# Proposed Algorithm for Smart Traffic Control using Ultrasonic Sensors

**Sandeep Chaware, Trushita Chaware**

***Abstract:*** ***In India, the concept of smart city has evolved since last few years. Smart city includes smart electricity distributions, smart parking, smart lighting on streets, smart water distribution, smart drainage system, smart pipe gas system, smart traffic control system etc. All smart systems listed need smart use of technical solution so that all systems will play critical role in making city as smart. As far as smart traffic control is concerned, there were few solutions suggested and implanted such as sensor with CCTV, camera with IR sensor and tags etc. The technical solution may include software, hardware, communication models, networking, usage of data and of-course data analytics. As large amount of data may be generated by the objects/components involved in the system, it must be analyzed properly. The data may be in structured or un-structured format. In this paper, smart traffic control system with efficient algorithm has been proposed with data analytics to control traffic, which controls the timing of the signal dynamically. At a junction, there is need to control the traffic and signal timing such that air and noise pollution also will be monitored and controlled. In this model, IoT system has been proposed with ultrasonic sensors to control the traffic. The signal timing will be dynamically monitored and adjusted with traffic density within a region. This will give solution to control, monitor the traffic at every signal in a city.***

***Keywords: smart city, ultrasonic sensors, digital camera, traffic density, traffic signal***

## I. INTRODUCTION

In India, cities are growing in leaps and bounce with all public facilities. But there are many limitations and hurdles in overall development of cities, especially in India. Smart traffic management and control plays an important role in the development of smart city. We the citizen of this country must follow the ethics in all parts of our life. When we are travelling in a city must follow the traffic rules. But, there are many persons who use to break the traffic rules or travel very rubbishly. This may create chaos or traffic jam which leads to many problems like accidents, damage to vehicles, loss of fuel, increase in air and noise pollution etc. This all causes due to our approach not following traffic rules. This may happen especially at junction or at signal where there is no traffic police to monitor or signal is not working. This is routine work almost in all cities of India including metro cities.

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There is need of automated system which will monitor the traffic and dynamically control it. We are in a need of this system since number of vehicles and so the traffic is increasing day by day in all cities. In this paper, the proposed suggested model will work to solve many problems listed earlier. Full implementation of this system can solve many issues mentioned above and can help in reducing traffic problems, which will ultimately help in making city smart.

## II. REVIEW OF WORK

There are many technical solution suggested in order to regulate the traffic in city. Some of them are discuss here:
The count of vehicles has been done once it passes through a PCB with inductance loop [1]. A committee led by the chairman of MSRDC, traffic police, transport and IT department suggested an intelligent traffic monitoring system on Mumbai-Pune Expressway in 2016 in order to avoid accidents. As the number of vehicles reaches to the threshold, it stops the traffic with some predefined timer. The controlling of traffic depends on vehicles passed. This give simple solution but the main drawback is the system is static. There is wastage of signal timer when there is no enough vehicles passed through. In this, CCTV is used to monitor and control the traffic with some sensors and microcontrollers along with communication unit [2]. There is proposed traffic and road condition monitoring system in 2008. A GPS-based tracking system has been proposed with SMS facility in case of emergency [3]. In this, a system consists of camera, IR sensor, RFID tags and reader, GSM unit with IoT microcontroller. The vehicles are being monitored by RFID tags and reader and in case of violation of traffic rules, a message is being sent through GSM module to the offender to pay fine [3]. In this, there is uniform organization of traffic flow with certain rules like small vehicles, heavy vehicles, light vehicles will be in a particular lane in order to avoid accident [4]. An emphasis is given to design of road and vehicle to avoid accident. In this, the density of vehicles will be count as per their size, type and weight. Once they reached the threshold, the traffic will be blocked with some predefined timer [4]. In this, Fuzzy expert system uses the traffic patterns at particular location. Traffic data is being collected as patterns and their waiting period. Based on patterns, traffic is being controlled [5].In IIT Kanpur, research model had been proposed where images of traffic are being captured in regular intervals, process all images and output is given to controller which controls the traffic signal by comparing with the threshold value [6].

