Smart Traffic Management System

Vidya Sagar¹, Amrit Shrivastav ², Prof. Neeraj Panday ³, Aman Mishra ⁴

¹CSE, College of Engineering, Roorkee
²CSE, College of Engineering, Roorkee
³IT, College of Engineering, Roorkee
⁴IT, College of Engineering, Roorkee

Abstract: Due to increase in population, the number of vehicles is increasing rapidly. Increase in vehicles leads to many traffic problems like traffic jams, accidents, money loss, wastage of time, pollution, health problems and many more. So it is necessary to manage and control traffic. Various traffic management techniques are used each having its own advantages and disadvantages. Currently used techniques are not so efficient in terms of performance, cost, maintenance etc. In this paper, we will discuss traffic management system based on Digital Image Processing. Use of digital image processing will help in better traffic management and also it is cost effective.


I. INTRODUCTION

There are number of technologies used to detect the congestion of traffic and to manage it.

A. Manual Control

Nowadays, traffic is controlled manually. A traffic police is hired to control traffic on highways or roads and whistle is used to control traffic. But it becomes a difficult job for him if the traffic is huge.

B. Automatic Control

Another method used to control traffic is Traffic light System. A numerical value is loaded in timer for each phase. Depending on changes in timer, light is set at ON and OFF states on different lanes. Problem with this approach is that it is not good to have a green light on an empty lane. Another method used to control traffic is by using sensors. Sensors will get the traffic information about a particular lane and accordingly traffic lights might be set. But the problem is traffic information provided by sensors is limited.

C. Image Processing Control

Much better approach is to use the concept of Digital Image Processing. In this methodology Cameras is placed on a long pillar from where the lane view can be taken clearly. Camera is used to take images or videos of lane to check out the traffic at any instant on that lane. It will take the real time values in concern. Vehicles can be detected under various challenging conditions. Images captured by camera will be processed using image processing techniques and number of vehicles on each lane is counted. Times assigned to traffic light on each lane according to the count or density of vehicle on that road with priority given to ambulance.
II. DIP APPROACH
Digital Image Processing deals with manipulation of digital images through a digital computer. A digital image is passed to a system as input, system process the image using algorithms and produces a valuable image as output. Human eyes can easily detect traffic jam. Computers can only process binary data. The picture on the road is actually a binary data, which needs to be represented as a digital image. The image when captured is unformatted and raw. Programmers process the raw image and extract useful information from them. For properly managing the traffic, it can be continuously monitored using cameras. Video recorded is extracted into frames which are then sent to the server. The server further processes the frame with different activities i.e. performs brightening, blurring, sharpening etc. Then the concurrent frames are compared and depending on their results and the count of vehicles in the frame, the server updates status as high or medium or low traffic.

![Diagram of Traffic Control System]

First step is Image acquisition. Initially image is of the empty lane is captured for reference purpose. It is considered as a raw data. It is converted to grey scale and then converted to a binary image. Image captured is then pre-processed i.e. enhanced so as to remove the noise and other environment effects on the image. Then edge detection is done to count the number of vehicles and vehicle density.
II.a. **Preprocessing** is done to get a clear image. Since the images are extracted from real time video frames they can be distorted, blurred or dark. Images can be blurred when the weather is foggy or rainy. Similarly, images can be darker when captured at night time conditions or can be too bright when it’s very sunny (like in afternoon). Therefore different pre-processing methods are applied on the images to improve the quality of the image, according to the need of the user.

II.b. **RGB to Gray conversion**: Real time image of lane is captured, and converted into grey scale. This conversion is important. In RGB format there are three separate image matrices storing amount of red, amount of green, amount of blue in each pixel, whereas in gray scale we do not differentiate how much we emit of different colours, we emit the same amount in every channel.

II.c. **Image enhancement** highlights certain features of interest in image and involves operations like blurring, brightening, edge enhancement etc. to improve the information content. Sometimes
image captured is blurred. As the moment of image capturing can’t be recalled, deblurring of image is performed to enhance the image quality.

