Real Time Traffic Management System Using Image Processing

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***Abstract*—The traffic control system in our country is non-flexible and non- adaptive to the ever increasing number of vehicles . This causes traffic congestion and has great impact especially in populated cities. Time and fuel that are very important resources are wasted. In this paper we propose a real time traffic control system to reduce traffic congestion. This system analysis can be useful for public safety and time management. The system is designed based on computer surveillance system where information is extracted from the video using computer vision and patter recognition techniques. It then processes the information of the video using image processing , computes the volume of the traffic and sets the time of the traffic signal accordingly.**

I. Introduction

Traffic congestion is a problem that is increasing day by day. Sometimes the length and width of the road can be too small to allow the vehicles to pass. The density of the traffic changes at different time interval which results in traffic jam. The conventional traffic system cannot manage these ever changing density of traffic. If one road has more traffic jammed compared to others the system fails to prevent traffic congestion. To solve this problem, a real time based traffic system should be designed that will change the traffic signal according to the traffic density. In this paper different systems are proposed where the vehicles are detected, density of vehicles are calculated according to which the time of the traffic signal is set.

II. Methodology

In paper [1], first the RGB colors are taken and then it is send to the central sever where it is converted in to grayscale image which undergoes edge detection. Sobel edge detection technique is used as it gives better results for edges detection. After this the image is converted into binary image. One issue that is faced using this algorithm is that the shadows of huge objects such as buildings cast on the road mess up the thresholding process as the values may introduce to noise or get rid of important information. Therefore, in [1] Otsus multiple thresholding algorithm is used over different pixel areas in the image which gives better output. Using trigonometric operations, a relation is formed between pixel location and its distance from where the camera is mounted. The distance is scanned and calculated which is then multiplied with the width of the road which gives the total area covered by traffic. Figure 1 shows the work flow of this paper. It also uses ORB algorithm which observes the camera image and checks the image of same lane after a particular time, if the image is 90

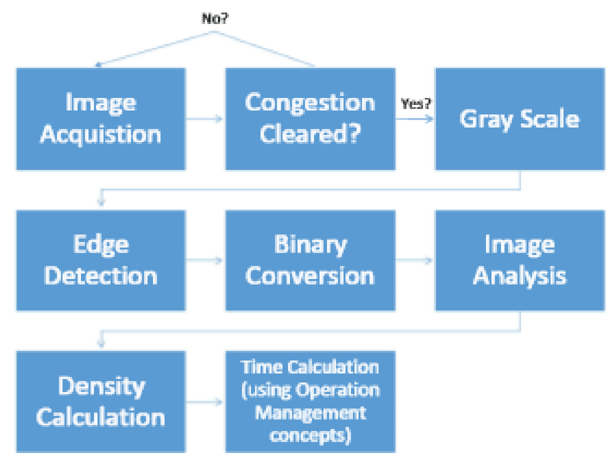

Fig. 1: Workflow of the system[1]

In paper [2], the traffic congestion is estimated using few steps. First the image acquisition process is done where the images are captured of roads with or without vehicles.Figure 2 shows the image acquisition. Image cropping process is

Fig. 2: Image of Roads with vehicles[2].

done to reduce processing time as well as analyse our region of interest to remove unwanted objects like trees, buildings, etc. These objects create some unwanted errors. Figure 3 shows the cropped image. The color (RGB) image is

Fig. 3: Image of Roads cropped[2].

converted to gray image to detect the edges clearly. Figure 4 shows the converted grayscale image. Later the unwanted

Fig. 4: Image converted to grayscale[2].

objects are removed like trees, buildings, etc . on both sides of the road as these object will decrease the accuracy of the measurement of traffic density. Then edge detection process is done using Canny edge detection technique. After applying Canny edge detection method there are gaps between the edge segments on the image that does not give us proper outline of the vehicles.So image dilation process is done to fill the gaps in the image. Figure 5 shows the image of road with vehicles after image dilation. After applying the

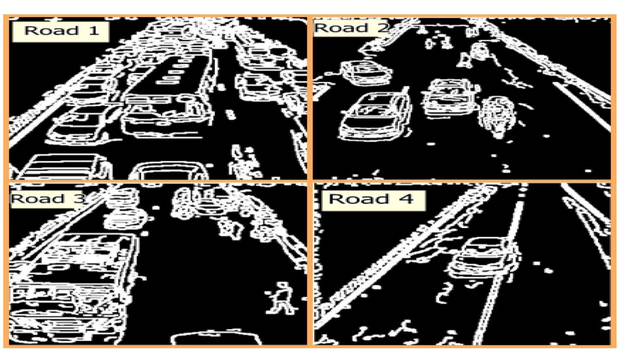

Fig. 5: Dilated Image[2].

