be given first priority as a green light for the defined time for particular level of jam will be set first for that particular road.
- ❖ We assume the first road as reference road and after that traffic light will shift in clockwise manner. After that when time period for green light on first road remains only 5 sec then at that peak of time, microcontroller activates the ultrasonic sensors on the road which comes first in clockwise direction to the reference road and measures the traffic density of that road and microcontroller takes the decision for setting the timing interval.
- ❖ After that the same process will be repeated for next road and the cycle will be continued.
- ❖ If there is a traffic jam which is longer than distance covered by ultrasonic sensors than the maximum time unit according to the type of road will be given by the setup engineers.
- ❖ When there is no traffic jam (maximum in nights) then the yellow light will appear on all the roads.
- ❖ If there is any crash of vehicles or vehicle is just standing on the road in front of sensor, that sensor is forwarding '1' pulse to the microcontroller. Through programming microcontroller has to understand that, when only one sensor in between all other sensor on road are giving pulse of '1' , then there is no traffic jam and not to calculate the result for that sensor.

#### E. Traffic Light Display

Traffic light display will be same as that we are having now a day's RED, YELLOW and GREEN . But the format of changing light is handled by microcontroller through US sensors.

Minutes display can also be introduced using programming skills but they will never show the exact time for RED light on others road because it is changing with respect to the density of others road.

#### F. Gsm Module

GSM is GLOBAL SYSTEM FOR MOBILE COMMUNICATION. through this module we can send and receive calls and messages and the traffic light can be monitored through mobile phones of authorized person. we are using it as, when any problem arises in the system i.e. sensors not working damage of any part in embedded system etc. then this module will send a message to the authority person describing the pillar number and location in the city with the problem.

this will help for better results in improving the conditions of road.

Further research in this field can introduce troubleshooting of small problems using mobile and computers. which saves man power too.

#### V. FLOW CHART

- ❖ Figure 5, shows the flow diagram of working of proposed system with ultrasonic sensor.  
In our proposed technique of density measurement and traffic controlling our system functioning is defined in algorithm.  
This system of controlling traffic is different from older system which is in use now a days.
- a. First of all when power supply is given to the system our system will start functioning and gets wholly active.
- b. Then our first step is to measure the traffic density of all the streets represented by  $n$  (where  $n$  is 1), this is done by activating all the sensors( $s_n, s_{n+1}, s_{n+2}, s_{n+3}$ ) of all four roads simultaneously and the receiving the pulses from the ultrasonic receivers of all four streets.

- c. In next step sending these pulses to 8051 microcontroller that takes decision of level of jam on that road. Decision is taken as, let  $d_n, d_{n+1}, d_{n+2}, d_{n+3}$  be the traffic density of all four roads.
- (i) When condition is,  $d_n > d_{n+1}$  is false that is traffic density of first road is less than the density of second road, then it will check the condition  $d_{n+1} > d_{n+2}$  and if it is also false then it will check  $d_{n+2} > d_{n+3}$  and if it is also false then it will check  $d_{n+2} > d_{n+3}$ . This will tell us that the which road is highly dense in respect to road density of first road.
- (ii) Now if the,  $d_n > d_{n+1}$  is true than it will check the condition  $d_n > d_{n+2}$  and if this condition is false, then it will check the condition  $d_{n+2} > d_{n+3}$ . this condition will tell us that the which road is highly dense in respect to road density of first and second road.
- (iii) Now again if condition  $d_n > d_{n+2}$  is true then it will check the condition  $d_n > d_{n+3}$ , all these conditions after processing gives us the highly denser road among the four road.
- (d) Now we know which road is highly dense then we make that road as reference road and microcontroller makes the output to the all the traffic lights on the poles as  $g_n, r_{n+1}, r_{n+2}, r_{n+3}$  where  $g$  denotes green light for the road which is highly dense and  $r$  denotes red light for remaining three roads.
- (e) Our microcontroller always checks the time period of green light, when our allotted time period for green light remains only 5 sec then microcontroller activates the ultrasonic sensors of next road which comes first in sequence of clockwise direction.
- (f) The sensors on next road will sense the density of road and sends the pulses to the controller and it takes action according to density of road.
- (g) And our pattern will shift to  $r_n, g_{n+1}, r_{n+2}, r_{n+3}$ .
- (h) In next step if our count goes more than 5 i.e. if  $n > 5$  then the loop goes to first road and repeating this process with in a loop again and again.