II.d. Edge Detection: In the Canny edge detection method an adaptive background subtraction is used. After that, canny edge detector will detect all the edges of the vehicles present in the image. Canny edge detector may prove to be effective as it considers all neighborhood pixels while detecting edges.

III. METHODOLOGY
Initially, a video clip is read and segregating into number of frames. Each frame is then considered as an independent image, which is in RGB format and is converted into Gray scale image. In the proposed project, we assume a stationary background for all video sequences. The next phase is identifying the foreground dynamic objects (vehicle), which is obtained by subtracting background image from the given input video frame. The difference between the frames at certain intervals is computed to detect the moving object as shown in . The vehicle attributes (width, height, perimeter and area) are obtained by feature extraction technique of image processing.

III.a. Video data analysis
Video data analysis includes digital image processing technique to automatically analyse the scene of interest and extract information for traffic management system. The CCTV cameras can be used to capture the images. Images from camera are stored in a special format. Images are taken at a particular duration of time. It is compared with the image of an empty road pixel by pixel so as to find the number of vehicles available on the road [4, 11].

As well as specific tools to enable video analysis, it is also important to consider how to go about performing the analysis itself. A number of techniques can be used to examine video data and it largely depends on what line of inquiry the researcher wishes to take. For example, suggests three sets of alternative guidelines:

1. Whole-to-part inductive approach
2. Part-to-whole inductive approach
3. Manifest content approach

The first approach is suggested for identifying patterns in the data where there are no initial hypotheses, theories or predictions, the employing a more grounded method. The second approach is in direct contrast to this, where the video data is scrutinized for specific types of events and is most relevant where the research is driven by existing questions, theories or hypotheses about those events. The manifest content approach is where interactions are selected and examined, that focus around particular subject or pedagogical content.

Another way in which video can be analyzed is through the use of the Critical Incident Technique. This technique was originally used in aviation, requiring pilots to record incidents in the cockpit.

IV. LITERATURE SURVEY
The problem of detecting and tracking vehicle belongs to the field of traffic surveillance which is a subfield of Intelligent Transport System. Many systems and research proposals have been found
and reviewed in order to derive the best solution for the initial objectives. The big picture is drawn starting from evaluating the aims and development stage of current Intelligent Transport System. Using a top down analysis, different methods of the Traffic Surveillance will first be reviewed and compared, then the specific approach of using computer vision in traffic surveillance as a non-intrusive methodology will be introduce [IEEE Workshop Applications of Computer Vision, 1998, pp. 8–14][2].

Lastly, different systems and literatures on two main streams of detecting and tracking vehicles at daytime and nighttime will be presented to reveal the possible approach for a robust nighttime traffic surveillance system. Intelligent Transport System Known as one of the keys that help to create the future of the urban world Intelligent Transport System (ITS) really attracts many research groups in developing state-of-the-art theory and novel applications. The term Intelligent Transport System is used to define any system that applies Information and Communication Technology (ICT) into the development of transport infrastructure and vehicles [IEEE Transactions on Intelligent transportation Systems, vol. 1, no. 2, pp. 98-107, June, 2000][3].

Vehicle-based illustrates the characteristic of using some kind of devices installed in vehicles to locate its position using different methods of realizing and identifying. The three popular applications are Global Positioning System (GPS), Transponders, and Wireless Phones. Global Positioning Systems use earth-orbiting satellites to obtain the global map, and locate position of all vehicles with GPS box installed. The second approach using Transponders which are some kinds of vehicle tags that left inside the car and using synchronous data signal between the vehicles and the controllers on the transport infrastructure to recognize the occupation of the vehicle on the roads. The last method using Wireless Phones to send and receive traffic information from the Transportation Management Center (TMC) to notify the drivers about the neighboring traffic condition for efficient driving. All these methods are proven to produce high accuracy and fast data speed, but they all require vehicle owner to invest an initial capital to install one of those devices in their vehicles. That creates firstly a barrier for drivers with low budget, and second the privacy threats for those who do install one of those devices in their vehicles, since all the information is frequently and automatically sent to the database server [2nd Int. Conf. on Computer Technology and Development, Cairo, Nov 2010, pp. 27-31][4].