dilation image traffic congestion is estimated according to the area and the timer of traffic signal is set accordingly after comparing the roads with number of vehicles in it. [3] Anurag Kanungo , Ayush Sharma and Chetan Singh propsed a model where traffic estimation is done using Hard coded and Dynamic coded system. Hard coded system is like our static traffic control system where the traffic signal changes after particular time irrespective of the changes in density of the traffic. Whereas, Dynamic coded system takes in account the density of the traffic after few seconds and changes the traffic signal accordingly.Figure 6 shows the table with comparison of Hard coded and Dynamic coded system which shows that maximum number of vehicles at different time durations are passed using Dynamic coded system and gives better results.

S.no	Algorithm	Time (secs)	Lane 1	Lane 2	Lane 3	Lane 4	Total
1	Hard	30	0	25	20	24	69
	Dynamic		14	1	17	6	38
2	Hard	60	1	51	28	45	125
	Dynamic		11	1	9	24	45
3	Hard	90	26	70	0	76	172
	Dynamic		8	20	2	25	55
4	Hard	120	45	85	1	91	222
	Dynamic		1	8	24	13	46

Dynamic system may not be used during night as it may not capture clear image in camera due to low light. In [4], Vehicle Detection System is done based on Probability Based Vehicle Detection algorithm. Where the frames are captured from the image and converted into monochrome image. The image then goes through edge detection, binary thresholding, dilation, erosion and labelling operations of different frame. Then the area is calculate to separate the vehicles from the image to reduce noise. After that the number of vehicles are counted and send to Traffic Signal Control System. Then, the Data Display system displays the number of vehicles calculated, total number of pixels that each vehicle contain, the number of vehicle fall into each category and priority to the road. Vehicles are categorised based on size small, medium and large.Figure 7 shows the system design of this paper. In

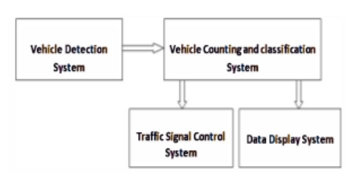

Fig. 6: System design[4]

paper [5], first the vehicle detection process is done applying low pass filtering and edge detection operations. Selection of Edge detector is done where it detects the edges between the vehicle and background . Size of the window has a strong effect on performance of whole system. Here less the number of size of window results in more errors. But as the size of frame increases the computational time increases. In the end, the traffic parameters are measured.

In this paper[6], the author has proposed the use of Wireless Sensor Networks (WSN) to collect volume of traffic that is currently present on the road. After this data has been collected, the system also tries to determine if there is any emergency vehicle that is present on the road. This is one of the most important features of this technique. If there is no emergency vehicle present on the road, lane with the highest amount of volume of cars is allowed to pass. If there is an emergency vehicle, its lane is given the green signal first. It is possible that there may be multiple emergency vehicles. Thus, the author has classified different emergency vehicles according to priority. If there are two emergency vehicles with the same priority in different lanes, the system calculates which emergency vehicle is closer to the intersection. This emergency vehicle is given a green signal. The system also determines the amount of time for which one lane will be allowed to have a green signal.

There are basically 6 cases of emergency vehicles. CASE 1:

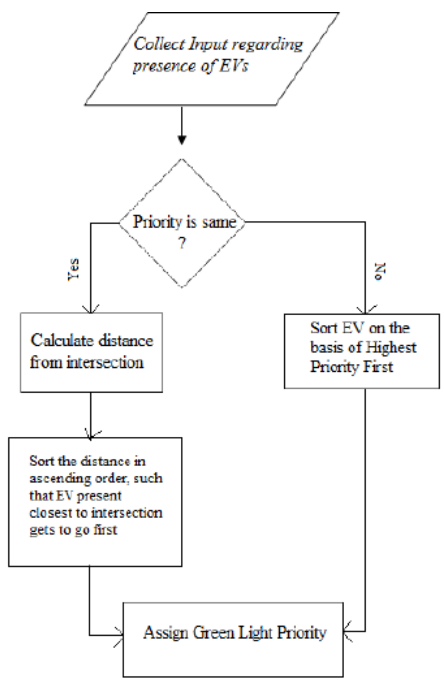

Fig. 7: Flowhcart of system [6]

