Comparative Analysis on Density Based Traffic Control System

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***Abstract*--**Traffic management and control is one of the primary problems which we have faced in many cities and countries. Especially in a country like India which is the second most populated country in the world traffic management is a major issue. Generally traffic is higher and gets jammed mainly at crossroads in many metro cities like Chennai, Mumbai, Kolkata, Ahmedabad, Delhi, Bangalore, Hyderabad and Pune. People at crossroads get tired of waiting for green signal which is a go signal, even if the green traffic signal appears due to heavy traffic only some vehicles are passed and some vehicles are left to wait for another turn of traffic light to go. This makes people furious and cross the roads without following rules and get subjected to accidents. So to avoid these kinds of situations we use image processing and through image processing we can extend the green traffic signal time and also in some special emergency cases like ambulance or some official military vehicles are passing by through image processing we can track the government vehicles and give them green traffic signals in order to pass immediately. Not only this we can also click the pictures of vehicles that are crossing the road and prepare a challan and send them to respective addresses. We can also gather the information from multiple junctions and crossroads and can calculate the probability of getting stuck in traffic, if you are heading in a particular direction of road.This review article discusses various schemes proposed earlier for density based traffic control system.
Keywords-- Traffic management; Density-based; Crossroads; Accidents; Vehicles

1. Introduction

Traffic is a social issue which is of utmost importance. Due to the high cost of infrastructure and present financial constraints, many traffic control and management techniques have been developed to achieve a set of objectives like:

(i) Increase in infrastructure capacity to include image processing tools and IoT [1].
(ii) Increase efficiency by developing new algorithms to improve the flow in traffic [2,3].
(iii) Preventing traffic jams and signals crossings [4].
(iv) Increase in road safety [5].

Traffic management relies on various tools and factors for optimization. There are some strategies which can be implemented in real life scenario as follows:

(i) Collecting information from crossroads and broadcasting on radio channels.
(ii) Traffic control systems such as control of access ramps and reversible lanes.
(iii) Variable tolling.
(iv) Adaptive signal controlling in which the duration and colour of traffic signals are varied [1-3].
(v) Density based traffic management system using sound analysis.
(vi) Real time scheduling algorithms for traffic signal timing [4,5].

Inorder to implement all these strategies, the important element to be considered is monitoring which can be done through cameras. The amount of area to be covered and also good design parameters isdependent on factors likenumber of cameras used;the optimal positioning of cameras; and the cameras placed should be able to cover the blind spots.

This paper provides the framework of decision support systems for real time traffic management depending on the type of road network. The further sections presents a brief description of drawbacks of the current framework and parameters like feasibility of the project, novelty of idea, challenges faced and how to improve the current framework and implement it on a large scale.The rest of the paper is organized as follows: Section 2 describes related workin the field of density based traffic control system,as well as their advantages and disadvantages. The conclusion and future work are concluded in section 3.

2.Related Work

A numerous techniques have been proposed up by many researchers for density based traffic control system. Poyen et al. [6] developed a density-based dynamic traffic light system where the signal light varies in timing. The architecture consists of a Passive Infrared Sensor (PIR) which is interfaced with an Arduino by sensing the traffic with green signal; time is extended for a specific lane which makes it efficient in controlling the traffic system. This system gives the illusion of delay adjustment of traffic signals supported by the number of vehicles that pass through an allocated section of the road. The four sides of the road are covered by the infrared sensors, when the vehicle is detected by the sensor the output voltage of the comparator gets low, within the same way the when object isn't detected the output of the comparator is high which is +5V. The controller counts this alteration of voltage from low to high and therefore the vehicle count is incremented. The sensor module circuit is shown in **Fig.1**. The restrictions of the project is when two vehicles are moving parallel to every other with reference to vertical axis of the IR sensor the vehicle count varies, and not only this when a vehicle is travelling between two vehicles the IR sensor cannot detect it, thereby causing the interference.

