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SMART TRAFFIC CONTROL SYSTEM

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***Abstract*— The project is aimed at designing a density based dynamic traffic signal system where the timing of signal will change automatically on sensing the traffic density at any junction. Traffic congestion is a severe problem in most cities across the world and therefore it is time to shift more manual mode or fixed timer mode to an automated system with decision making capabilities. Present day traffic signalling system is fixed time based which may render inefficient if one lane is operational than the others. To optimize this problem, we have made a framework for an intelligent traffic control system. Sometimes higher traffic density at one side of the junction demands longer green time as compared to standard allotted time We, therefore propose here a mechanism in which the time period of green light and red light is assigned on the basis of the density of the traffic present at that time. This is achieved by using PIR (proximity Infrared sensors). Once the density is calculated, the glowing time of green light is assigned by the help of the Raspberry Pi3. The sensors which are present on sides of the road will detect the presence of the vehicles and sends the information to the Raspberry Pi3 where it will decide how long a flank will be open or when to change over the signal lights. In subsequent sections, we have elaborated the procedure of this framework.**

***Keywords*— Traffic light, density, embedded system, raspberry pi, OpenCV, IR sensor**

I. INTRODUCTION

India is a big country and around the world India is second populous country and fast-growing economy, in today's life we have to face different kinds of problem one of which is increasing number of vehicles it becomes increase in traffic and chaos. Infrastructure growth in India and growth in number of vehicles is not equal, because of large population speed of increase in no of vehicles is much faster than infrastructure growth. Road's capacity and interaction along the roads (cross-roads / junctions) are not capable to handle higher number of vehicles. Major drawback of Indian traffic is non-lane based and chaotic. So, for Indian traffic the solution system is required which is different from developed countries. The paper is grouped into different part. We discuss each part one by one for better understanding. mining technique. The important aspect about the contract will be extracted. The only relevant aspects will be displayed to one or many acceptors, who will then decide whether to make an approach for the contract or not.

The traffic signal was first discovered in 1912 by a Detroit policeman named Lester Wire like two color, red-and-green light with a buzzer to warn pedestrians ahead of the impending transition. After that, in 1920, this basic design was updated by William Potts to include the tri-coloredred, yellow, and green lights widely used today. This simple, three-color icon has allowed for nearly a century with little change, using modern technologies such as automatic timers, diode lights and motion sensors.

Traffic signals are mainly developed to ensure the correct flow of traffic, provide an opportunity for pedestrians or vehicles to cross a junction and help to reduce the number of collisions between vehicles entering intersections from opposite directions. Traffic signals should be considered when they will alleviate more problems than they create. A warranted signal properly operated may provide for more orderly movement of traffic, and reduce the occurrence of certain types of collisions. Unwarranted signals can result in increased crashes, delays and congestion.

The traffic congestion problems are increasing day by day because of the increasing number of vehicles with limited infrastructure. Under this situation, the existing traffic light systems which are timer based are not able to control traffic. To solve this problem, a real time traffic control system is needed which will control the traffic signal according to traffic density. For effective traffic management and signal control, it's important to know road traffic density. Based on this density value time delay of signals can be set up dynamically.

A vast number of reports and statistics state the vulnerable role played by pedestrians in traffic accidents, especially in those who take place in surroundings considered safe by them. Walking is a healthy exercise with almost non-existing negative consequences except for those caused by road traffic. Walking under those circumstances is approximately ten times more dangerous than travelling as a passenger by car. The availability of a wide database of accident causes is considered as one of the most important building blocks in the strategy for the development of intelligent integrated road safety systems. For example, 15% of the total numbers of people killed on European roads are pedestrians, and 28% are vulnerable road users. It is stated that most accidents take place in urban areas where serious or fatal injuries can be produced at relatively low speeds, particularly in the case of children.