There is only one emergency vehicle that is present. Here, the lane which has the emergency vehicle will be made green.
CASE 2: There are two emergency vehicles present and each has a different priority. The lane having higher priority emergency vehicles is made green first and then the lane with the other emergency vehicles is made green.
CASE 3: There are two emergency vehicles, both having the same priority. The vehicle that is closest to the intersection is allowed to go.
CASE 4: Four emergency vehicles, each having different priorities and each placed at one of the four lanes. Here, we use Highest Priority First to allow the emergency vehicles to pass.
CASE 5: Four emergency vehicles, each having different priorities and each placed at different lanes. We use the shortest distance algorithm, where the emergency vehicles which is closest to the intersection is allowed to go first.
CASE 6: The emergency vehicles arrive in particular two lanes only. This situation can be can be rightly tackled by increasing the green light time in repeated interval for other phases, when emergency vehicle is not present in any phase 1.

Figure 8 shows flow of the system. The proposed system[7] requires the following things to work:
1.Determination of threshold capacity.
2.Calculations of current flow and tendency of flow at traffic junctions.
Threshold capacity is defined as the number of cars that can pass on the road at the same time without causing congestion. We use Fuzzy Logic to determine the threshold capacity of a road. The inputs of the fuzzy logic are:
1.Number of lanes of roads. 2.Road surface.
3.Visibility.
4.Development of FIS for threshold capacity. The steps of FIS are listed below:
a.Range of fuzzy inputs.
b.Membership functions of fuzzy inputs. c.Graphical and mathematical representation of linguistic variables.// The current flow is the number of vehicles that are present on the road in time i over a particular period of time. It gives us the real time traffic and congestion status of that particular road. The proposed system tries to ensure that the current flow does not exceed the threshold capacity of the road. Figure 9 shows the overall flow of the proposed system. Once we have calculated current flow, threshold capacity and tendency of flow, the proposed algorithm has got its inputs and diverts the traffic as to get the current flow of all roads below their threshold capacity for a smooth movement of cars on all roads.

The author of the paper[8] tells us that the traffic management systems that are currently being used cause a loss of Rs.60,000 crores. This paper suggest a solution which can help reduce this loss significantly, that is, by using internet of things and big data analytics to perform intelligent traffic management. Figure 10 shows overall flow of the proposed system.
In the figure shown above, first, all the sensors placed on the road collect data, patch all the data together and send it for big data analysis. Once the data has been analyzed, all the users on that road gets latest traffic updates and best routes to reach their destination. The amount of time traffic lights remain open depends on the density of traffic. So, if there is more traffic on one road and less traffic on another, then the road with more traffic is allowed to remain open for a longer period of time. The practical implementation of the system is achieved in three parts.

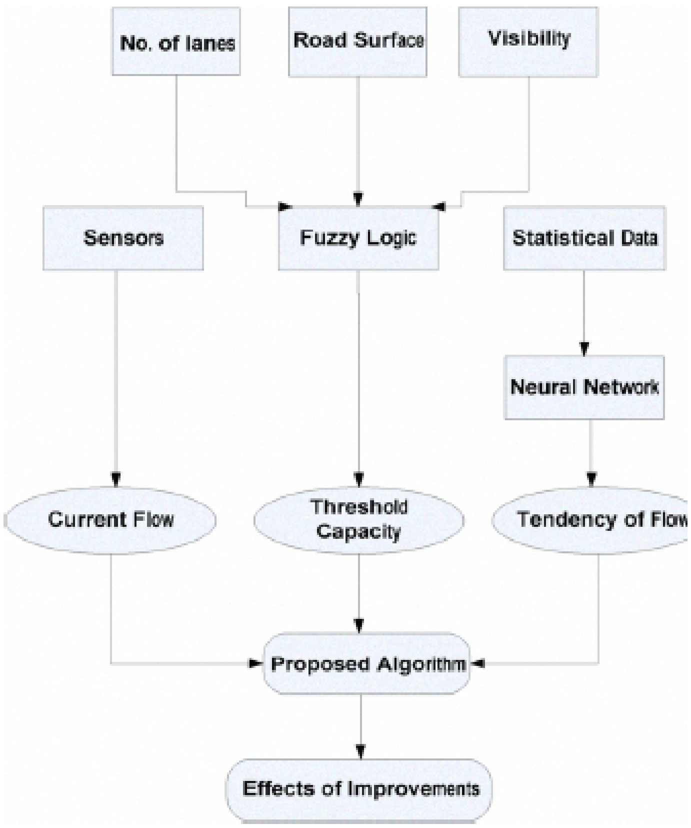

Fig. 8: Flowhcart of system[7]

