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Automatic Signal Scheduling For Efficient Traffic Management

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ABSTRACT- Increase in population in cities due to urbanization has led to enormous growth in traffic and congestion problems. Present traffic control systems have been inefficient in solving everyday traffic problems as they involve preset signal timings and result in increased waiting time of vehicles as it does not consider the density of vehicles on the roads thereby increasing traffic congestion. In this project, we implement an automatic signal scheduling approach using image processing techniques like background subtraction and blob analysis to estimate the vehicle density and accordingly allocate and set signal timing so as to be able to clear the traffic in less time thereby decreasing congestion and problems caused due to it. This is a real time approach of solving traffic congestion problems analogous to a traffic personnel who regulates traffic by taking better decisions to clear the traffic, based on the density of vehicles on the road.

INTRODUCTION

Increase in population mostly in urban areas and increasing vehicles on the roads is non linear to the space for development of roads and intersections. This has led to problems like traffic congestion, accidents and rule violation on the roads. Existing methods to control traffic include the use of automatic control system along with traditional traffic management. Traditional approach being most reliable it is useful for better and critical decision making and handling emergencies in real time. Traffic personnel decide time for traffic signal according to the density at particular lanes. But it is limited by the time a traffic personnel can work and health concerns of the policemen. In most countries traffic signals are based on only one factor that is time. Present automatic traffic control system employs preset signal timings to control traffic on the road. The automated system's cyclic method of signal release will cause inconvenience when large number of vehicles are waiting to cross the junction and when there are no vehicles in opposite lane but still it is given green signal because traffic signals change depending upon time interval. Existing traffic surveillance system sensors include inductive loop detectors (the detectors that count the number of vehicles during a unit of time, these are cost effective but are subject to a huge failure rate), magnetic sensors (magnetometers-involving magnetic loop detectors buried in the road), radar sensors (infra-red sensors require separate systems for traffic counting and for traffic surveillance and are affected by fog hence cannot be used for effective surveillance) and microwave detectors. These technologies have many demerits and none of them are efficient to maintain and manage the heavy traffic flow as they are not portable, are not able to detect very slow or stationary vehicles and expensive to install. Existing systems do not give any priority to emergency vehicles like ambulance or fire brigade. To solve traffic congestion problem we have implemented a system which is real time and has the ability to sense density of traffic at different signal junction and accordingly communicate, coordinate and synchronize with nearby signals to control and manage the traffic flow. This system is a real time application to adjust the timer for traffic signal light at each lane according to the traffic density and would provide us additional information about traffic flow density, minimum speed of vehicles and vehicle count on the lane at each interval. Our main objective is to develop an approach for intelligent video surveillance of traffic by automatic vehicle detection and counting through the video cameras installed on the road junctions. Image processing techniques are used for vehicle detection and counting and thereby signal scheduling. Image processing is a type of processing in which the input applied is a digital image, such as an image or video frame. The output of image processing may be either an image or parameters related to the image. Detection of vehicle is a crucial part of video surveillance.