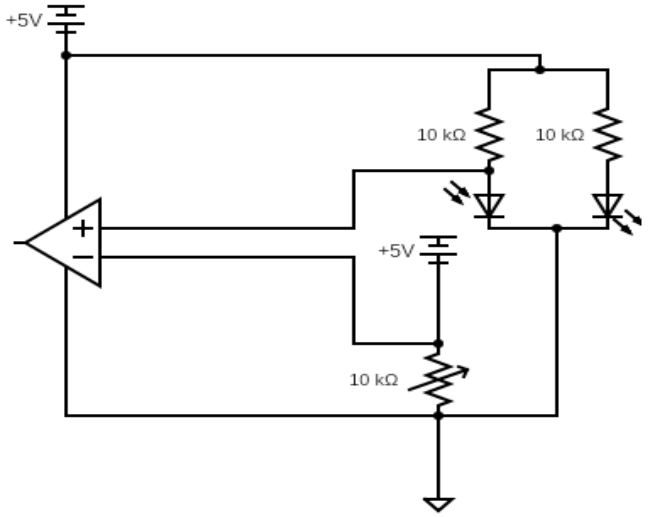

Fig. 1: Circuit diagram of sensor module [6]

Prakash et al. [7] had designed a completely unique real-time system which evades traffic using image processing. In each stage of traffic, a webcam is used during this method to collect pictures of the roads in which traffic always seems to take place. The vehicle count in such images is obtained using image processing tools in Matlab; and dynamic timings are assigned in accordance with the count in conjunction with such a green signal for vehicles to move past the traffic. Through the image matching process captured pics are compared to a picture of the road with no vehicles. Canny edge detection operator is used to operate out the images boundaries. Traffic clearance is regulated by hoping on the proportion of matches between the images. Some other system uses a video camera to capture road images and use that data to control traffic signals instead of finding the total number of vehicles; they specify traffic density comparable to the entire area occupied by road vehicles in relation to the pixel ratio on the video frame. The proposed system is being introduced in Matlab with the aim of reducing the density supported by the traffic. The architecture of system consists of four main steps: a) image acquisition; b) RGB to gray-scale transformation; c) image enhancement; and d) morphological operations. A camera is configured, and will not capture highway video. The video is constantly recorded in sequential frames, and each frame is compared with earlier images captured. Using such algorithms, the total number of cars present in the video is confirmed. The limitations of the project depend totally on the weather and also the position of the cameras installed. When the weather becomes foggy or when there's heavy rain the image quality is affected thereby preventing the execution of further steps within the algorithm. More advances are often created to the system to identify vehicles undergoing the system circle that might help clear traffic. This system is implemented using IR technology and microcontroller PIC16F887. As shown in **Fig. 2**, PIC16F887 has very efficient architecture that can be used low-end security systems, and IR is widely adapted communication technology. For the green signal, the delay lifespan is directly proportional to the number of vehicles on the road. **Fig. 3** shows the flowchart of proposed system.

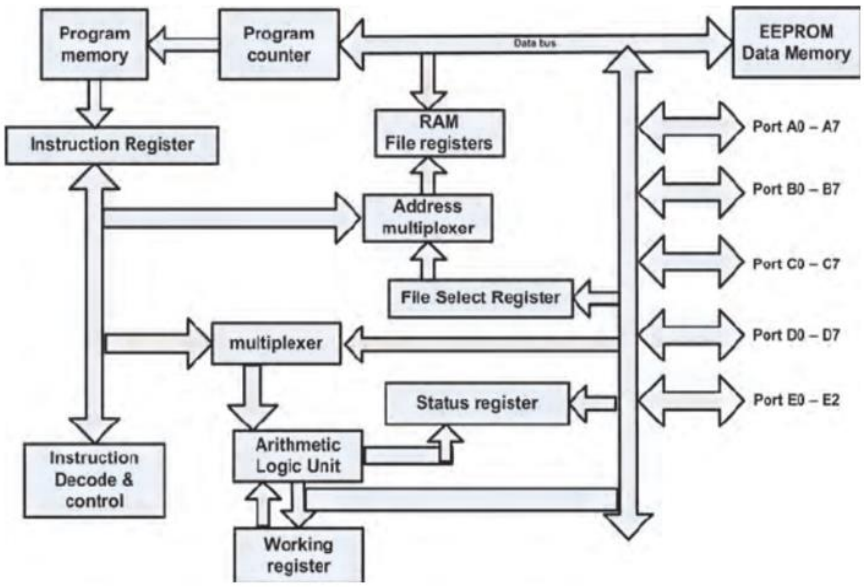

Fig. 2: Architecture of PIC16F887 microcontroller [8]

