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Density Based Traffic Control using Image Processing Methods: A Review

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Abstract:- **Congestion on the roads can result in fatigue, increased fuel consumption, energy and time waste, increased depreciation and fuel costs, air pollution, accidents, and verbal and physical altercation among the commuters. Cost, untrustworthy technology, and the inability of the contemporary system to incorporate elements of the new technology are the few of the challenges which has to be dealt with. Advanced image processing algorithms, such as segmentation and edge detection, can be used to detect vehicle presence in different lanes and calculate traffic density. Thus, India's traffic management system can be improved and enhanced using low-cost solutions. This paper presents a review of various techniques for automated density-based traffic management.**

Keywords:- Traffic Control, Density based traffic management, Image processing, edge detection.

I. INTRODUCTION

Congestion on the road creates havoc and makes it difficult for commuters to travel. Many major cities are grappling with the problem. Congestion in traffic can have a significant impact on a country's economy. This problem is caused by a variety of factors, the most common of which are poor traffic management, cars changing lanes, unplanned stoppages, and so on. Congestion on the roads can cause fatigue, increased fuel consumption, increased depreciation and fuel costs, considerable wastage of energy as well as time. There are a number of problem areas in the domain of smart traffic control system such as high implementation cost, unreliable technology and rigidity of the existing system in place. The issue with this traditional system is that traffic light scheduling is done regardless of instantaneous traffic density detection. As a result, even when there is no vehicle passing in one direction, the schedule of the passage for that direction is considered, and time is wasted. Existing traffic control and management systems are obsolete and incapable of dealing with the various situations that arise as a result of different levels of traffic congestion throughout the day. Another issue in this area is the scheduling and prevention of traffic accidents at intersections. The length of time a traffic light stays green in one direction and how long it stays green in the opposite direction is typically determined by simple scheduling and calculated when the intersection is designed.

Existing traffic control and management systems are obsolete and incapable of dealing with the various situations that arise throughout the day as a result of varying levels of traffic congestion. Another issue in this area is the scheduling and prevention of intersection traffic accidents. The length of time a traffic light remains green in one direction and the length of time it remains green in the opposite direction is typically determined by simple scheduling and calculated when the intersection is designed.

Current real-time traffic signal control technology is expensive and frequently inaccurate. Thus, the emphasis is placed on this critical point, and every effort is made to be fair.

It has the potential to significantly reduce daily traffic by smoothing traffic flows and providing real-time priority to the busiest lane. The system can be configured to handle any unexpected traffic flow.

In this paper a review on various types of prominent image forgery and tampering techniques have been discussed along with the work done till date in the past decade by researchers in the area of image forgery detection and image forensics has been discussed.

II. RELATED WORK

A. Kanungo et al. [1] reduced the image matrix by estimating vehicle and empty space in the path, calculating congestion in all red directions, and signalling the green light to the most congested path using a MATLAB simulator. Congestion on a previously green path is reduced to zero, whereas congestion on two red lights in opposite directions remains unchanged. The number of vehicles that can pass through each congestion per second is also factored into the green signal schedule. This design improved by 35% when compared to the standard situation, in which the green light signal is given the same amount of time in both directions.

M.M. Hasan et al. [2] proposed an image-processing-based method for determining road traffic congestion, as well as a model for controlling traffic signals using data from road-camera images. Instead of counting vehicles, they calculate traffic density, which is the total area of the road occupied by vehicles in terms of total pixels in a video frame. They have set two output parameters based on traffic density for each road, variable traffic cycle and weighted time, and control traffic lights sequentially.

Image processing, according to D.Sitaram et al. [3], can be used in situations where the surveillance camera is too slow to send the live video in a fraction of a second, or where the server of the website that displays the live feed from these surveillance cameras is too slow. They access websites hosted by the Public Traffic Information System, which display real-time traffic images captured by surveillance cameras installed in various locations. The traffic density is calculated by assigning a rating on a 10-point scale ranging from 1 to 10.

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N.R.Islam et al. [4] proposed implementing a smart traffic control system based on traffic density measurement using a real-time video processing technique. To determine the most effective method, video sequences from a camera are analysed using object detection and counting methods. In order to control the traffic signal brilliantly, the computed vehicle density is compared to other parts of the traffic. RFID sensors are used in the system to ensure that law enforcement is carried out. As a result, any vehicle or car breaking traffic laws can be easily identified.