Traffic congestion control is one of the major problems in every big city. Traffic accidents sometimes may cause major deaths and injuries. Road accidents deaths caused in many cities majorly result due to traffic-related accidents. As more and more vehicles are stepping into the already congested traffic system, there is an extreme need for advanced methods to overcome the crisis. Since building the new roads, flyovers and elevated expressway etc. will become expensive and lots of time is required; the main goal should be on availing the existing infrastructures more efficiently with the help of advanced technologies.

Managing the traffic dynamically will reduce the traffic congestion. The videos are captured by stationary cameras. Then images from the live videos are retrieved one frame in a second. Image processing is performed over these retrieved frames. The output obtained from the image processing algorithm is the number of vehicles coming from a specific direction. Using this output, we apply a real time traffic management algorithm which controls the traffic signal by synchronizing all the neighboring signals and manage the time duration of the signal accordingly.

Fig.1. Traffic ccongestion at Ttraffic signal

We propose a technique that can be used for traffic control using image processing. According to the traffic densities on all roads, our model will allocate smartly the time period of green light for each road. We have chosen image processing for calculation of traffic density as cameras are very much cheaper than other devices such as sensors. The proposed model is constructed as follows: We have a Raspberry Pi that is connected to 4 sets of LEDS that represent the traffic lights. It is the process of monitoring the traffic density of each side and change the signal according to the density in every direction.

II. LITERATURE SURVEY

Rao et. al [1] has proposed dynamic traffic system based on real time detection of traffic congestion. This system makes use of image processing techniques such as background subtraction, canny edge detection by using a camera module to detect the density of traffic. The camera module takes in the video footage of traffic and processes it frame by frame. The main objective is to detect the dynamic objects. OpenCV software is used to perform background subtraction. A background model is created by comparing the input frames, the images which are static in nature. This background model is subtracted from the next frame, therefore creating a foreground mask which consist of the dynamic objects. Further canny edge detection algorithm is used to detect the edges of the dynamic objects. The results are such that dynamic and static objects are black and white pixels respectively. The prediction mechanism using clustering is also included to plan for the future congestion beforehand.

Ng et.al [2] has proposed a hybrid intelligent traffic light system for solving traffic congestion in Hong Kong. In this algorithm a set of conditions is specified for building an intelligent traffic light system (ITLS). A pygame simulator is built to simulate the visualization of traffic. A regression model is built by training using simulation results to predict the average

waiting time for different parameter sets. Camera is used to record the video at the intersection. This generated video frames are processed by the object detection application and machine learning algorithms. The application used is TensorFlow. This application recognizes the road users i.e. vehicles as well as pedestrians. The proposed algorithm calculates the waiting time for vehicles and pedestrians based on factors which include vehicles queuing at the intersection, pedestrians queuing, extension period of flashing green light for pedestrians e.g. elderly, disabilities, or pedestrians are still on the crossing line. Various set of parameters are taken into consideration to find the optimal parameter set.

Guchhait et.al [3] has developed multiple vehicle detection model using C-OFDM based RADAR for advanced collision warning. In this RADAR signal is combined with C-OFDM which is used to detect the vehicles on roads. Arbitrary Waveform Generator (AWG) is used for signal generation and is transmitted and received through two horn antennas. To replicate multiple vehicles on roads, multiple flat plates are kept with slight distance between them. The distance between the radar antenna and the target is calculated by delay in the received RADAR echo signal. The system is able to successfully detect multiple targets which are displayed on network analyzer. The conventional RADAR system fails to detect multiple objects accurately due to background clutter which is detected and eliminated by COFDM. It also eliminates the probability of undetectable target due to blind speed.

Lam et.al [4] has proposed a real-time traffic congestion detection system using on-line images. This uses online real-time traffic congestion images. It uses real-time but low-resolution images through stationary cameras installed from different locations. There are three main parts in the proposed real-time traffic congestion detection system. First, real-time on-line images provided by the government website are downloaded continuously into a local storage, which are used to estimate the number of vehicles in the images using Haar-like features. The congestion condition is determined using image correlation coefficient. Two degrees of traffic congestion are considered: NORMAL and CONGESTED. When the number of vehicles and the correlation coefficient between consecutive images are greater than a pre-set threshold at the same time, the system will change the traffic status to CONGESTED, otherwise, it will be in the NORMAL. Both thresholds are determined by trial-and-error experimentation using a large number of images. Finally, the traffic congestion information is stored in the database and then extracted by the road users and the government agencies through mobile applications or a website.