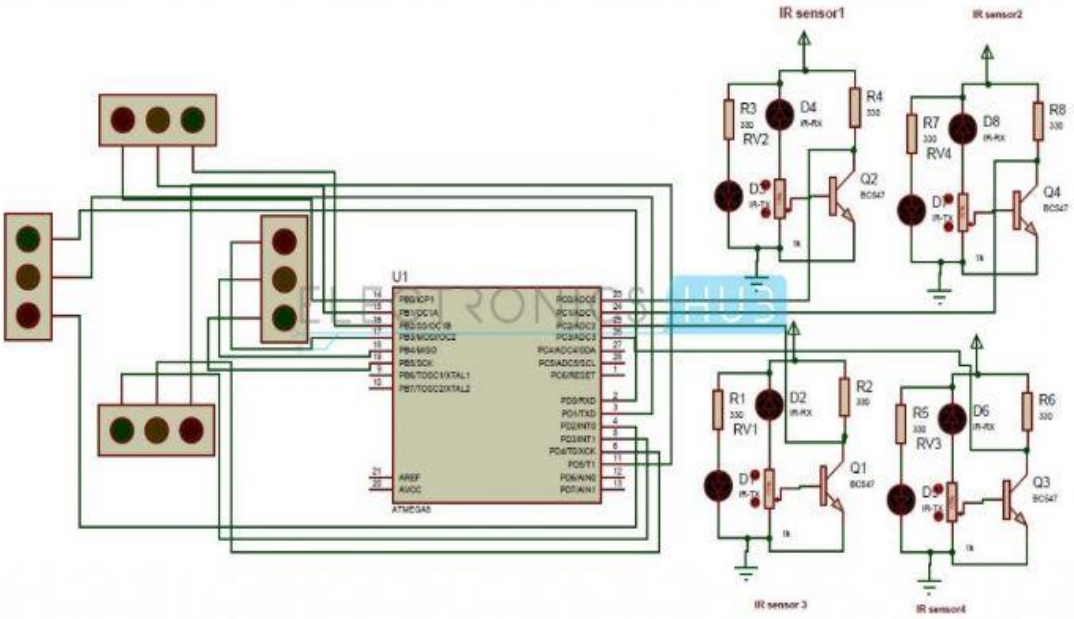

Fig. 3: Flowchart of proposed system [8]

Saiba et al. [9] designed a density based traffic light system with a PIC microcontroller. They were using IR sensors to live the traffic within this system. For each road they also mounted three IR sensors; the space between these sensors depends on the traffic character of a particular junction. These sensors will sense the amassing of vehicles thereon particular road. They have assisted all such sensors; the controller recognizes the traffic congestion and finds out the time delay of signals dynamically. This system uses an IR sensor-interfacing with PIC microcontroller. Three IR transmitters and IR receiver are positioned for each road. When a vehicle crosses between certain IR sensors, the photodiode is activated and therefore, the object is detected and the counter gets a clock pulse. The data collected about the density for each junction, each road is then analyzed to change the green light delays accordingly. Traffic density is measured as low, medium and high used on this density as shown in **Fig. 4**, varies the duration of traffic light for a specific route. The waiting time will not be displayed on LCD displays (**Fig. 5**). The whole procedure is going to be repeated during a cyclic manner for each road. The positioning of the sensors is shown within the **Fig. 6**.

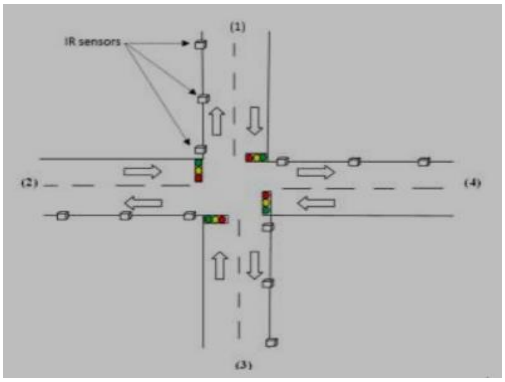

Fig. 4: Placement of sensors on all sides of the crossroad [9]