## III. PROPOSED MODEL

In this model, some assumptions are made which are below.

1. A junction where 4 roads met.
2. Each side has road lane which defines the boundary for the road. The vehicles either parked outside the lane boundary are not considered as traffic.
3. Traffic patterns with all category of vehicles including light vehicles such as two wheelers, medium heavy vehicles like cars, heavy vehicles like truck, bus etc.
4. Lane length as 100metres as traffic density.
5. Signal timers as 60 seconds per lane by default.
6. Each lane is equipped with a camera, ultra light sensor with 180 degrees rotation with Raspberry kit.
7. Centralized server who is collecting all data from each controller from each lane and make predictive decision to control the signal timing of next or previous signal.

### A. Proposed System Architecture

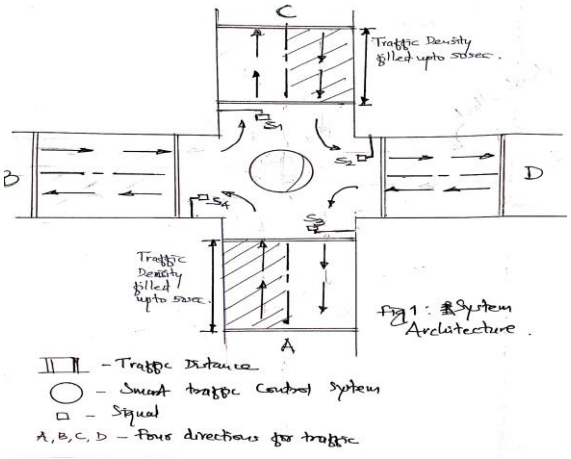


Fig. 1: Proposed System Architecture for smart traffic control system

Figure 1 show the proposed system architecture as proposed model for smart traffic management at junction.

Figure 2 shows smart traffic control system with camera and USS/RSPs deployed in the center of the junction. The cameras will take the real time videos from all 4 sides and USS/RSP will control the system with IoT to set or reset the timer of the signals.

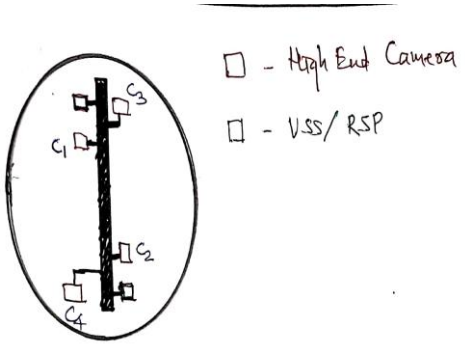


**Fig. 2: Smart Traffic Control System**

Figure 3 shows block diagram of controlling of timing of signal depends on traffic data from input sources. The diagram shows all interfaces of software and hardware modules involved in the system.

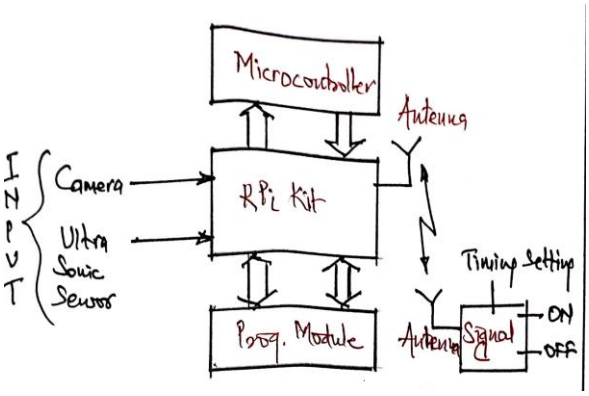


Fig. 3: Block diagram of Smart Traffic Control System

### B. Blocks of System Architecture

- ✓ **Input data**: The input from ultrasonic sensors and video streams from video camera as traffic density will be continuous captured and inputted to the Raspberry PI microcontroller board for further processing. This interface is possible through MIPI-CSI2 with BCM2835 processor. Both streaming data are being stored in memory which is available with board.