Khalil et.al [5] has proposed paper on traffic congestion detection by use of satellites view. Satellites are used as a source to detect the congestion on roads in high resolution. This video is extracted into frames. Image processing techniques like background extraction and frame difference are applied on these frames to detect the static and dynamic objects, here vehicles. Masked image is generated which is the binary image of particular area captured by satellite. Required active area, roads in this case, are detected by subtracting frames from masked image. Roads and other area are white and black respectively. To detect the moving vehicles background subtraction is applied on the current frame with reference to the previous frame. If the vehicle is detected to be moving, they are marked with yellow color while the static vehicles are marked red.

Ellappanet.al [6] has discussed multi-intelligent traffic light optimization techniques by applying modified component analysis algorithm. This estimates the traffic flow using image analysis and machine learning. Real time video is acquired using camera and traffic density information is obtained using Principal Component Analysis (PCA) algorithm. The Hog Feature Extraction is implemented on images from the video which are pre-processed. These results are fed to the trained k-NN classifier. This algorithm is simulated using MATLAB based GUI. If low volume of vehicle congestion is detected then, the traffic signal will have high waiting time to maintain the average waiting time and vice-versa. In this way traffic volumes are estimated.

Sarath et. al [7] has proposed priority based real time smart traffic control system using dynamic background. This algorithm explains that if emergency vehicles such as ambulances, fire engines and police vehicles are detected, the priority of that lane increases. In pre-processing step streaming of video data and RGB to HSV color space conversion is done. After obtaining the binary image and performing morphological dilation and erosion operations, priority vehicle is detected. Traffic density is found using combination of gradient magnitude and direct subtraction method. By using Dynamic Background Traffic Cycle Calculator Algorithm (DBTCA), the traffic cycle is calculated and based on that a weight factor is determined to allocate time for each road. The presence of priority vehicle will increase the priority of that lane and thereby increasing the time.

Chowdhury et. al [8] has proposed a vehicle detection technique for traffic management using image processing algorithms. Day and night images are differentiated and two different methodologies are used to detect the number of vehicles during daytime and night. Foreground RGB image is converted to HSV and then v-histogram is computed. By comparing v-components value with threshold value, day and night is differentiated. To detect the number of vehicles in daylight, RGB images are converted to grayscale images and binary is extracted. By comparing the vehicle areas and threshold value, vehicles are counted. To detect night time vehicles, the foreground image is converted to binary, to filter only the pixels with high intensity thus extracting the headlights. Object counting methodology is used to detect boundaries with no holes and the circularity of the white areas is calculated and compared with a threshold value to distinguish the areas which are more probable to be headlights and the reflections are ignored.

Anandhalli et.al [9] has proposed vehicle detection and tracking algorithm based on color feature. HSV color image are filtered, so that the vehicle colors are extracted apart from any other environmental colors. Before applying blob analysis, morphological operations are applied in order to reduce the noise. Blob analysis is done to detect the number of blobs i.e. the number of vehicles. To determine blobs in a regular shape, convex hull technique is used. Centroids of blobs are calculated. Total number of blobs is defined by total number of centroids. These centroids are tracked by multiple Kalman filter. Data association is used to allocate the same centroid to the Kalman filter which it is tracking. Data association is a matrix where in the detected centroid points are arranged in the matrix form. After mathematical modelling the results are such that columns define the distance and row define the tracker.