Among various emerging ICT fields, there exists a subfield called Computer Vision, which has existed for more than thirty years, but only recently that it is considered as a formal research area, thanks to the emergences of fast computer processors. The main objectives of Computer Vision are to learn ways of perceiving the world through graphical representation. Two main research areas of Computer Vision are in Robotics and Traffic Surveillance, where there normally exist some kinds of cameras that take the snapshot of the real world, and only by looking those images, there can be derived different information which is helpful to autonomously control an operation. Some famous applications of Computer Vision can be seen in face detection, image segmentation, 3D scene reconstruction, and general pattern recognition techniques. The employment of Computer Vision in traffic surveillance helps to reduce the implementation cost by reusing the roadside CCTV cameras installed on the road. In addition, by modeling the real traffic system, the information comprehensive to the machine includes all that are desirable for human purposes, for example, the position of the vehicles on the lanes, their speeding status, and their travel trajectory.
A vehicle tracking and classification system made by Lipton et al., identifies moving objects as vehicles or humans, but however it does not classify vehicles into different classes. A vision-based algorithm was developed for detection and classification of vehicles in monocular image sequences of traffic scenes are recorded by a stationary camera. The processing is done at three levels: raw images, region level, and vehicle level. Vehicles are modeled as rectangular patterns with certain dynamic behavior. Daniel et al., presents the background subtraction and modeling technique that estimates the traffic speed using a sequence of images from an uncelebrated camera.[(IJAEEE), ISSN (Print): 2278-8948, Vol. 2, Issue 5, 2013] [5].

The combination of moving cameras and lack of calibration makes the concept of speed estimation a challenging job. Toufiq P. et al., in describes background subtraction as the widely used paradigm for detection of moving objects in videos taken from static camera which has a very wide range of applications. The main idea behind this concept is to automatically generate and maintain a representation of the background, which can be later used to classify any new observation as background or foreground. In, background subtraction also involves computing a reference image and subtracting each new frame from this image and threshold the result. This method is an improved version of adaptive background mixture model, it is faster and adapts effectively to changing environments. Karmann and Brandt discuss the segmentation approach using adaptive background subtraction that uses Kalman filtering to predict the background. Segmentation requires vehicles to be accurately separated from the background with minimal amount of initialization. Chen et al., have addressed the issues regarding unsupervised image segmentation and object modelling with multimedia inputs to capture the spatial and temporal behavior of the object for traffic monitoring. D.Beymer et al., proposes a real time system for measuring traffic parameters that uses a feature-based method along with occlusion reasoning for tracking vehicles in congested traffic areas. Here instead of tracking the entire vehicle, only sub features are tracked. This approach however is very computationally expensive [IEEE Computer Society Conference on Computer Vision and Pattern Recognition (CVPR’06), 2006][6].

Cheng and Kamath compare the performance of a large set of different background models on urban traffic video. They experimented with sequences filmed in weather conditions such as snow and fog, for which a robust background model is required. Kanhere et al., applies a feature tracking approach to traffic viewed from a low-angle off-axis camera. Vehicle occlusions and perspective effects pose a more significant challenge for a camera placed low to the ground. The moving-target identification and feature-aided tracking approach described in combines kinematic association hypotheses with accumulated target classification information obtained from high range resolution(HRR), inverse synthetic aperture radar (ISAR), and synthetic aperture radar (SAR) signatures, to obtain improved classification and association. The vehicles are detected using mathematical modeling [(ICRTMS),” 2nd Int. Conf. on Computer Technology and Development, Cairo, Nov 2010, pp. 27-31][7].

