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Traffic Congestion Management

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Abstract: *Nowadays traffic congestion problems are escalating owing to the rising usage and growing vehicle count, this brings about the need for the usage of advanced technology in managing traffic congestion. This system manages traffic with the help of processing of images and machine learning techniques instead of the simpler ways of having a timer for each traffic light or embedding a sensor to detect vehicles. It captures images using a camera installed on the traffic light, along with an empty road image for reference. After processing the image, the two images are matched for density calculation of traffic according to which the duration of traffic lights is controlled.*

Keywords – *image processing, edge detection, traffic congestion, vehicular density, time calculation*

I. Introduction

In today's time, one of the most pressing issues that are directly affecting the lives of people is the problemof traffic congestion. Mainly in metropolitan cities of India, the traffic congestion is so high that 3 cities - Mumbai, Bengaluru, and Delhi, are rated the top 10 worst traffic cities in the globe. Experts have come up with different kindsof solutions to overcome this problem. Each solution works best in certain conditions and regions. In our project, wehave proposed a smart traffic control system that has greater advantages over traditional traffic control systems. Time-controlled traffic lights or sensor detection do not work effectively. Time Controlled traffic lights cannot analyse the real-time traffic congestion and the sensors have a limit to the number of vehicles they can detect. Further, the sensors may become outdated in the future and constant maintenance and installation are not cost-efficient. Digital image-based processing of traffic parameters is a better alternative. Hence, we are proposing Image Processing. Image processing solves both the problems posed by timer-controlled and sensor-controlled traffic systems. A camera captures the live broadcast of the road along with the density of the vehicles is calculated to determine the length of the traffic signal cycles. Image processing is a technique in which digital images are taken as input and one or more algorithms are run on it to get the necessary results. It is one of the few technologies growingrapidly as it contains many advantages. A camera can cover a wider area than sensors. Live images give better and more accurate information on traffic situations. Using efficient algorithms and good-quality cameras, we can achievehigher percentages of accuracy.

II. Literature Survey

The Indian traffic system is rigid and inflexible as the vehicle count keeps growing rapidly and does not consider the change in vehicular density throughout the day. Which in turn results in wastage of fuel and time. So, this paper aims to analyse and improve congestions using operation management based on traffic density. Dependingon the vehicular density, traffic is splitted into various packets. When vehicles need to pass through the intersection,at any moment maximum packet having high density will pass through the intersection resulting in higher throughputof packets. Shadows from buildings, bridges cast on traffic lanes are resolved using Otsu's multiple thresholding. To provide an optimal solution and to detect traffic patterns, machine learning techniques are used by the proposed system [1]. Due to the usage of the IoT (Internet of Things) and image and video processing techniques to achieve the number of passing cars, traffic management has become one of the most critical concerns in today's world. Furthermore, the Raspberry Pi device and the OpenCV tool are used to implement it. The proposed models' efficiency in the direction of the crossroad is demonstrated by analytical and experimental data. The image is set as a reference image for each direction in the Raspberry direction, else the ready images of traffic control cameras are prepared foreach side and then provided to the original image. White pixels are counted after the edge image is displayed as a white color and a reference image is obtained. The information is then sent to the scheduling algorithm, which decides on any other place to monitor on the fly, and traffic is controlled to reach path traffic statistics using the Raspberry Pi and the onsite network platform [2]. Proposed a system that recognizes license plates of automobiles using verticalSobel edge detection and extracts them using morphological operations with 100% accuracy. Scanning techniques are used to align, segment, and isolate the characters on license plates. Finally, the Prewitt detection of edge method will recognize license plates. Initial step of the procedure is to photograph the automobiles. The license plates must then be detected and extracted from the collected photos. These images are adjusted to required formats by converting RGB into the grey image, applying vertical Sobel edge detection, binarization of the image, edge horizontal histogram for threshold selection, and the morphological operation are used to locate candidate license plate locationsin a binary vertical gradient image Because vehicle photos may be obtained from different perspectives, the license plate must be aligned in the next stage. The segmentation of characters, numerals, and words from the license plate image is the following step. All unwanted license plate regions will be deleted, photos will be adjusted as needed, and the license plate will be binarized. The final stage of the proposed system is recognizing each segmented character, number, and word that are extracted from license plate regions. The Prewitt edge detection algorithm is used in this stage, where the percent value will be determined for each character, number, and word. The resulting value compares with 11 the values stored in the prior determined database [3]. The suggested technique includes a framework that may continually transmit the vehicle count to the controlling station and produce an alarm in the event of a big vehicle gathering. From this, their vehicle count is found using contour properties. Furthermore, the monitoring data is sent through the internet to a remote controlling center located anywhere in the city. The footagein real-time of the movement of traffic on the road was captured using a camera system. After obtaining the footage from the camera, the data was processed using a portable Raspberry Pi processing device. Finally, after determining the average vehicle count during a certain time frame, the same processing mechanism is employed to send the same data to the system of central control. Vehicle counting here is achieved by first extracting the individual frames from the input video stream. Then using OpenCV in python, the foreground image is developed using background subtraction. The quality of the image is improved, and the noise is removed using morphological operations. Then the Otsu thresholding method is applied for obtaining the binary threshold image. Finally, the vehicle count is obtained from the binary image using contour detection and using contour properties. This data is then transmitted for traffic management using the internet through the following steps. Fetching the per sec vehicle count data, interfacing of firebase google server Raspberry Pi, establishing connection with firebase, and sending data to the real-time cloud [4]. This research presents an image processing-based method for minimizing traffic congestion by recognizing and tracing blobs. It also provides a solution to clear the traffic route for emergency vehicles by using Bluetooth. The camera is firstly mounted to cover the full lane for vehicle recognition and counting. Then minimization of image is performed, in which the frames from the video are compared to identify the contrasts between them. The contrast then traces the blobs. The changes detected are the blobs or the moving vehicles. To ignore pedestrians, blobs of very small size are ignored. To track the blob, a line of thresholding is done to compute the number of automobiles. Next to this traffic signal, drawing of a line is done to an optimal grade. These vehicles are only counted when they pass those lines. This automobile count can determine high or less density, as well as adjust the traffic signal time. A Bluetooth module (BM) and a phone with Bluetooth enabled are used to detect an ambulance. When the emergency vehicle gets close to indication, the individual in charge of the ambulance will sendout an order to the BM, which instructs the signal to adjust accordingly. The processed information will be sent onto an A-Microcontroller and terms are decided then [5].

