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Intelligent Traffic Signal Management

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bstract: Steady increase in number of vehicles has prompted new solution to manage traffic congestion. Intelligent Traffic Signal Management can control traffic in need of an hour by manipulating traffic signals based on real time traffic density using surveillance cameras. Existing system is pre-timed where each signal is allotted with specific duration, independent of vehicle's presence on that lane. Current traffic system disturbs and reduces the traffic fluency due to the queue delay at each traffic flow. ITSM will capture real-time traffic flow images of each direction and automatically assign specific duration according to the changes of traffic flow, thereby increasing the traffic efficiency of intersection of roads and achieving a best control for traffic. This work needs a study of traffic control over the city that will be implemented.

Keywords: Haar-Cascade, Intelligent Traffic Signal Management, ITSM, Raspberry pi, Traffic Congestion, YOLO.

1. INTRODUCTION

Millions of vehicles pass via roads and cities every day. Various economic, social and cultural factors affect growth of traffic congestion. The amount of traffic congestion has major impacts on accidents, loss of time, cost of money, delay of emergency. One approach most states are taking to address this issue is the expansion of roadways. However, this approach still comes with its share of challenges. Demolition of older roads can be quite costly. Most urban cities lack the free space required for such a venture. Even with the improvements in road infrastructure, it is evident that the rate at which travellers buy vehicles has surpassed that of new infrastructure development. Also due to expansions, roads are able to serve more vehicles, consequently utilizing the additional capacity. This is consistent with the 'fundamental law of highway congestion' suggested by Downs [1] who avers that increasing road supply invariably increases vehicle traffic.

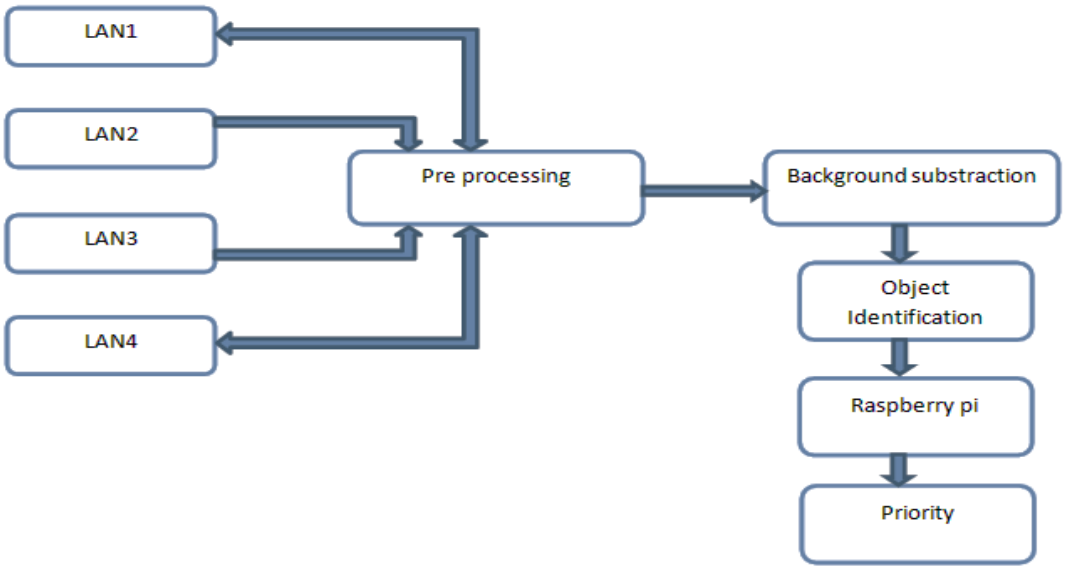

FIG 1

Many traffic light systems operate on a timing mechanism that changes the lights after a given interval. An intelligent traffic light system senses the presence or absence of vehicles and reacts accordingly. The idea behind intelligent traffic systems is that drivers will not spend unnecessary time waiting for the traffic lights to change. An intelligent traffic system detects traffic using object detection method.

Priority of duration will be assigned depending upon vehicular density in each lane. Rotational flow of signal will be kept as current system only timing of signals will be manipulated, maximum flow time of each lane will be fixed so other lane will not suffer due to heavy congestion on one lane.

2. LITERATURE REVIEW

Based on current scenario of Nagpur here are some stats on Nagpur's current traffic condition:

1) Nagpur is now the third largest city in Maharashtra faces traffic congestion particularly in the different road intersection due to rapid and uncontrolled development by an unacceptable level of disparity in transportation demand and supply scenario of Effectiveness for signalized intersections.