In rule based reasoning is used for vehicle detection, in which the results highly depend on the rules decided by humans. Automatic Traffic Density Estimation and Vehicle Classification for Traffic Surveillance System using Neural Networks were done with real traffic videos obtained from Istanbul Traffic Management Company (ISBAK). Different classification techniques have been employed after the moving objects are detected in order to identify the moving object.
In support vector machines is used to identify if the detected moving object is a vehicle or not. Vibha L et al., developed a framework for detecting the knowledge like vehicle identification and traffic flow count. The framework is made to monitor activities at traffic intersections for detecting congestions, and then predict the traffic flow which assists in regulating traffic. The algorithm for vision-based detection and counting of vehicles in monocular image sequences for traffic scenes are recorded by a stationary camera. Highway toll control requires automated and real-time classification of fast-moving motor vehicles. Julius Stroffek et al., made a modular software solution to the technical problem of how to classify vehicles on a highway with a tollgate equipped with a laser scanner with an angular resolution of 10 and a frame rate of 75 Hz. The software identifies individual vehicles and passes a set of descriptors to the classification process itself. The classification algorithm uses the shapes of vehicles, in the form of three-dimensional (3-D) reconstructions of scanned vehicles together with a series of inferred feature descriptors [IEEE Transactions on Intelligent transportations Systems, vol. 1, no. 2, pp. 98-107, June, 2000] [3].

V. OBJECT DETECTION
In general, object detection is usually the first module in video processing pipeline in smart surveillance systems. This module is designed to detect the relevant objects which are observed in the scene. This goal can be achieved in various ways. One of the groups of methods employs so called optical flow algorithms which, depending on specific algorithm, analyses the scene for characteristic point or estimate the motion on the basis of gradient calculated for the whole image. However, this set of methods is in general quite computationally expensive and is not suitable for real time processing of high resolution images and high frame rate videos. Still, some improvements and simplifications to the optical flow calculation algorithm can be found in the literature making it useful for specific tasks. This approach is generally a good choice in two cases. First, when a video stream from a non-static camera needs to be analysed. In such situation optical flow is very suitable as it allows to compensate the global motion detecting some local changes. The second case is related to crowded scenes where the information about single objects and their movement is difficult to acquire. By utilizing optical flow based methods for example a general crowd motion trend can be estimated.

VI. ALGORITHM USED
VI.a. Background model subtraction algorithm
Detection of moving objects is usually the first stage of video processing chain and its results are used by further processing modules. Most video segmentation algorithms usually employ spatial and/or temporal information in order to generate binary masks of objects However, simple time-averaging of video frames is insufficient for a surveillance system because of limited adapting capabilities. The solution implemented in the framework employs spatial segmentation for detection of moving objects in video sequences, using background subtraction. This approach is based on modelling pixels as mixtures of Gaussians and using an on-line approximation to update the model. This method proved to be useful in many applications, as it is able to cope with illumination changes and to adapt to the background model accordingly to the changes in the scene, e.g. when motionless foreground objects eventually become a part of the background. Furthermore, the background model can be multi-modal, allowing regular changes in the pixel color. This makes it possible to model such events as trees swinging in the wind or traffic light sequences. Background modelling is used to model current background of the scene and to differentiate foreground pixels of moving objects from the background. Object segmentation is
supplemented with shadow detection and removal module. The shadow of a moving object moves together with the object and as such is detected as a part of the foreground object by a background removal algorithm. The shadow detection method is based on the idea that while the chromatic component of a shadowed background part is generally unchanged, its brightness is significantly lower. Every new pixel recognized as a part of a foreground object during the background subtraction process is checked whether it belongs to a moving shadow. If the current pixel is darker than the distribution, the current pixel is assumed to be a shadow and is considered as a part of the scene background.

![Background subtraction](image)

**Fig 3. Background subtraction**

**VI.b. Kalman filter supported moving object tracking**

After the moving objects are found in each consecutive camera frame, movement of each object on the frame-by-frame basis is needed. This is the task of an object tracking module. For each new detected moving object, a structure named a tracker is created. The position of the object in the current camera frame is found by comparing the results of object detection (the blobs extracted from the image) with the predicted position of each tracker. The prediction process estimates the state of each tracker from the analysis of the past tracker states. An approach based on Kalman filtering was used for prediction of trackers' state. A relation between a tracker and a blob is established if the bounding box of the tracker covers the bounding box of an object by at least one pixel. There are some basic types of relations possible, each of them requires different actions to be taken. If a certain blob is not associated with any tracker, a new tracker (Kalman filter) is created and initialised in compliance with this blob. If a certain tracker has no relation to any of the blobs, then the phase of measurement update is not carried out in the current frame. If the tracker fails to relate to a proper blob within several subsequent frames, it is deleted. The predictive nature of trackers assures that moving objects, whose detection through background subtraction is temporarily impossible, are not "lost" (e.g. when a person passes behind an opaque barrier).