III. Methodology

The first step is to acquire the data in the form of images from various sources, by capturing the real-time live video of the Vehicular congestion. From the live video, video frames will be extracted every second. The obtained video frames will be in the form of RGB colors, it needs to be converted into grayscale. On the grayscale image, shadows of buildings and bridges will be casted on the road, which is treated as noise in the image. Duringthresholding, important details from the image can be lost due to the shadows. Every image will have a threshold value i.e., above the threshold value the image will be brighter compared to the value below. Grayscale images contain pixel values in the range from 0 to 1, a threshold value needs to be selected in the closed range [0.0, 1.0]. An image can have multiple threshold values. The value of the threshold is determined using the grayscale image histogram. For multiple thresholding, Otsu's algorithm is used over various pixel densities of the image. The input image containing different pixels is separated to form several classes, the classes are formed based on the gray intensity level present in the image. Further different thresholds are calculated based on the number of obtained classes. Algorithm returns two threshold values for three classes, which is the default number of classes. This results in better output, thus removing the noise. In a digital image, edges are large local changes in intensity. A set of connected pixels that creates a border between two discontinuous regions is known as an edge. Horizontal edges, Vertical edges, and Diagonal edges are the three types of edges. Edge Detection highlights the structural features and reduces the data present in the image. This helps in identifying various image sections and marks the end and start of each section. There are two types of edge detection operators: Gradient and Gaussian. Prewitt operator is based on edges being calculated on the difference between image pixel intensities. Image is a 2D signal. Mask being a signal is represented with a 2D matrix. In order to make images sharper, masks are used in the edge detection process. Prewitt operator will output a couple of masks for edge detection, first is in the horizontal direction and the other in the vertical direction. On applying the mask horizontally, vertical edges are made prominent. Like first order derivative based on the difference of various densities of pixel images of an edge. This results in increasing the intensity of the edge Resulting in increased edge intensity and enhancing the original image. On applying the mask vertically, horizontal edges are made prominent. Its working is based on the principle mask and it's calculated on the difference between image pixel intensities about that edge. The mask center row will have zeros thus not containing any original values of edges of the image, rather calculates the difference of pixel densities about the edges. This causes the image to become more sudden and prominent. The next step is to convert the image into a binary image, which consists of the values 0 or 255 by eliminating gray levels in the image. Edge based matching is performed by comparing the image with all the other edges with the Prewitt operator. Detected edge images will be matched and vehicle area density is calculated. Time Calculation for controlling traffic signal lights is done using machine learning models. The vehicular area density is the independent parameter, and the dependent parameter is the time which will be predicted using reinforcement learning algorithms. The reason for reinforcement learning is based on the previous vehicular density the current prediction would be done. This allows us to understand the trends and the peak hours of traffic to set the time of the signal accordingly. Fig.1 depicts the methodology.