- ✓ **Raspberry PI Board**: The raspberry PI board along with some interfaces like HDMI, Serial interface, USB is being used to process and store the data collected from sensors and camera. This board also has inbuilt memory such as ROM to store the application, which is used to process the data and make some decisions.

- ✓ **Application:** A small application in Python will be design and implemented to process the data and make some decision to manage and control signal timer. The algorithm is being design and developed and stored in memory of Raspeberry pi board.

- ✓ **Microcontroller:** Microcontroller is interfaced with Raspberry board through serial interface to execute the instructions of applications along with processing of data.

- ✓ **Interface with signal:** The Raspberry Pi board makes its interface to the signal through IR technique in order to control and adjust dynamically. The signal timer will be adjusted as per decision by the controller. This decision is based on algorithm design to control the timer.

- ✓ **Signal:** Signal timer will be adjusted dynamically so that traffic is being controlled. This decision is analyzed by on-board equipped with ultrasonic sensor and camera.

### C. Steps of Operations

1. Data as traffic density within specified distance at the junction is being collected by ultrasonic sensors which rotates 180 degrees along with digital camera.
2. The traffic density will be in terms of number of vehicles on the specified lane within specified distance.

**Table1: Supported Test Cases for Proposed Algorithm**

| Sr. no./Case No. | Signal 1 | Signal 2 | Signal 3 | Signal 4 |
|---|---|---|---|---|
| **1 (Case 1)** | ON (60 Sec) Traffic move from A->B A-> C, A->D | OFF (60 Sec) | OFF (60 Sec) | OFF (60 Sec) for D->B ON (30 Sec) from D->A |
| **2 (Case 2)** | ON (30 Sec) for A->B, OFF (60 Sec) A->C | ON (60 Sec) Traffic can move from B->D, B-> C, B->A | OFF (60 Sec) | ON (30 Sec) for D->A |
| **3 (Case 3)** | OFF (60 Sec) | ON (30 Sec) B->C, OFF (60 Sec) for B->D | ON (60 Sec) Traffic move from C->D, C->A, C->B | ON (30 Sec) for D->A OFF (60 Sec) for D->B |
| **4 (Case 4)** | OFF (60 Sec) | OFF (60 Sec) | ON (30 Sec) For C->D OFF (60 Sec) for C->A | ON (60 Sec) Traffic move from D->A, D->B, D->C |

### D. Algorithm

1. Checking for density of traffic for a particular lane within threshold timing such as 50sec.
2. If the traffic density of any lane reaches the threshold on or before 50 sec then the signal for that lane makes green even if it is off.
3. The signal timing for ideal cases will be as per table1.
4. Consider the traffic density gets filled on or before 50 sec at C location (as shown in figure) then timer of S3 dynamically adjusted as per CASE 3 will be executed.
5. Consider the traffic density gets filled on or before 50 sec at A location (as shown in figure) then timer of S1 dynamically adjusted as per CASE 1 will be executed.
6. Similar steps will be executed for other locations when traffic gets filled on or before the threshold timing.

D. **Results and Outcome**

Prototype is implemented as per figure 2 and obtained results with traffic density through ultrasonic sensors. It gives number of vehicles in a lane with predefined timer of the signal. If the density crosses within 50 sec, the timer for the lane changes to green.

The outcome of the project is to learn insights of the traffic controlling and management at the signal with dynamically change in timing of the timer as per need. This saves the time of commuters, save fuel and saves pollution. It increases the discipline among the commuters in a city. This will lead to the development of smart city.