Lakshmi et.al [10] has proposed intelligent traffic signal system. Total amount of pixels in a video frame are calculated which corresponds to the amount of area of occupied by vehicles on the road, thus detecting amount of congestion. The obtained foreground and background images are processed such as removal of noise. After application of Sobel Edge Detection technique, moving objects are detected by background subtraction method. Morphological Image Closing Operation is used to preserve structuring element, while eliminating all other regions of background pixels. To fill the holes in the objects with closed contours, flood filling operation is used. Traffic density is calculated by adding the total pixel values in the final binary image. Based on algorithm in MATLAB traffic cycle is estimated which is considered as the function of traffic density. The signal time is transmitted to Arduino from the MATLAB interface which controls signal lights.

III. PROPOSED SYSTEM

The block diagram of the proposed system is shown in Fig.1.

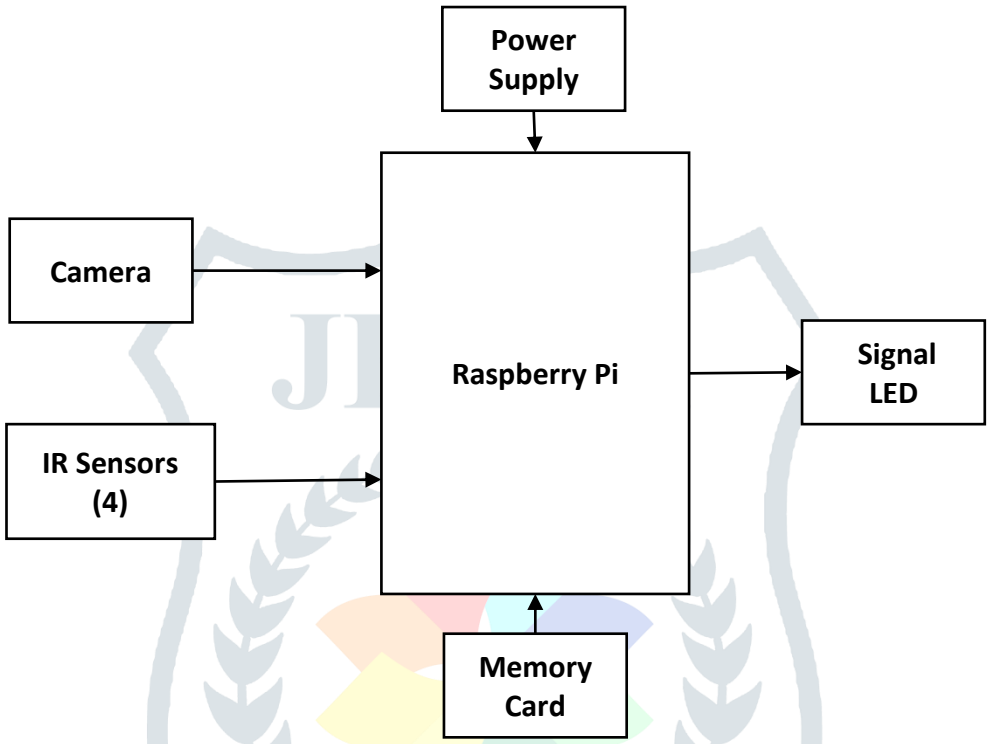


Fig.2. Framework of Density Based Smart Traffic Control System

In this project the hardware module is built as a prototype. The prototype considered the two-way traffic signal. The traffic lights are built using LED. Green, red and orange LED is used to build the traffic signal. The Traffic lights are working exact opposite manner. The red and green light of the signal is controlled through raspberry pi GPIOs.

The density of the road is calculated at each side by camera system place on the pole. The camera module takes a stream from both side lane. The camera position was set and execute the experiment. The proposed system is design for traffic density measurement. The traffic lights of the system is controlled according to the traffic density condition.

IR sensors are also used to detect the traffic density.

Each component of the block diagram of proposed system is explain as below:

- Power Supply:

PCB power supply design can encompass more than just an actual power supply; systems ranging from personal computers to home appliances need a power supply to convert AC power from the wall to DC power with low noise content. PCB power supply design is about more than just converting between AC and DC power.