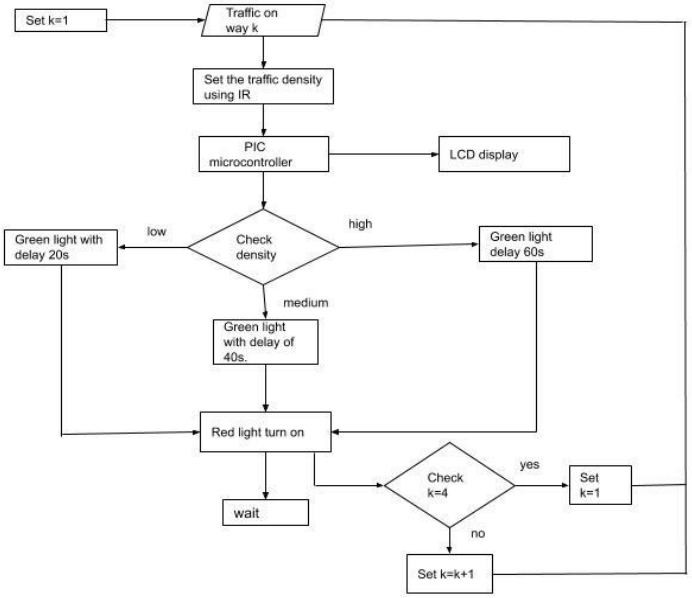

Fig. 5: Block diagram of the working system [9]

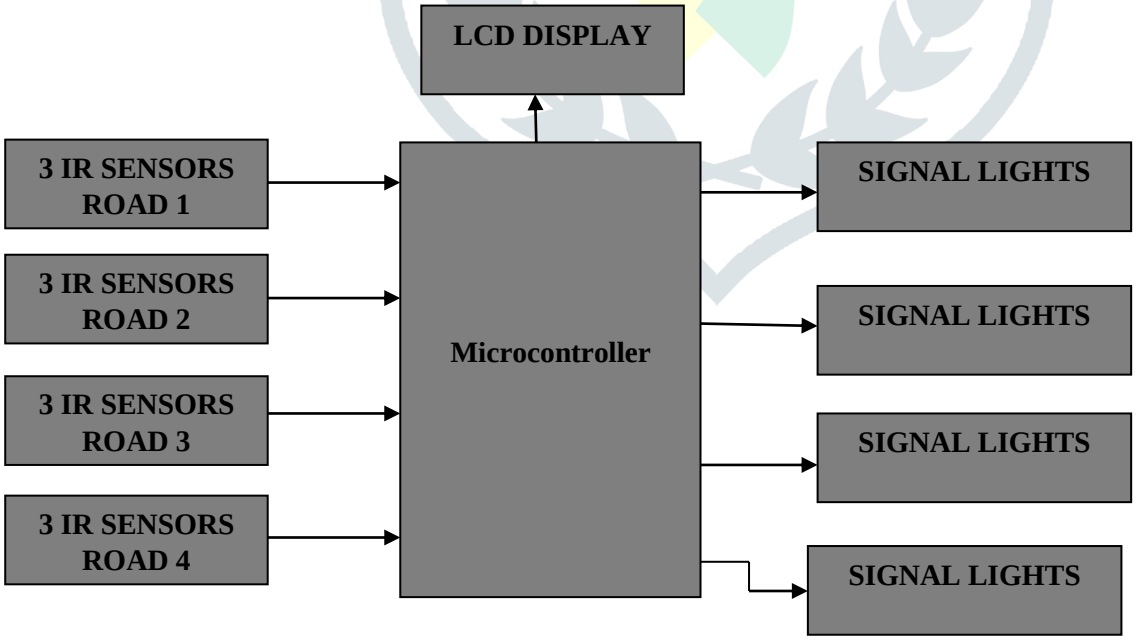

Fig. 6: Positioning of the IR Sensors [9]

Na et al.[10] designed a new acousting technique that utilizes an array of sound detecting equipment to detect the sound waves generated by the trucks passing on the highway. The signals detected are sent for digitization and processed by an on-site computer employing a analgorithm which utilizes the concept of correlation, with the help of this algorithm factors influencing the density of traffic are estimated, e.g., the velocity and clustering of trucks on the road. As compared with existing sensors of the clustering traffic, the

proposed system offers a budget friendly systemwhich can be afforded by even small villages and is a smaller amount intrusive to the encompassing built environment. The processing factors of the Acoustic traffic is shown in **Fig. 7**; the sound based traffic monitor is fitted on the side of a passage way above the horizontal plane. The way it is installed doesn't cause any interference, slicing the horizontal plane. The sounds emitted by Vehicles (consists of knocking of fuel, exhaust noise etc and other noise made by machine parts). The associative analysis of the signals is done, then, the crossroads positions are detected and factors like no of trucks, knocking sound pollution, velocity estimation and the process to derive these factors are shown in (**Fig. 8**).To detect positioning of trucks beam former techniques and also resonance parameters are used. The signal to noise ratio is also calculated using the array of sound detecting sensors. By the placement of array of sensors there are two types of zones formed, the first zone coloured red is a zone where the intensity of detection is high and the zone which is coloured in blue the intensity of detection and estimation in low, in a way we can say that trucks in red zone are estimated perfectly. So by forming a cluster of red zones we can form a cross junction to determine the traffic.