PROPOSED SYSTEM

In this project, we are developing an intelligent and automated system which where video cameras are used. Video camera is the most efficient traffic sensor because it provides more traffic information like vehicle detection and counting, measurement of vehicle's speed, detection of high priority vehicles like ambulance and fire brigade and the identification of traffic incident, it can be easily installed and upgraded, cost-effective, and also works in coordination with image processing techniques as they provide the flexibility to redesign the system and its functions by mere change of the system algorithms. Conventional traffic systems were time based unlike this system which is real time, based on vehicular density, where signals are changed depending upon number of vehicles on a particular lane. This system is build with a dedicated server, to which the input data is supplied and is processed. Basically there are four basic functionality in this System architecture : (1) detection of vehicles and vehicle counting, (2) allocation of time to signal as per the density of traffic that is the count of vehicles estimated on a particular lane, (3) detection of emergency vehicle and, (4) rule violation. All these activities are performed in real time approach. The system flow starts with initialization of the camera and setting timer for it, which is first module were we are setting the time for each camera on each lane which captures input in the form of video. The system works by detecting the entering vehicles into the camera range, and detecting them throughout the video. These input videos are continuous data streams in the form of frames used at a rate of 40 frames per second. This recorded input video is send to a dedicated sever where background subtraction techniques BLOB analysis are performed on the input video to detect individual vehicles and extract information like vehiclular count , vehicle type seen in the video etc. Then as per the count of vehicles on lanes corresponding signal's timer is set. The lane with maximum number of vehicle will get maximum time of green signal so as to clear the traffic on that lane and the lane with minimum number of vehicle will get less time for green signal to release the traffic. The flow of the traffic signal will be clockwise, only timer setting will change every time for successive rotations. The efficiency and performances of the surveillance system depends on the algorithm used for background subtraction and vehicle detection. That is how fast it performs, how much memory it needs and how efficiently it detects the vehicles. The various steps of our proposed system are a camera is fixed on poles or other tall structures to overlook the road or lane.Each frame is extracted from the video and is analyzed to detect and count vehicles. Thus depending on the signal cycle (1 minute), signal timer is set for each lane. For example, if the number of vehicles on a four way intersection is 5, 25, 10 and 35, then the lane which contains 35 vehicles is given green signal first and then the lane with 25 and then lane with 10 and lane with 5 vehicles.

1. PROPOSED SYSTEM

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IMAGE PROCESSING TECHNIQUES USED

Background subtraction**:** A video surveillance system includes challenges such as: vehicles vary in size, shape, colour; changing lighting and weather conditions; occlusion of a vehicle by another one etc. All this problems are solved by using background subtraction method for vehicle detection. For vehicle detection through image processing three methods can be used. First is optical flow which detects motion of the object characteristics which changes with time and detects the image in the video .It gives good results under the moving cameras, but is a complex approach , as lot of calculation is required hence does not give proper output for the traffic control system. Second is frame differencing method. In this pixel by pixel subtraction is done. Current video frame pixel values are subtracted from previous frame pixel values or prototype frame pixel values. The obtained pixels are considered as foreground and rest of the part is background. This approach is easy to implement and less calculations are required. It fails to detect pixel values of some moving vehicles. If applied to a complex system it would not be able to recognize the vehicle properly. Next is background subtraction method. The system works by detecting the entering vehicles into the camera range, and detecting them throughout the video.In our application, the camera is fixed above a road; therefore the background seen is static.

Techniques used in background subtraction method:

A) RGB to GREY conversion: The input image is a colour image we have to convert it into grey scale image to enable vehicle detection. After the conversion of video into frames, colour image is converted into black and white scale. Image is of 24-bit when supplied to the server for processing, it. Grey scaling is performed to convert it to 8-bit image. For example-initially image contains separate red, green and blue hues i.e. RGB. Each pixel of image are scanned and each pixel also contains RGB values and blurring extracts these values to obtain grey scaled image which is divided by three and resulting value is given to that respective processed pixel. In a similar way, all pixels are processed.

B) Preprocessing technique: Preprocessing helps to reduce or remove noise and misdetections in each frame. Preprocessing is done using various filters such as median, mean, and convolution filter. The mask of the filter will multiply with frame and remove the noise present in the frame to produce accurate result.

C) Background frame initialization: Background frame initialization is a crucial part of this algorithm. In this methodology we compute a background prototype model of the road is made using the first few frames of the video. This background model collects the statistics of the background of the recorded frames such as trees, buildings, road etc. This model is then used to distinguish the objects to be counted (vehicles) from the surroundings.

D) Subtraction of background from current frame: once the background frame is initialized subtraction is done pixel by

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pixel. Background subtraction method subtracts the moving vehicle objects i.e the foreground from static road images i.e. the background depicted in the frame. It means that simply each frame is compared with the background model and the algorithm will subtract the current frame from background frame. Since the camera is not in motion, the background will remain constant. Pixels in the current frame which differ considerably from the prototype are considered to be the vehicles. The pixels belonging to foreground are further processed for object localization and tracking.