T. Tahmid and E. Hossain [5] proposed a traffic control system that measures real-time vehicle density using canny edge detection and digital image processing. This commanding traffic control system outperforms existing systems in terms of response time, vehicle management, automation, reliability, and overall efficiency. Furthermore, the entire technique is depicted with proper schematics, from image acquisition to edge detection to green signal allotment, and the final results are validated by hardware implementation, using four sample images of different traffic conditions.

K. V. Najiya and M. Archana [6] proposed a novel framework for estimating traffic flow parameters from aerial videos using improved vehicle detection. To improve contrast, the frames are first subjected to Adaptive Gamma Correction. The proposed method employs the Kanade-Lucas-Tomasi (KLT) tracker, the Support Vector Machine (SVM), and connected graphs. The KLT tracker is used to analyse motion based on key points of interest. Vehicles are distinguished from other moving objects using the SVM classification. Two of the seven features extracted from the frames are the contourlet transform coefficients and the Gray Level Co-occurrence matrix (GLCM). Finally, the number of vehicles on the road, the average speed, and the bidirectional flow densities are computed.

According to Okaishi et al. [7], vision-based surveillance systems are widely used in traffic data analysis due to their ease of installation and accuracy. A real-time image processing system for detecting and classifying vehicles at intersections is proposed in this paper. This data can be used to estimate traffic density at intersections and adjust traffic light timing for the next light cycle. The background subtraction technique is used in the detection operation, and the approximated median filter is used to extract and update the background, after which the vehicles are tracked in the detection area. Then, to classify vehicles, a convolutional neural network will be used.

Ua-areemitr[8] proposed a low-cost image processing system for estimating road traffic state based on time-spatial image (TSI) processing. The TSI is a technique for combining multiple video images into a single image. As a result, the TSI can save memory resources when compared to traditional methods. A camera can be used for traffic-state estimation by integrating with TSI generating and processing modules. Variables such as space-mean-speed, flow, and density can also be estimated. Several experiments' empirical results are presented to show that TSI processing is a viable low-cost approach to traffic state estimation.

P.Faldu et al. [9] proposed a real-time traffic information collection and monitoring system to address the issue of traffic road management. The proposed model, which is a function of real-time traffic density, sequentially controls the clearance time of each lane. The approach is hybrid in nature, combining sensor networks and camera technology. The combination of image processing and IOT yields greater accuracy and efficiency than the traditional approach. RFID allows for the prioritisation of emergency vehicles, as well as the reduction of traffic congestion. Other technologies are also used, such as stolen vehicle tracking/detection. A simple user interface improves the system by making it easier to manage in the control room.

In the absence of an emergency vehicle, S. S. P. Moka et al. [10] proposed and implemented a smart traffic surveillance system in which access will be granted to the lane with the highest traffic density. When an emergency vehicle is detected in any lane, the lane in which the emergency vehicle is detected is given priority. The presence of an emergency vehicle is detected using signal processing techniques, and the density of traffic is computed using digital image processing techniques. The entire proposed system is depicted with appropriate schematics, from image and sound acquisition to canny edge detection and noise removal using a Least Mean Square (LMS) filter, and finally green signal allocation to lanes based on the output results.

III. TRAFFIC CONTROL USING IMAGE PROCESSING

Image processing is any type of signal processing in which an image, such as a photograph or video frame, is used as input and the output is either an image or a set of image-related characteristics or parameters. The vast majority of image-processing techniques involve treating the image as a two-dimensional signal and applying standard signal-processing techniques to it. A road image can be represented as digital data, or binary data, but it must be processed before it can be used to extract useful information. This is required because images captured in their natural environment are raw and unformatted. Figure 1 depicts a basic framework used in the majority of image-based traffic density measurement techniques.