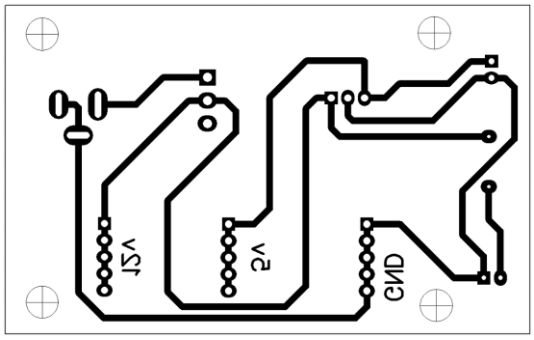


Fig.3. Traffic congestion at traffic signal

A. Camera:

The camera will be located near the traffic lights. It will capture videos of the traffic coming from a particular direction. It will be located on an angle so that it can capture maximum number of vehicles. The camera will send the captured video to the Raspberry Pi board

B. Raspberry Pi Board

Raspberry Pi is a credit card sized computer. It will hold the camera driver. The videos which are captured by the camera will be processed here. Images will be extracted one frame per second from the live video. An image processing algorithm will be enforced on the extracted frames. The number of objects seen in the image will be counted and it will be taken as input. A dynamic traffic management algorithm will be performed which will synchronize the traffic signals.

C. Computer Vision Model

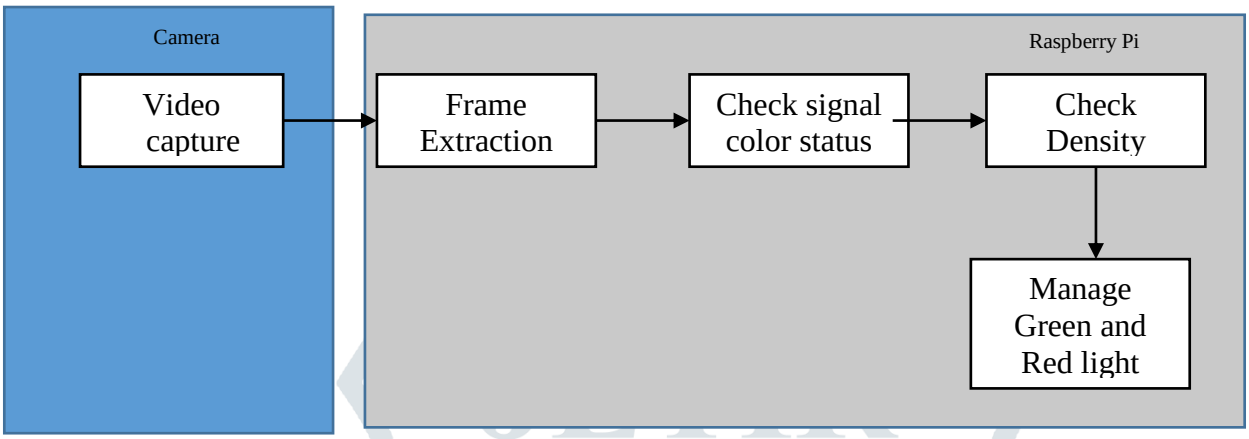


Fig.4. Density detection framework

D. Video Capture:

The video feed is capture from the webcam install on the signal. The camera places at the signal monitor the activity of opposite side of signal.

E. Frame extraction:

The frames are extracted from the video feed which is used for further processing.

F. Detection of traffic density

The frame from the camera is in RGB format. First system converts, RGB image into grayscale and then take an absolute difference between the first frame and next frames. The absolute difference gives the positive difference value of changed pixels. Any change in the scene is detected and have some grayscale value while unchanged pixels have zero value. The thresholding technique is used to convert grayscale into binary. The binary image has 0- and 1-pixel value. The count of 1's value gives the area of occupied vehicles and this area divided by total area of lane is called as density.