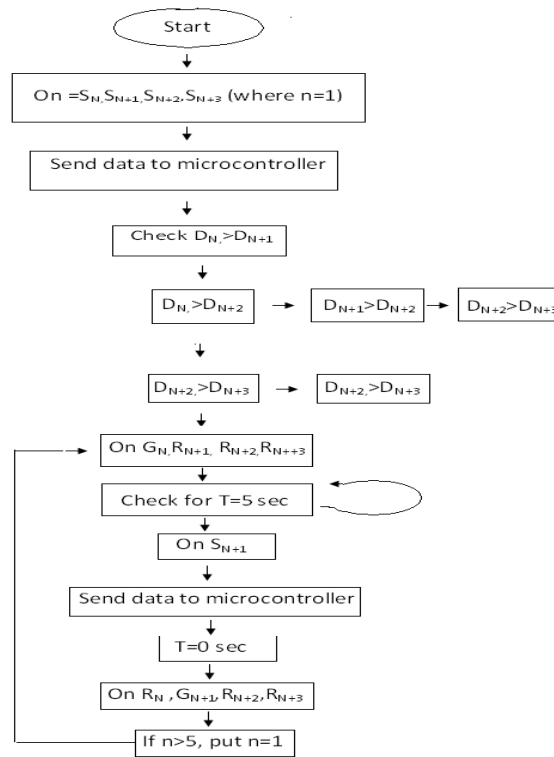


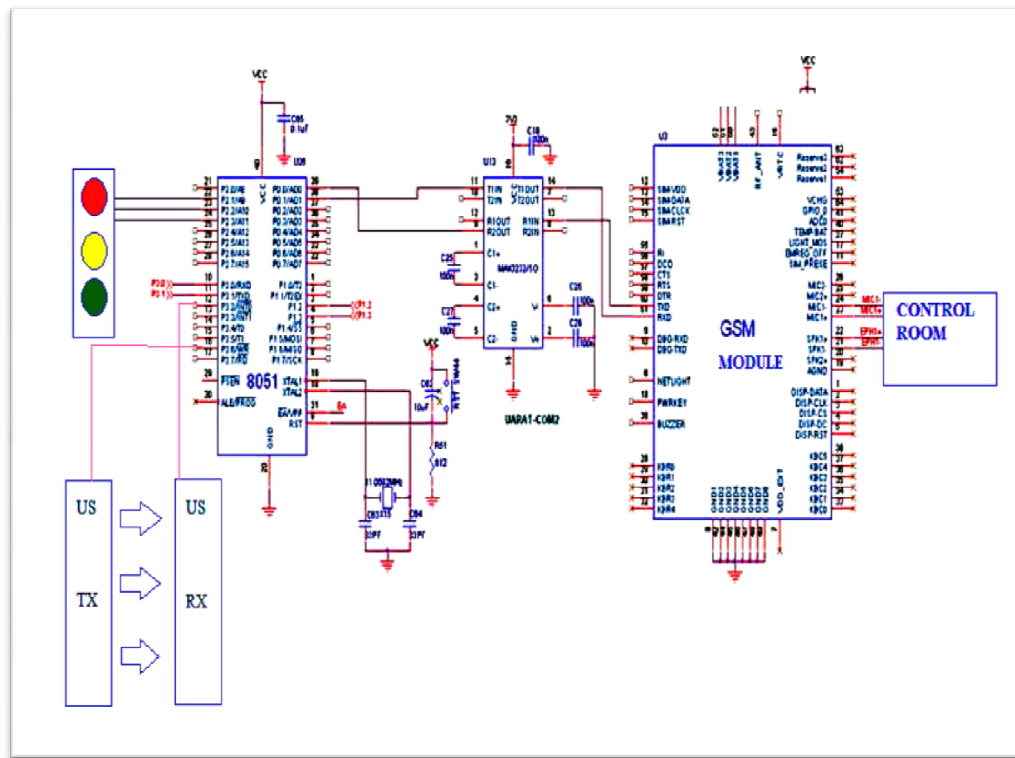
figure5: Flow chart showing working of model

## VI. FUNCTIONING OF GSM

Whenever there is any malfunctioning in the system then this system sends the message to the operating authority of that traffic light, which was very helpful in avoiding the heavy traffic jam in the city because the authority gets to know which traffic light is not working properly and they can easily reach to the pole and repair it, for controlling traffic at that moment this message instantly can be sent to traffic police also.