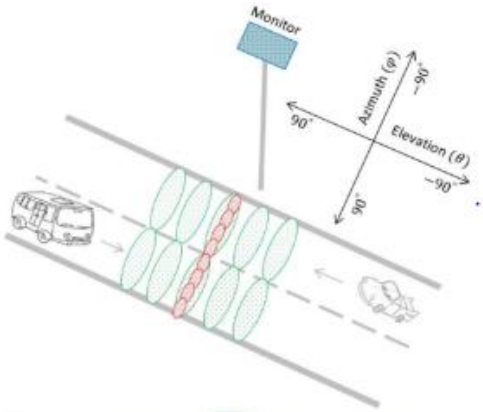

Fig. 7: Zones of detection [10]

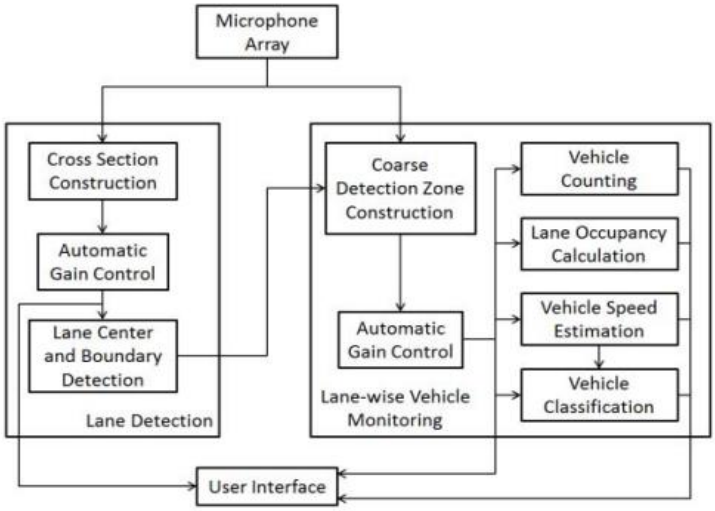

Fig. 8: Architecture of the proposed system [10]

The factors concerning analysis of the above systems are shown in **Table 1.**

Table 1: Analysis of existing systems

Author	Year	Technology Used	Advantages	Disadvantages
Poyen et al. [6]	2016	Proximity Infrared (PIR) Sensor, Arduino microcontroller	Easily Programmable microcontroller and simple to use, very less power consumption by the sensors and the microcontroller	Delay introduced cannot be dynamic, it has to be predefined in the Arduino program, emergency cases like ambulance or government vehicles are not considered.
Prakash et al. [7]	2018	Convolution neural networks (CNN)	Dynamic delay, emergency cases like ambulance or government vehicles are considered.	High implementation cost, image quality affected due to weather conditions and power consumption is also high.
Lakshmi et al. [8]	2018	PIC16F887 Microcontroller, IR sensor	Efficient microcontrollercan handle many sensors and data input at once.	Programming PIC16F887 microcontroller is a bit difficult due to its huge architecture, emergency cases are not considered, no case of dynamic delay.
Saiba et al. [9]	2017	PIC microcontroller, IR sensor	Less implementation cost, sensors can be replaced easily	Interference may occur from infrared emitters such as car remote, the count of the vehicles is also not perfect and may vary in many instances, apredefined delay is given for green signal which may cause trouble in real time situations.
Na et al. [10]	2015	Sound recorders, attenuators and some processing tools.	Passive monitoring technique(no effect on human body),faster than image processing,vehicle speed estimation.	Interference caused by other sources of sound, Exact number of vehicles cannot be estimated

3. Conclusion

In this paper, a comparative study is provided on many related works of density based traffic management system. Many models have been introduced with microcontrollers which lack dynamic delay allocation of green signal; although works related to image processing are proposed major cases include vehicle detection which is mostly dependent on the quality of the image or video. Rather than counting the vehicles the area unoccupied at the junction can be calculated and the no of vehicles can be estimated which provides a better and a faster algorithm. Many factors like alarming for overspeed, imposing challan on particular vehicles by identifying the vehicle registration plates and providing green signal to a particular lane in case of emergency can be included to the system. Also by collecting information from all the junctions of the city traffic at a particular junction can be estimated which may prevent traffic jams.

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