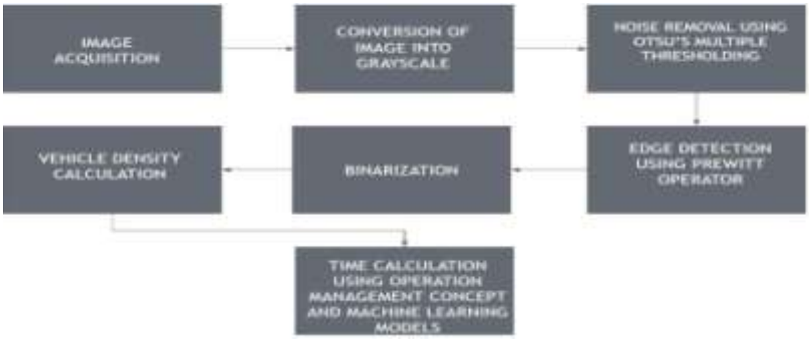

Fig. 1 Block Diagram of Traffic Congestion Management System

IV. Results

The proposed methodology was implemented using toy cars. Fig. 2 and Fig.3 are loaded as input images. Fig. 3 is converted to grayscale image shown in Fig. 4. Otsu's Multiple Thresholding is performed resulting in Fig. 5. The Prewitt operator detects the edges of binarized image in Fig. 6. On comparison with the reference image, the difference image is obtained in Fig. 7. This image is used to calculate Structural Similarity Index and vehicular density. Fig. 8 shows the difference in density using red boxes. The output is obtained as shown in Fig. 9, in terms of SSIM and density percentage.

Fig. 2 Reference Image Fig. 3 Input Image

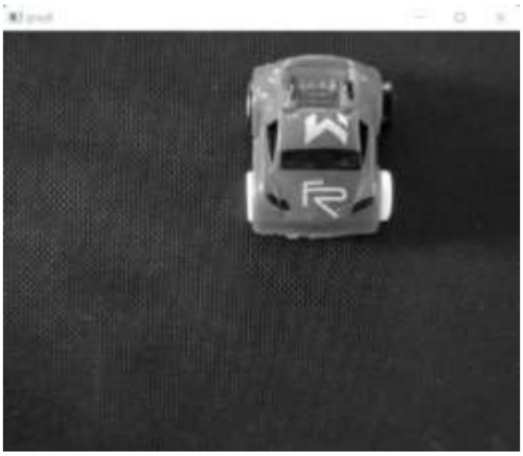

Fig. 4 Grayscale Image   Fig. 5 Otsu's Multiple Threshold Image

Fig. 6 Edge Detection using Prewitt Operator   Fig. 7 Difference Image

Fig. 8 Density Calculated Image

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SSIM: 0.7424197186195353
Density: 25.75802813804647 %
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Fig. 9 Vehicular Density

V. Conclusion

The proposed traffic management system overrides the traditional traffic control systems in terms of installation and maintenance cost, delay in result and accuracy. Reducing waiting time and congestion leads to fewer traffic signal violations which in turn leads to fewer accidents. This system of traffic coordination will also provide data for future road designs and constructions. Image processing is a field that is getting more and more accurate over the years. It allows the machine to become self-sufficient as no external data is required. Each traffic light junction will act as a separate entity as it will be customized to that junction only. This increases the efficiency drastically. The proposed system has the potential to really improve the traffic condition in our country if implemented properly. In future, improvements in the algorithm used and higher camera quality can further increase the efficiency.

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