2) Areas with high traffic congestion in Nagpur are Wardha road, CA road, Hingna T-point, Mahal, Gandhibagh and many more. Taking consideration one of such area is from Chatrapati square towards Hingna T-point, this location is identified on the basis of traffic flow taken into account by the views and problems faced by the local people travelling through this routes which faces heavy traffic congestion at morning and evening peak period due to heavy traffic, which leads to accidents and environmental imbalance.

3) The city's traffic scenario is a study in contrast. While the traffic is bursting at the seams, police are reeling under the perennial staff crunch. The vehicular population in Nagpur has crossed the 20 lakhs marked. The number of traffic police to monitor vehicles can be gauged from the fact that just 644 policemen have been employed to monitor the 20 lakh vehicles in the 400 square km area of the city. It means that 1 cop for 3106 motor vehicles. The top priorities are given to busy roads, the flip side is that the internal roads get left out of enforcement, for which the demand is only growing each day proportional to the problems they are facing. But there is little the traffic police can do.

4) Average speed of a city is often used to determine the growth and flow of the traffic in the city , the current average speed of Nagpur city is 27km/hr. if no changes are made for the traffic management the average speed may go on to 23km/hr. .NIT has targeted this average speed to be 35km/hr. by 2032.

5) Nagpur's population has reached to the mark of 24 lakhs, but the use of public transport haven't reached to the level resulting in most of the people using their private vehicles causing more traffic on the roads. It is targeted to have 50 buses/lakh which is currently 8 buses/lakhs. It is also observed that the commercial vehicles move a lot from ward road, Amravati road etc. which takes up more space and causes more traffic.

6) The emission of the vehicles currently is 29ton/day which would go on up to 69ton/day if nothing is done.

Current most efficient technology on Traffic Management is DSRC (Dedicated Short Range Communication) which was introduced by Department of Telecommunication and will be implemented in the near future. DSRC technology is potentially a much cheaper technology for detecting the presence of vehicles on the approaches of an intersection. However, at the early stages of deployment, only a small percentage of vehicles will be

equipped with DSRC radios. Since this adoption stage could last several years due to increasing vehicle life, new control algorithms that can handle partial detection of DSRC equipped vehicles are required.

3. INTELLIGENT TRAFFIC SIGNAL MANAGEMENT (ITSM)

INTELLIGENT TRAFFIC SIGNAL MANAGEMENT (ITSM) algorithm considers the real-time traffic characteristics of each traffic flow that intends to cross the road intersection of interest, whilst scheduling the time phases of each traffic light. The introduced algorithm aims at increasing the traffic fluency by decreasing the waiting time of traveling vehicles at the signalized road intersections. Moreover, it aims to increase the number of vehicles crossing the road intersection per second.

In this method we are proposing to reduce the heavy traffic and congestion on the road by using raspberry pi. This would work using image detection using surveillance camera and raspberry pi processing images using open-cv. Output of surveillance cameras will serve as input to raspberry pi which will detect traffic density using image detections algorithm like

Haar-cascade and YOLO (You Only Look Once) depend upon accuracy.