If there is an unambiguous one-to-one relation between one blob and one tracker, this tracker is updated with the results the related blob measurements. However, if there is more than one matching blob and/or tracker, a tracking conflict occurs.
First, groups of matching trackers and blobs are formed. Each group contains all the blobs that match at least one tracker in the group and all the trackers that match at least one blob in the group. Next, all the groups are processed one by one. Within a single group, all the trackers are processed successively. If more than one blob is assigned to a single tracker, this tracker is updated with all blobs assigned to it, merged into a single blob.

This is necessary in case of partially covered objects (e.g. a person behind a post) that causes the blob to be split into parts. In other cases, all the matching blobs are merged and the tracker is updated using its estimated position inside this blob group. This approach utilizes the ability of Kalman trackers to predict the state of the tracked object, provided that it does not rapidly change its direction and velocity of movement, so that the predicted state of the Kalman filter may be used for resolving short-term tracking conflicts. The estimated position is used for updating the tracker position, change of position is calculated using the predicted and the previous states. The predicted values of size and change in size are discarded and replaced by values from the previous filter state, in order to prevent disappearing or extensive growth of the tracker, if its size was unstable before entering the conflict situation. Therefore, it is assumed that the size of the object does not change during the conflict.

**Fig 4. Object detection**

**VII. POSSIBLE WAY TO REDUCE TRAFFIC CONGESTION:**

It is impossible to have smart city if the citizens of city are not feeling safe. For proper monitoring the Cameras should install on the main roads, in and out of the city to get images and share the information with traffic division headquarters. On the same time the license plate cameras should allow plates to be crosschecked against a database of stolen vehicles and can identity vehicles that have not paid their registration fees. The zero casualties on the road should also prime aim while we are developing the smart traffic management system. To achieve the target of zero casualties
on road, the ambulance should equip with GPS, providing way to hospital. On the same time a message should sent to hospital prompting them to be ready. To reduce traffic congestion, smart road should construct having analytic platforms every few hundred meters distance to track traffic flow these analytic platforms are used to get real time data from sensors, traffic signals within 2 km and GPS mapping of road. When threshold reached, a signal should send to motor driver and asked to drive on alternative route. On the other hand if numbers of vehicles are below the threshold, message should display on stop display and drivers should ask to move towards signals.

VIII. CONCLUSION
The vehicle classification system is use to automate the process of traffic monitoring system by making identification and classification of moving vehicles on road. The system uses image processing of vehicle sample images to extract the features (area, perimeter, width, length). The features were passed as input to build a classifier model to classify new vehicles. Automatic traffic density estimation and vehicle classification through video processing is very important for traffic management especially in mega cities. The benefits of the system are reduce human effort and errors in traffic monitoring, reduce the cost of traffic monitoring system, reduce the time in conducting survey and analysis of data and complete automation of traffic monitoring system.

IX. FUTURE SCOPE
Video sensors have distinct advantages for road transportation applications. Compared to traditional road sensors, such as inductance loops, which can collect data only at a point along a roadway, video sensors cover relatively large areas. They can therefore be called spatial sensors. The main obstacle to their more widespread use in transportation applications is the availability of automated analysis methods to interpret video data. After the beginning of computer vision
research in the 1960’s, transportation applications have been developed since the 1980’s for detection and the 1990’s for tracking. Commercial systems such as Autoscope (from companies like Econolite and Citilog) exist to replace traditional road traffic sensors to count and classify vehicles at specific locations as well as to detect incidents for simple environments such as highways. However, automatically detecting and tracking all road users in complex urban road environments such as intersections in all conditions is still an open problem. These urban road environments involve various types of road users (cars, buses, trucks, cyclists, pedestrians, etc.) at varying levels of density that may enter and exit the camera field of view through several zones, may turn, stop and park for varying amounts of time.

REFERENCES

I. www.docs.opencv.org