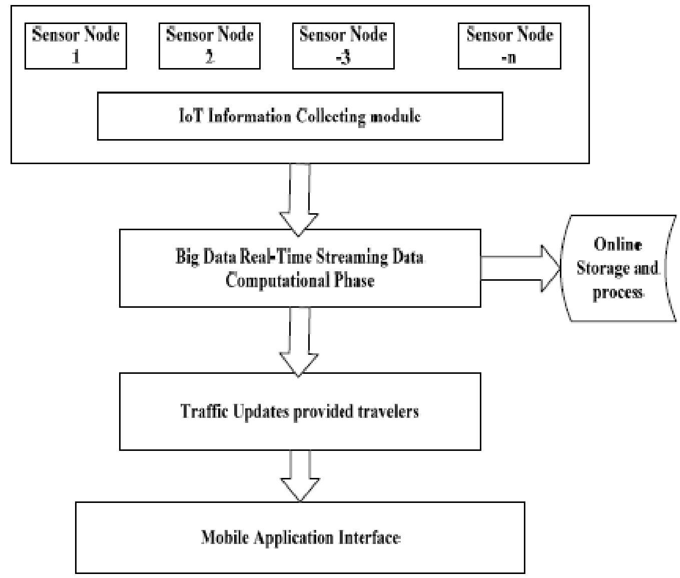

Fig. 9: Flowhcart of system[8]

Fig. 10: 3 major components of system[9]

Internet of things-
Here, collection of data takes place. Use of Intel iot kit is done. It consists of many sensors related to vehicle detection. Sensors can be placed after every 500 meters or 1 kilometer. A minimum of 10 sensors are connected to a single kit for optimal solution. The kit then sends data for big data analytics.
Big data analytics-
This module receives input from the sensors planted on the road, with id of each sensor so that this module can know which data is there for which part of the road and in which area this data has come from. Data analytics operations are performed on the data that has been sent to this module. Certain algorithms can be used to make analysis of traffic.
User interaction modules-
In this module, the user can see the optimal routes to reach their destination and it contains latest analytics as well as some decision tools which can help people reach their destination very fast. Figure 11 shows the 3 modules.

The proposed system [9] has been built to satisfy the requirements of real time navigation at the fastest path level. The basic components of the system are:
1.mobile unit.
2.route guidance system.
The mobile device allows the users to see the router that they have to take to reach their destination as fast as possible. It can be a PDA, smartphone or tablet. Since these devices cannot perform complex tasks, the system uses a client-server model. The route guidance system is the server, one of the most important part of the proposed system. It is this system that will determine which route the user has to take to reach their destination as soon as possible. The server consists of 4 modules. They are:
1.input module.
2.data collection module.
3.path calculation.
4.output distribution module.
The input module converts all the data taken as input into a standard format which is recognized by the system. The data collection module requests on data retrieved from a third party's database. The real time data that is used is:
1.average velocity of monitored arcs.
2. accident reports of the urban networks.
3. current location of customers.
The path calculation happens by working on the real time data that is collected. The travel time is calculated from all the arcs. Then, the system calculates the near optimal fastest path using PRPF Algorithm [4].Output distribution module sends paths the users have to take to them. The algorithms used are:
1.Shortest cost algorithm.

2.Travel time prediction and estimation algorithm.
3.Prediction Based Real-time Fastest Path (PRFP) Algorithm.