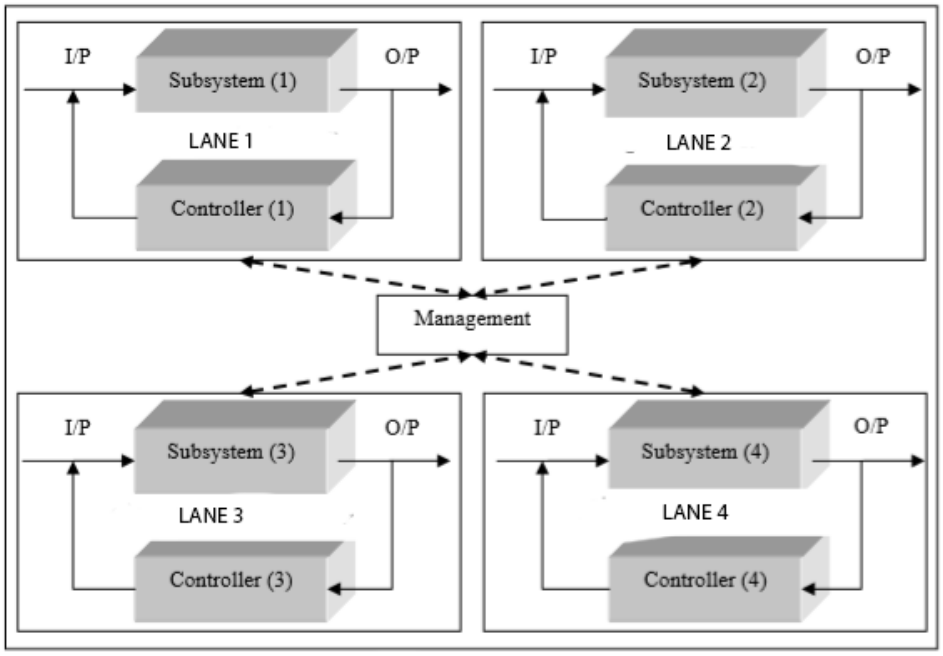

FIG 2

As fig 2 depicts complete control system of ITSM, where subsystem shows combination of camera and signal. There would be 4 raspberry on each traffic signal and main controller which would act as communication device between 4 subsystems. Each vehicle would be allotted with flow time and depending upon density of vehicles green time would be allotted to each lane which would vary dynamically based on output from subsystem. Flow time will also vary depending upon size and shape of vehicles. In emergency conditions vehicles like ambulance and fire brigade given special priorities. Raspberry pi will be used as controlling device which itself is a single board computer having ARM Cortex microcontroller. Raspberry usually runs on 5V supply.

4. VEHICLE DETECTION ALGORITHM

4.1 HAAR-LIKE FEATURE

A Haar-like feature considers adjacent rectangular regions at a specific location in a detection window, sums up the pixel intensities in each region and calculates the difference between these sums. This difference is then used to categorize subsections of an image.

For example, vehicle, it is a common observation there would be different in intensity of background and object.

Therefore, a common Haar feature for car detection is a set of two adjacent rectangles that lie on vehicle. The position of these rectangles is defined relative to a detection window that acts like a bounding box to the target object. For creating haar cascade file, we have to train classifier by giving positive and negative images brute fully.

$$f(x, y) = \sum_i p_b(i) - \sum_i p_w(i)$$

As above equation shows difference in intensity of pixels, for high value of f(x, y) object would be detected. As we trained our model we have achieved efficiency of 73% which is quite low.

4.2 YOLO

Prior detection systems repurpose classifiers or localizers to perform detection. They apply the model to an image at multiple locations and scales. High scoring regions of the image are considered detections. YOLO use a totally different approach. We apply a single neural network to the full image. This network divides the image into regions and predicts bounding boxes and probabilities for each region. These bounding boxes are weighted by the predicted probabilities. YOLO model has several advantages over classifier-based systems. It looks at the whole image at test time so its predictions are informed by global context in the image. It also makes predictions with a single network evaluation unlike systems like R-CNN which require thousands for a single image. This makes it extremely fast, more than 1000x faster than R-CNN and 100x faster than Fast R-CNN. Advantages of YOLO over other models are accuracy and Speed (45 frames per second — better than real-time), Network understands generalized object representation.

5. RESULT

Here we consider a normal width of the lane and assuming only two vehicles can pass at a time and taking flow time of car as 3 sec and delay time as 2 sec, maximum green time allowed to each lane will be 60 Sec.

Following table shows time allotted by ITSM system to each lane:

NO. OF VEHICLES	LANE NO.	CONVENTIONAL TIME (Sec)	ITSM SYSTEM TIME (Sec)	TIME SAVING (Sec)
24 Cars	**1**	**60**	**48**	**12**
10 Cars	**2**	**60**	**25**	**35**
40 Cars	**3**	**60**	**60**	**0**
8 Cars	**4**	**60**	**20**	**40**

6. CONCLUSION

Traffic congestion and tidal flow management are recognized as major problems in urban areas. This method will help reduce congestion on roads and would help in coping with accidents the proposed system is an efficient and highly economic solution to traffic problems in metropolitan cities in India, where exponentially increasing traffic is a growing concern.

Some outcomes of ITSM:

1. The average speed of the vehicles will decrease and this eventually lead to rapid growth in overall person's efficiency and this will combinedly increase the efficiency of the city.
2. Huge manpower is lost for controlling traffic jams across the city this can be compensated by our ITSM; these traffic policemen can be deployed in other places where there presence is essential.
3. Traffic jams causes drastic effects on human life due to noise as well as air pollution which can be tackled with help of ITSM.
4. Accidents can be minimized.
5. Other infrastructural projects can be smoothly executed.

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