E) Segmentation using thresholding: Thresholding converts 8-bit image i.e. grey scale image into 1-bit image i.e. black and white image. Thresholding value is usually set to 128. If the pixel value is greater than threshold value(128) then it is considered as a background image with logic 1 and represented by black colour and it is less than threshold value it is considered as a foreground image with logic 0 and given white colour. Processing is done pixel by pixel. So segmentation process represents the moving vehicles by white and static road and background other than vehicles by black colour. In this way vehicle detection is done. The vehicles that are the objects of interest are hence obtained and are then tracked throughout the video until they leave the cameras range.

F) Morphological filtering: The background and the foreground image contains noise due to various environmental factors like effect of light on roads and vehicles. This step is used to process images depending on their shapes and reducing the noise in detected images. A morphological operation gives proper edges to the moving vehicles by reducing the noise around vehicles. Each pixel value in the output image is computed by comparing pixels in the input image with its neighbouring pixel values. Different morphological filtering operations used are closing, erosion, dilation, opening etc. The vehicles that are the objects of interest are hence obtained and are then tracked throughout the video until they leave the cameras range. Using all the above steps objects are detected accurately in the background image i.e. vehicles on the roads are detected accurately. Using this algorithm, vehicles are detected on each of the four way road. Once the vehicles are detected using background subtraction method vehicular counting is performed. Gaussian mixture model (GMM) and BLOB analysis method is applied on the result obtained to counting the number of vehicles. Gaussian mixture model gives the better segmentation to the original images. BLOB analysis produces the bounding boxes to the vehicles. After a vehicle is detected it is marked or bounded with a rectangle called bounding box.Gaussian mixture model: Gaussian mixture model (GMM) is important part counting of vehicles. It is used to give better segmentation to original images. Gaussian mixture model (GMM) calculates the pixel values from reference pixel's mean and variance values. It is updated for each new frame value and computedfor each pixel. Various parameters of Gaussian mixture model used are number of Gaussians, number of training frames, learning rate, variance, subtraction ratio etc. Gaussian mixture model is applied to the four way traffic road. After the segmentation morphological filtering is used to reduce the noise. BLOB analysis: BLOB analysis means the assembling of the connected pixels. It is widely used to evaluate characteristics such as size, area, location etc. BLOB analysis is very efficient method to reduce the computation time and gives the better output. The background subtraction model supplies foreground pixels. In the blob detection algorithm, in the current frame, foreground pixels are grouped, together by performing a contour or edge detection algorithm on them. The individual pixels are grouped into separate classes, and then find the edge of each class. Thus each class is marked as sample blob. These blobs are then checked and small blobs are removed from the algorithm to reduce false detections and noise. The blob analysis algorithm finds out which sample blobs belong to the same vehicle. There may be many sample blobs of a single vehicle. To find out all the blobs of the same vehicle, positions of sample blobs in the current frame is considered. The positions of the sample blobs are compared using the k-Means clustering. K-means algorithm finds out the centers of clusters and groups the input samples blobs around the clusters.Then the algorithm will track each blobs in successive frames. The cluster of blobs with their centroid are surrounded by a bounding box. This represents a single vehicle. it is also applied on the four way traffic road. Vehicle counting: In Traffic Log activity numbers of vehicles are

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counted. The main aim here is to count and register the respective vehicle id for each lane. Hence this method sets base line, for each road which can be adjusted in the application. The tracked blob or mask is considered as the input for counting. Two variables are maintained: count to track the number of vehicles passing the base line and a register counter, which allots an id to each vehicle so that each vehicle is not counted more than once in a scenario. When a new vehicle is detected, it is first checked whether it is already registered in the buffer, if the object is not registered then it is assumed to be a new vehicle and count is incremented, else it considered that the vehicle has already been count. The final count of vehicles is given to variable count.