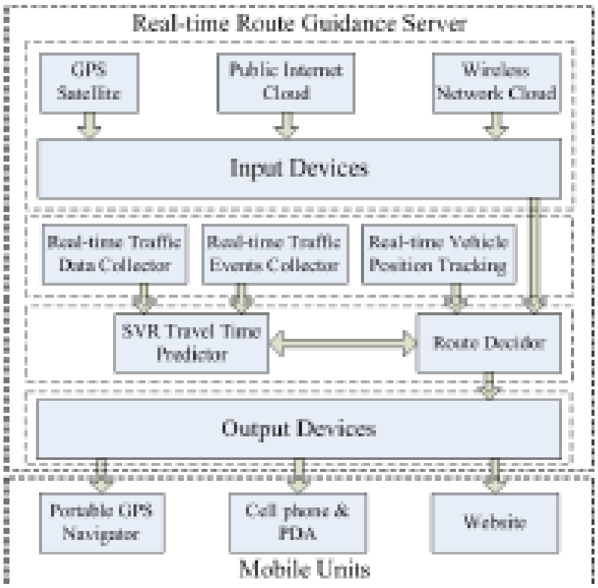

Fig. 11: Overview of the proposed system[10]

The paper [10] talks about how computer vision can be used for managing traffic as efficiently as possible in super busy cities where a traditional signal system just does not reduce it. The paper describes how vehicles are detected using computer vision so as to set signals dynamically based on the cars that are present on a street. There are various algorithms that can be used for detecting vehicles, but the one described in this paper is the Gaussian Mixture Model, also known as GMM. The surveillance is done using three major steps, which are, vehicle detection, vehicle tracking and vehicle classification. The basic flow of the signal management is done in the below mentioned manner. Firstly, the video is provided as an input to the algorithm, which in turn subtracts the background from the video, applies the vehicle detection algorithm, counts the number of vehicles that are present on each side of the road, determines the road with the most traffic and then sets the appropriate signal green, holding other signal values as red, so as to create as less jams as possible. Compared to current traffic management system our attempt will aim to reduce the real time traffic problems using image processing. The research paper says that we can detect the number of vehicles in the lane and try to give the lane with highest number of vehicles first priority to flow. Ambulance ,fire brigades, will be given first priority and with the fastest route for the betterment of society.
The research paper also mention that the basic ways to control real time traffic problems and which devices are used in this, including the ultrasonic sensors which helps to detect traffic and it also helps in detecting number of vehicles.
Figure 13 shows overall working of the proposed system.

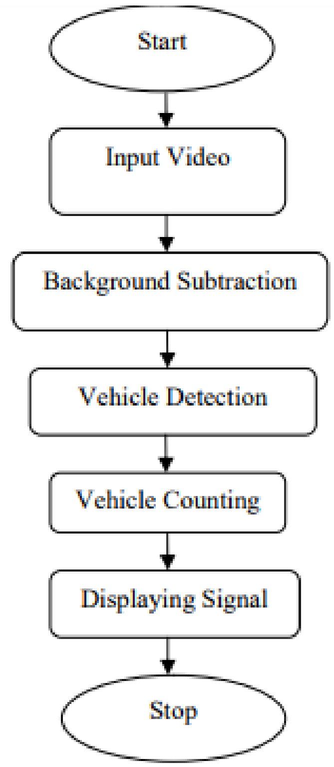

Fig. 12: 3 major components of system[11]

The paper [12] discusses about intelligent traffic control system based on real time traffic flow using MCS 51 single chip microprocessor which achieves real-time monitoring by using ultra sonic sensors. By using tradition traffic system we get to know the duration of the traffic lights which can be adjusted by using this system. With the help of the single chip computer and ultra sonic sensor. The biggest disadvantages of the traditional traffic system is the control time is fixed even though the traffic direction are different at different times. The ultrasonic sensors can work all day and have a accurate reading throughout the day. With which the testing for independent intersections can be done. The system consists of a transmitter which sends out an ultra sonic signal at 40KHz and wavelength of 6mm. The signal is received by a receiver which is featured as piezoelectric effect. Then the receiver can produce weak signals upon receiving the signal. The difference between the voltage of the transmitter and the receiver receiving it detect the amount of traffic. Each lane is deployed with 4 sensors each to detect the amount of traffic and to calculate which lane should be giving priority as shown in figure 14.