In this system when red light ends the traffic density at that time is calculated and ratio of both side density is taken i.e.d1/d2. If the ratio is greater than 1 that means the traffic density at signal 1 is more than that of signal 2 while if the ratio is less than 1 means the traffic density at signal 2 is more than that of signal 1. According to the density ratio, the traffic lights time adjusted.

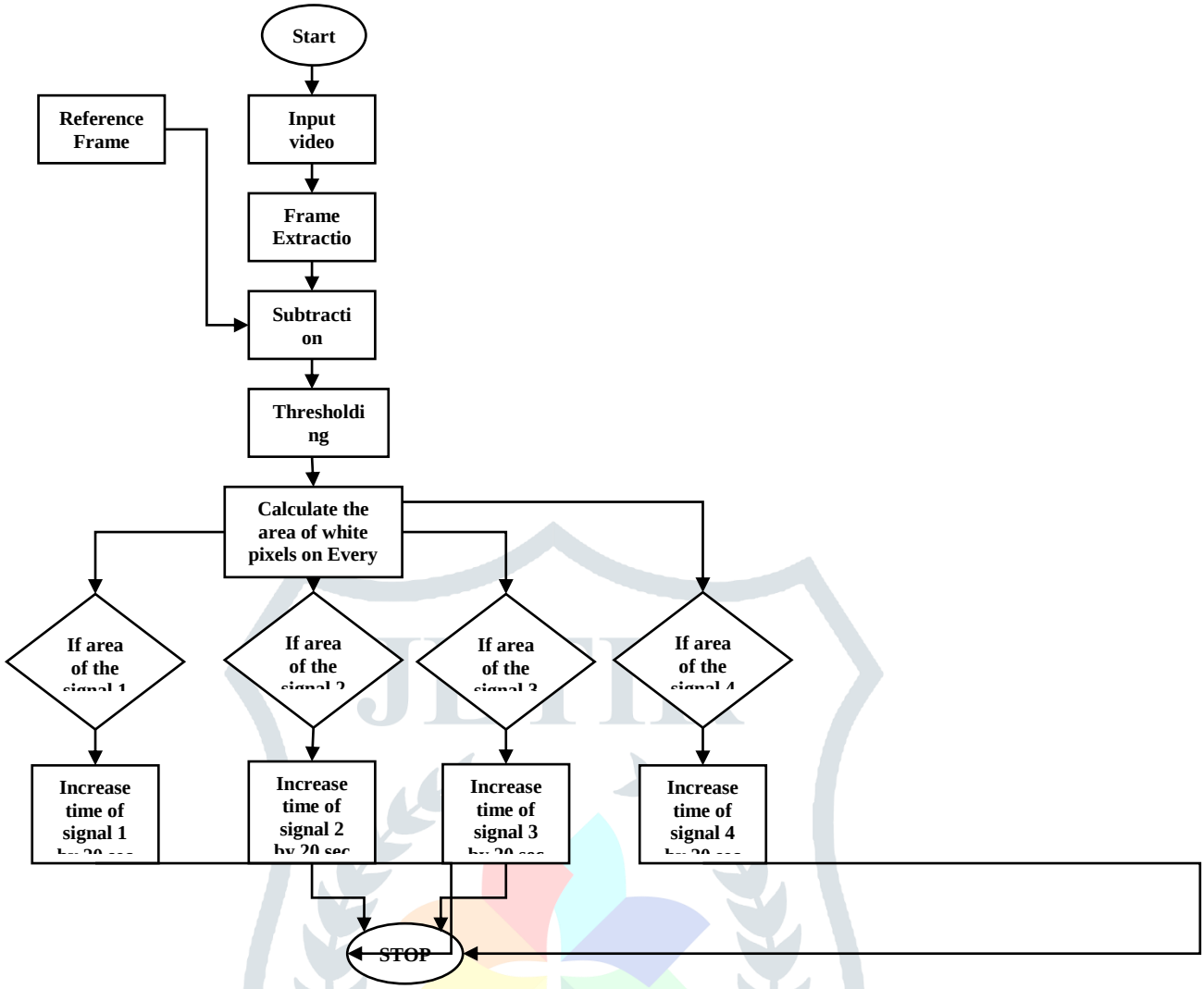


Fig.5. Density detection framework

The background subtraction algorithm is applied to detects the changes. The blank road frame is considered as a background and next frames are subtracted from it. The Thresholding segmentation technique is applied over the subtracted images to get a binary image.