### A. Problems That May Arise

1. When the sensors are not in working condition: This is detected by microcontroller if it does not receive the



message signals from the sensors for a given time limit then it will assume that there is a problem in

Figure6: Circuit Diagram Of Proposed Technique

sensors and send signal to GSM.

2. When the traffic light is not working: when the traffic light LEDs are blown off then the current will drop and it can be easily sensed by controller and it will order the GSM to send message.
3. When the whole system fails down: when our whole system excluding GSM fails then also , GSM sends message.
4. When the sensors shows maximum traffic: when all the four roads indicates the maximum traffic density for given time limit then it will send message to the authority and traffic police to handle the situation at the instant.

### B. Advantages

In our concept time interval is changing according to the traffic density on each street and we can say this system as real time operating system (RTOS).

By using this algorithm we finds that this system consumes very much less power because all the ultrasonic sensors of all four streets are not active all the time, they are active only for 5 sec during the transition of green light from one street to another.

## VII. CIRCUIT DIAGRAM

The circuit shown in the below Figure 6 is complete circuit diagram of intelligent Traffic Light Control And Monitoring System Which Shows The Interfacing Of Some Peripherals, Sensors And Ics With The Microcontroller At89s52.

Microcontroller receives the 11.0592MHz clock frequency from the crystal oscillator at XTAL1 and XTAL2 pins. Pin 9 act as reset switch when connected in manner as shown in figure no. 6 with micro-controller which provides manual reset of the microcontroller. Resistances which are of 10K are provide at each port to properly differentiate between high i.e. '1' and low i.e. '0' TTL signal which are known as Pull-up network resistances.

Our intelligent traffic light control and monitoring system stores the received signals into its flash memory through its feature of In-

Application programming. Data is stored with the real time and data stamp with it.

A 8051 microcontroller is the brain of our system which calculates the density of our road, finds the level of jam and takes decisions as giving time period to GREEN signal accordingly as programmed by the programmer.

8051 is interfaced with GSM module which works according to the programming done by the programmer. programmer feeds in the memory of GSM when to send, what to send and whom to send the message. programmer through interfacing it with their PC feeds in contact no. and description of messages which has to be sent when any problem arises.

## VIII. CONCLUSIONS

In this paper we have studied about optimization of traffic density control with the help of very intelligent ultra sonic sensors which are ready to work even in adverse weather conditions and micro-controller with GSM in an area .We have enclosed this paper with fig. showing block diagram, figure .showing circuit diagram and another figure showing algorithms which will make the explanation more clear and easy to understand. We have studied the paper via various perspectives. The aim behind this proposal or system is to minimize the traffic density by making use of sensors which are available on the four roads, the pulses received by the sensors will b sent to micro-controller and comparator is going to compare the traffic on the four roads, the first priority will be given to the road with maximum density. and this road will be considered a reference for other roads and process will continue in a clockwise manner .microcontroller is going to supervise the delays which are fixed for the roads and it will regulate the process in the continuous manner.GSM module will help us to monitor the traffic light through mobile phones of authorised person. The traffic light display would be in the same format which we are studying since childhood but the its changing will be governed by micro-controller and US sensors.

The most important outcome is that it is a power saving system as the sensors present on all the streets does not remain active all the time ,they are active only for 5 sec during the transition and follow a chain process taking priority road as a reference.GSM has made it more advanced and intelligent to use by providing information to the authorised person about mal-functioning of the pillars, sensors along with the location. Today traffic congestion is the biggest problem which is seen everywhere and very hard to face. So this system will help us to replace today's problems with the best solutions and benefits. This system will really help us to make the future roads very light and free with downfall in the accident graph.

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