The sensors detect number of vehicles in the particular lane with which the signal time is adjusted appropriately. The sensor detect the signal at every 5 sensor for accurate reading. The duration of green light can be increased according to the number of vehicles. The system module include hardware like 4 groups of light emitting diodes- red, green, yellow and a count down display. The count down display would have 2 slices of 8 segment segment tubes. The ranging module

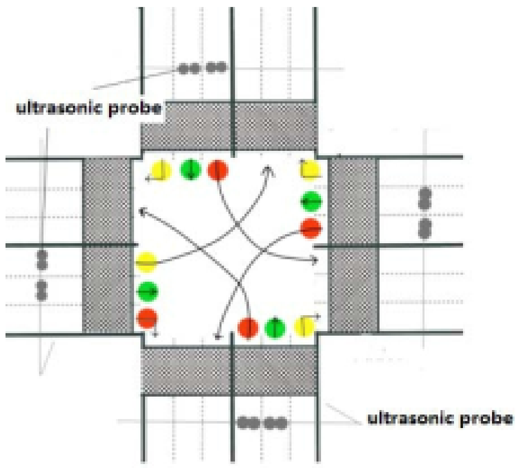

Fig. 13: Lanes deployed with sensors[12]

includes ultrasonic sensors which sends signal higher than 10uS. This calculate number of vehicles while actual distance can be calculated by sound propagation speed. The lights are connected to P 2.0 - P2.2 and P 2.4 P2.6 of the single chip computer.

The paper [13] discusses the morphological change detection system for real time traffic analysis by using edge detection and background subtraction. A number of sensors could be used in detecting the traffic but due to various weather conditions it is too difficult to maintain. The installation of these sensors makes traffic disruption. Instead this method detects moving vehicle in static and dynamic environment by capturing live video. In edge detection the image contains sharp points which corresponds to an edge which is very difficult in a noisy image and due to various surrounding changes edge detection becomes difficult. To solve this various edge detection techniques are used like- sobel operator, Robert operator, prewitt operator, canny edge detector, morphological edge detector, background subtraction. It also uses change detection to detect whether there is no change or not. With that measure the speed of the vehicle through frame by frame detection. The high quality video gets converted into grayscale after which it is subjected to frame extraction step. Next step is motion detection using background subtraction which is done by pre-processing step binary morphology. Figure 15 shows flowchart of this system.

Paper [14] discusses real time estimation of travel speed using urban traffic information system and cctv. The proposed system uses UTIS for real time traffic information by using the on board equipment. The OBE communicate with other OBE system for a fast processing of traffic information. The OBE are fitted into taxis inform of high powered radio with efficient Global Positioning System. The cctv fitted at the intersection have receiver with collect data from the deployed vehicles and form a digital map with the amount of traffic in that location and transmits the data to other OBE vehicles. Then the OBE vehicles calculates the fastest route to a location as it has a digital map where get the intensity of traffic and avoids it by this process. Figure 16 shows the schematic view of UTIS.

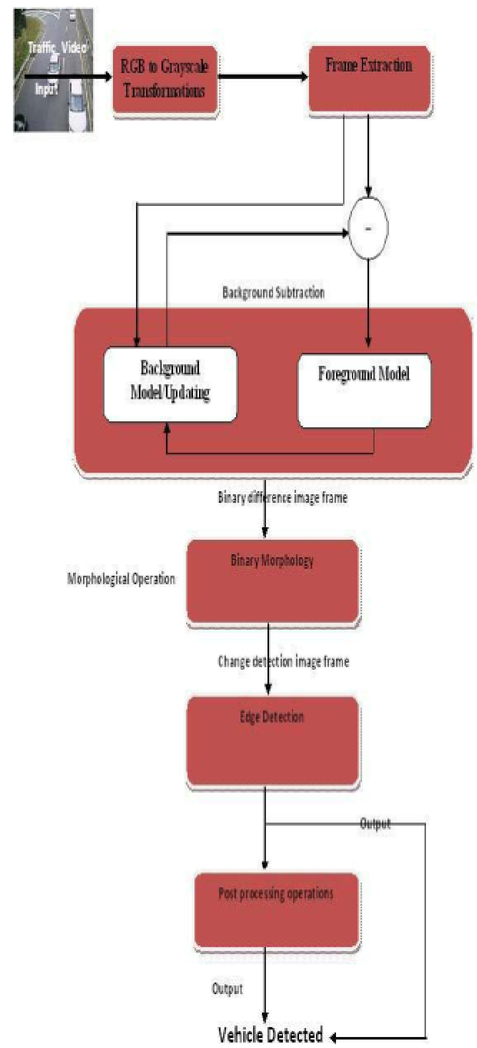

Fig. 14: Flow chart[13]

Paper [15] works on the basis on low complexity model by using cctv installed all different intersections the proposed model records a video of the road the horizontal plane and line of the plane must be 45-90 degrees and the resolution should be greater than 320 x 240 pixels with a refresh rate of 10 frames per second. The cctv cameras place a virtual detector on the road with a size of an average width and length of the car. When a car passes the virtual detector it detects the change in the virtual detect at different time frame it detects the time taken the car to pass by hence detecting the rate of flow of traffic. Figure 17 shows the workflow of this system.