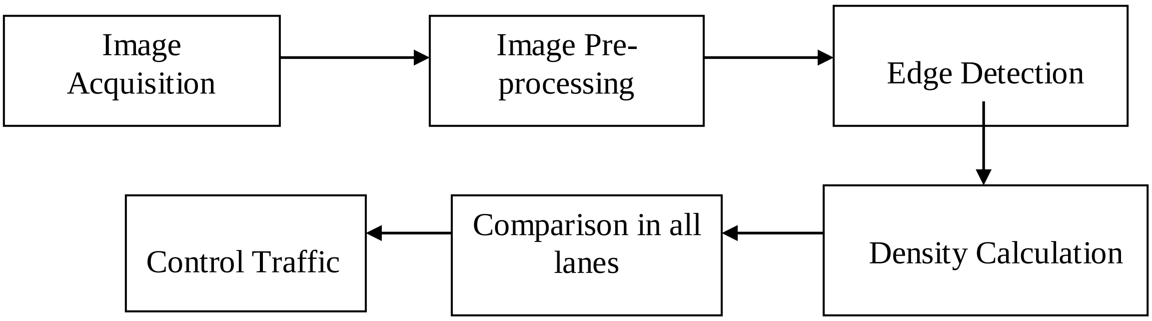

Fig. 1: General Framework for Traffic Control System using Image Processing

Image Acquisition: Cameras are used in all of the methods discussed in this paper for image acquisition. To capture the view of the traffic scene on the road, a camera is installed at any tall structures, such as polls, at traffic intersections. The captured video from the camera is then used to extract image frames. These frames are then analysed and preprocessed in order to detect and count the number of vehicles present, also known as vehicle density.

Image Preprocessing: Preprocessing is done to obtain a clear image. Because the images are extracted from real-time video frames, they may be distorted, blurred, or dark, as in foggy or rainy weather. Similarly, images taken at night can be too dark, while images taken in bright sunlight can be too bright (like in afternoon). As a result, depending on the user's goal, different preprocessing methods are used on images to improve image quality. Figure 2 depicts the original acquired image (a) and the preprocessed image (b)[5].

Fig. 2: (a): Original Image (b) Preprocessed Image

Edge Detection: Techniques for detecting and distinguishing vehicles from the background are used. There are several thresholding and edge detection algorithms available, including canny edge detection, sobel edge detection, and prewitt edge detection. Figure 3 depicts the image following edge detection[5].

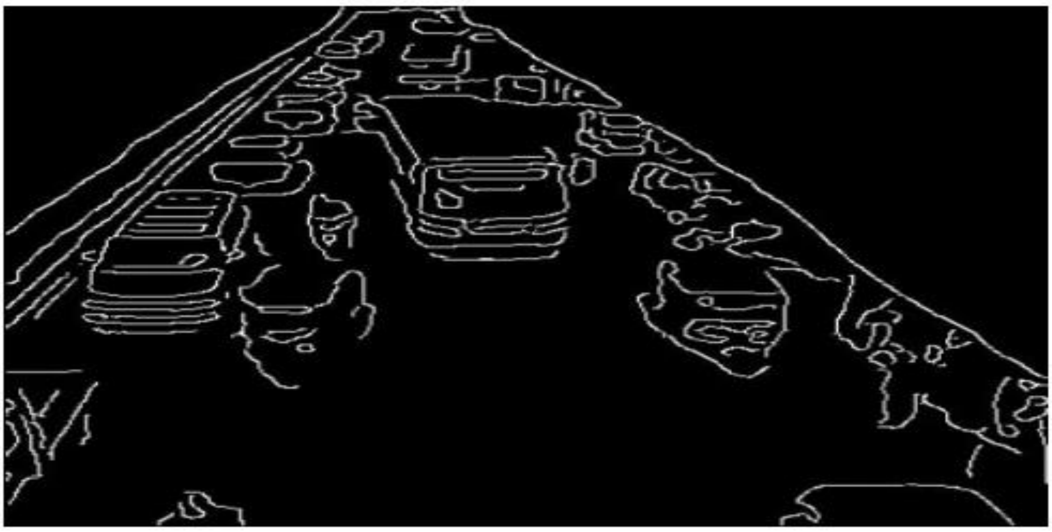

Fig. 3: Image post Edge Detection

Density Calculation: This is done to determine the density of vehicles in each lane. Several techniques, such as histogram-based thresholding and morphological operations such as dilation, erosion, and filling, have been presented. Edge detection methods were also used to estimate the density within the lanes.

Based on the preceding steps, the density of vehicles in each lane can be estimated, and then decisions can be made for effective traffic management and control.

IV. CONCLUSIONS

Image processing is used to automatically estimate and control traffic density, which is critical for traffic management in megacities. Congestion on the roads is becoming a major problem. Traffic congestion can be caused by a variety of factors, including ineffective transportation management, a lack of traffic information, and so on. Traditional methods for estimating traffic density, such as radars, loop sensors, ultrasonic waves, and so on, have some limitations, such as high cost, sensitivity to external environmental conditions, lighting conditions, and so on. The use of computer vision technology can aid in the resolution of the problem. Advanced image processing algorithms, such as segmentation and edge detection, can be used to detect vehicle presence in different lanes and calculate traffic density. Thus, India's traffic management system can be improved and enhanced using low-cost solutions. This paper contains a thorough discussion and review of various concepts, methods, and work done by previous researchers in the field of density-based traffic control.

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