Algorithm:

1. Start
2. Capture video from the web camera
3. Extracts the frames
4. Select Region of interest for maximum limit of traffic
5. Convert the RGB image into grayscale
6. Convert the gray image into binary using thresholding.
7. Calculate the density of the binary object in the scene
8. If the area is greater than the threshold set by user then timing of the signal is set to be more than default
9. end

IV. Result and Discussion

The result and analysis of the proposed system are presented in a qualitative and quantitative manner.

A. Qualitative analysis

Fundamentally means to measure something by its quality rather than quantity. When we do qualitative analysis, we are exploring how we describe something. Very often, we cannot use numbers or numerical expressions to describe those things. When we do qualitative work, we work with descriptions. We work with feelings, thoughts, perceptions. We attempt to understand motivations and behaviours. In simple word, the qualitative analysis is the pictorial representation of the approach.

The qualitative analysis of the proposed approach is as shown below.

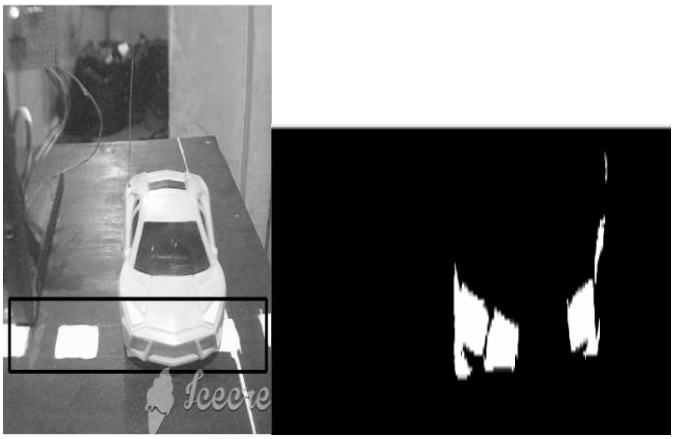
B. Traffic Density

Fig.5.1 Traffic Density (A) Traffic Density (B)

Fig.5.3 Qualitative analysis of anomaly of the proposed system (Traffic Density)

Fig (a), shows the traffic at signal 2 while Fig (b) shows the traffic at signal 1. It is observed that traffic at signal 2 is greater than traffic signal 1. hence the green signal of signal 2 should be greater than signal 1. Fig. (c) shows the time of green light at signal 1 is less than signal 2.

C. Zebra Crossing



(a) (b)

Fig.No.5.4 Qualitative analysis of anomaly of the proposed system (Vehicle on Zebra Crossing)

Fig (a), shows the vehicle on the zebra crossing when the red light is ON. It is calculated by the frame differencing between the first frame where the object is not present and the current frame. It gives the difference and its binary image is as shown in Fig (b). When an object is detected, the frame is saved for further investigation and evidence.

V. CONCLUSION

The proposed system is implemented using computer vision and Embedded system. Camera and IR sensors are used to detect the traffic density. Computer vision algorithms are effective in case of object detection hence system would be more precise. The system is built on portable, low powered raspberry Pi 3B+ hardware platform. In this approach, the prototype for road traffic signal is design. The USB camera is used to record the videos. The IR sensors are used to detect the traffic. The vision-based algorithm is designed and implemented using python language and OpenCV library. The proposed system shows satisfactory results.

In future, the zebra crossing rule violation can be extend further for number plate detection and recognition of number. The SMS can be sent to the respective vehicle owner. In addition to this we can monitor the different anomalies in the road traffic scenes. The ambulance detection is one of the tasks can be achieve in future.

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