III. Advantages

These algorithms helps to reduce traffic congestion allowing more number of vehicles to pass. Estimation is done using real time traffic system that helps removing congestion from intersections.

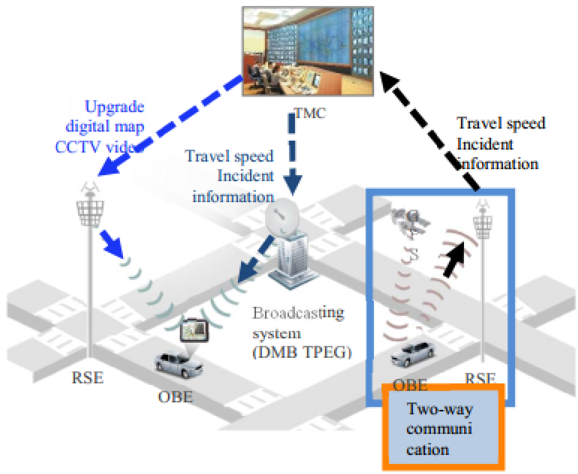

Fig. 15: Shematic view of UTIS[14]

IV. Disadvantages

The system may not give accurate results due to low lights. The systems cannot navigate directional traffic.

V. Inferences

Dynamic coded system do not give accurate results at night due to low lights hence Hard coded system is used not reducing traffic congestion according to the density of traffic[3]. Real scenarios object shape is distorted during processing of real time video mainly due to edge detection and morphological operations like dilation, erosion[4]. While measuring traffic parameter in [5] 10

VI. Conclusion

In this paper, different algorithms are performed for estimation of real time traffic which helps in reducing the traffic congestion. This is area based traffic density estimation methods that can be implemented easily in an intelligent traffic control system in a populated country. This reduces waiting time and will lessen the number of accidents, reduces fuel consumption which will help in controlling air pollution.

VII. Future Scope

In future we plan to design a system that is more intelligent. That calculates the density of the traffic based on weights of the vehicles as heavy vehicles takes more time to pass compared to light weight vehicles. Priorities should be give to emergency vehicles for which audio detection can be used. Also we plan to incorporate an efficient algorithm in which our system learns to navigate the directional traffic, that is rerouting the traffic not only in straight path but also adjacent right turns.

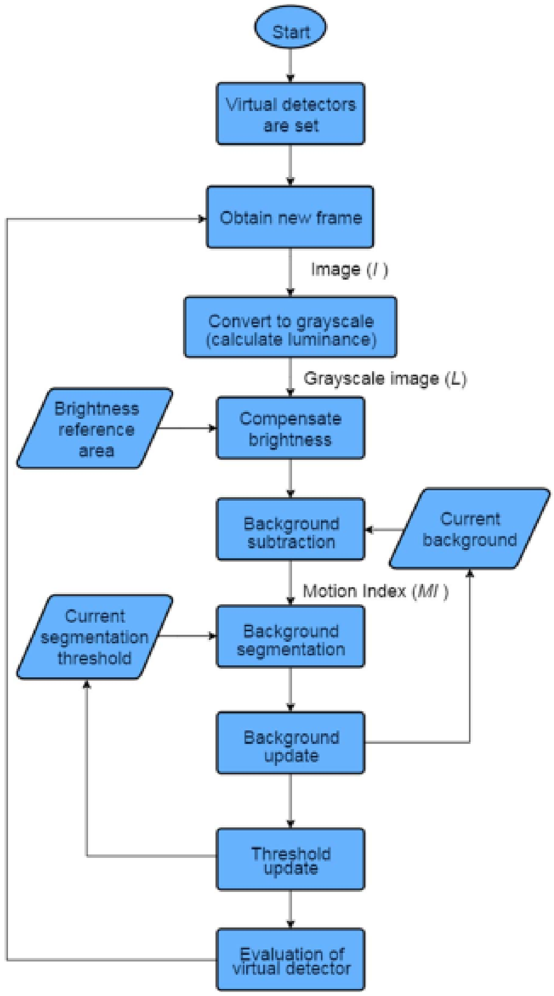

Fig. 16: Worlflow[15]

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