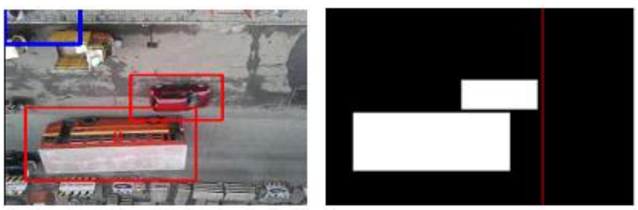
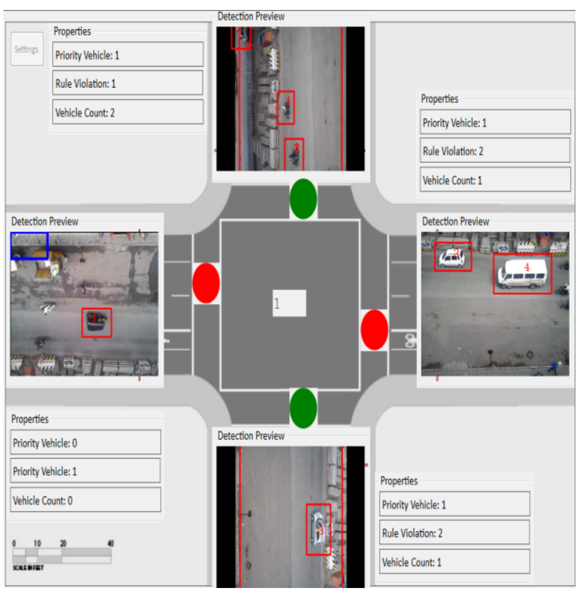


Figure 1.1 Original video frame and the result of the blob analysis algorithm.

RESULTS



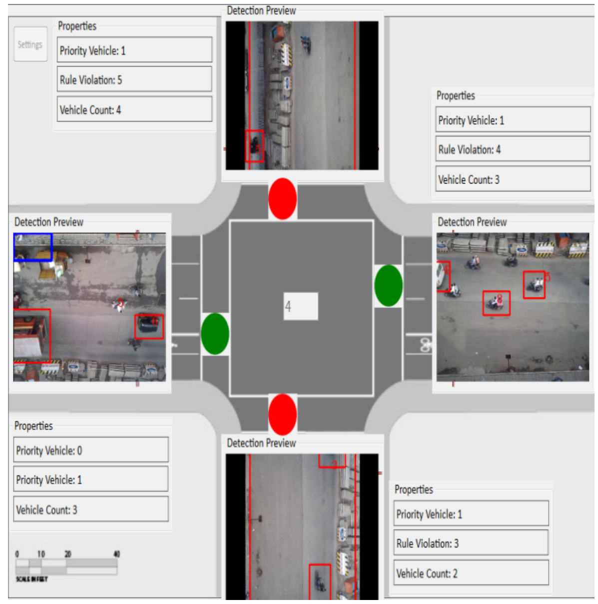


Figure 1.2 The application showing a four way cross road and allocation and change of signal timer based on the density of traffic. The above system has been implemented in C#. The system can process around 40 frames per second on a dual core processor at 2.4 GHz. The system performed computations on video with 320_240 pixels under different kinds of illumination.The video was recorded from an urban area with a cluttered background. The system was successfully able to detect and count most vehicles. Some errors were noticed while the detection process especially in the scenario where some vehicles were moving very closely to each other. But when the leading vehicle separates from the other vehicle or leaves the detection range, the system was able to detect the second vehicle separately. The system is also able to correctly detect emergency vehicle like an ambulance and the signal of the corresponding lane was set green to allow the ambulance to leave immediately.

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CONCLUSION

In this project we have implemented a video based traffic control system which is a real time application. Implementing background subtraction method gave improved results for vehicles detection within a short interval of time. Vehicle counting is also performed efficiently using the Gaussian mixture model and BLOB analysis technique. BLOB algorithm produced perfect bounding boxes to each of the vehicles on four way traffic road. Traffic controlling is also done in a much better manner compared to present methods. The signal timer scheduling was done very effectively by the system thus being able to control heavy traffic and the system was also able to detect emergency vehicles like ambulances and fire brigades and gave them higher preference. Thus this system will be very useful to control the growing traffic problems in metropolitan cities.

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