Figure 4,5 and 6 shows screen shots of prototypes being implemented for smart traffic control system. The prototype measured traffic density with distance and number of vehicles within distance range. Also, in figure 6, traffic density is being measured via ultrasonic sensor is shown. Table2 shows the result for case3 from proposed algorithm. The A side of the junction has been filled before time out, so signal1 must be started with timer as say 60 sec. Accordingly other all signals will be dynamically set to control the traffic.

**Fig. 4: Screen shot of proto type for traffic density**

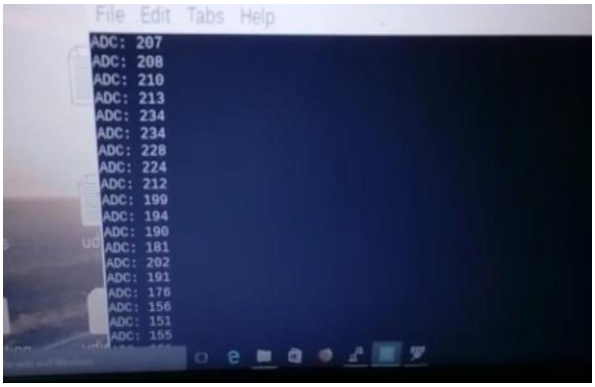


**Fig. 5: Smoke Detection levels**

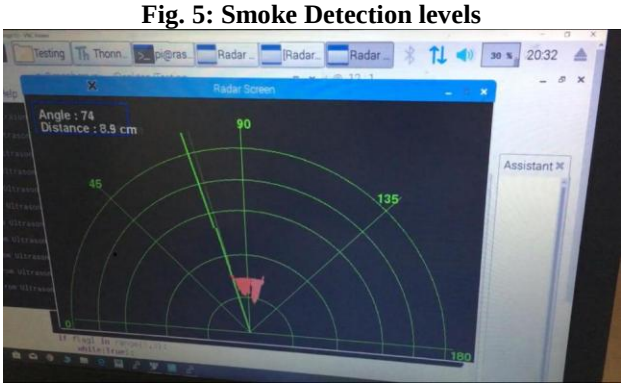


**Fig. 6: Traffic Density Measurement via ultrasonic sensor**

**Table2: Result for Case3 from Algorithm**

| Case 3 | Dynamic Signal Timing |
|---|---|
| S1 | OFF (60 sec) but as traffic full before 60 sec, it must be turn ON (60 Sec) |
| S2 | OFF (60 sec) |
| S3 | ON (60 Sec) Traffic move from C->D, C->A but OFF for C->B |
| S4 | OFF (60 sec) |

## IV. CONCLUSION

Prototype gives insights about smart traffic management and control at the junction in a city. This gives dynamic monitoring of signal and hence reduction in the pollution and saving of fuel are the most important advantages of this system. Major hurdle of traffic issues will be solved with this system which is cost effective and simple and it makes our life better, safe and time saving. The outcome of this project can be further applied in different applications to give IoT based solutions under different ongoing projects of smart city.

## REFERENCES

1. Rahul Jagtap, 'Intelligent Traffic Monitoring System', a report from chairman MSRDC, traffic police, transport and IT dept, Mumbai-Pune expressway , 2016.
2. Ashish Dhar, 'Traffic and Road condition monitoring system', MTech thesis, IITB Mumbai, 2008.
3. Megha Nirbhave, Shashi Prabha, 'Accident Monitoring System using Wireless Application', International Journal of Advanced Research in Computer Engineering & Technology, 2014, vol3(4), pp 1532-1535.
4. S.M.Sharma, 'Road Traffic Accidents in India', International Journal of Advanced & Integrated Medical Sciences, April-June 2016, vol1(2), pp 57-64.
5. Roxanne Hawi et al., ' Techniques for Smart Traffic Control: AN in-depth Review', International Journal of Computer Applications Technology and Research, Vol 4(7), 2015, pp 566-573.
6. Rashid Hussain et al, 'WSN application: Automated Intelligent Traffic Control System using Sensors", Soft Computing and Engineering, vol 3(3), 2013, pp 77-81.

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