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Vehicle Detection, Tracking and Counting for Traffic Surveillance using Digital Image Processing

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Abstract: ***Traffic Surveillance system is being more important with the increasing number of vehicles. Much better ways for traffic analysis are also developed. Traffic analysis is the analyzing the cloud of vehicles in defined place for specific interval of time and the vehicle classes. Now a day most of the people involving in sensor use to detect the vehicles. Even though these systems are highly effective and matured and not very budget friendly. These systems need high maintenance and periodic calibration; so it causes highly smarter computer vision based systems for traffic surveillance. Our proposed system takes the input data in the form of RGB images and converts into gray level images. System extracts the features of different vehicles and gives a vehicle counter and classifier based on combination of several different video-image processing techniques including background Subtraction, Gaussian mixture model(GMM), frame differentiation, Gaussian blur filter. Proposed system detects and counts the vehicles with accuracy of 97.22%. Implementation is performed using python programming language and uses image processing algorithms for real time images with different library.***

Keywords: ***Background Subtraction, Gaussian mixture model, Vehicle detection, Vehicle count, classification***

I. INTRODUCTION

The efficient management and monitoring of vehicle traffic is most important as increase in number of vehicles on road, this may results the problems like traffic congestion, traffic accidents and air pollution from vehicles and so on. Currently Traffic congestion is most challenging problem that we are facing. Rate of increase in transportation infrastructure and more pavements and wide roads are main cause for city congestion. To prevent congestion problem some investigators give their attention on intelligent transportation system (ITS), congestion detection is been done from monitoring of activities at traffic intersections. Increase in population mainly causes high traffic congestion in metro cities [18,19,20]. The heavy traffic create loss of money, loss of population and affects human routine lives directly and sometimes cause human routine losses also. [21,22,23]. The processing and monitoring of information results into better understanding of traffic flow, an increasing importance on traffic surveillance is in need for efficient detection of vehicle at wide roads. Autonomous intelligent transportation system is mainly developing from the intelligent visual surveillance for vehicles on road. Image processing methods are consumes more time to performing the operations. To save the time, it needs to do some automation for classification and counting of vehicles so using of python programming language in our system helps to save the time for vehicle detection, counting and classification. In our proposed system we set up the video camera first on road side. Then capture the video from real-time analysis and differentiate the video as foreground and background mask. Then remove the noise from video using binary morphological operation as dilation and erosion methods, this noise removal can helps to detect the vehicle more efficiently. Vehicle detection and tracking use segmentation with background subtraction using morphological operator. Classification is done based on area of vehicles moving on road. Counting is done by considering two imaginary lines. Rest part of the paper describes sections as follows. The Literature view was given in 2nd section and proposed work is briefly explained in 3rd section and results and future scope is clearly explained in 4 and 5 sections respectively is document is a template. For questions on paper guidelines, please contact us via e-mail.

II. RELATED WORK

There are huge number of researches is been done related to traffic surveillance and vehicle monitoring on highway roads using Background Rejection method. This section helps us to understand the importance and limitations of methods used in these researches. Dr. Ravindra kumar and Reha Justin[3] proposed a system of vehicle counting and detection using image processing methods. In this they have used edge detection algorithm and kalman filter to detect and track the vehicle. They use the python programming language for time saving. P. Choudekar, S.Banerjee, M. K. Muju [2] proposed the system of Real time traffic light control using image processing. Image processing techniques are playing an important role in case of analyzing video. In this dynamic vehicles were detected by comparing continuous frames. The extraction of object in motion in real-time video sequence is proposed by X. Fu, Z. Wang, D. Liang, J.Jiang [1] In this paper they explains the conversation of RGB colored image to gray leveled image it gives more acceptable results in video processing.

Lei,M. [5] proposed the another video based vehicle counting system. In this surveillance cameras were used to acquire the traffic video stream by mounting the cameras at relatively high place. The Gaussian shadow eliminations and Adaptive background estimation were used in this system. System accuracy depends on the ability to remove effects of ghosts and shadows and also on visual angle. Here the incompetency in system helps to classify the vehicle types. Another video analysis method to count the vehicles is proposed by Bas et al [6]. In this detection and tracking of vehicles was based on size of adaptive bounding box in accordance with the estimated distance from the camera to vehicle and here ROI is taken by defining inbound and outbound boundaries for an image. System is not efficient to track the vehicles when any variation in direction.

In case of traffic surveillance the vehicle detection is very important process as it highly impact on many algorithms. Here correct detection and extraction of foreground objects is a most important process. System uses many techniques for foreground detection like frame differencing [4], used for simple segmentation and foreground detection based on close relationships between the images sequences that are in motion.

Collines [7] proposed the system of improved frame differencing method by taking the multiple frames differences for computation of foreground instead of initial frame use.

Vehicle detection and counting was proposed by Nilakorn et al. [8]. System uses the different background subtraction steps and also uses techniques such as adaptive morphological dilation and erosion methods for removal of noise in image for extraction of foreground objects from the video. Friedman, N. and S.Russell [9] were proposed the GMM method. Stauffer, c. and W.E.L Grimson [10, 11] were used the refined GMM for real time tracking. In Gaussian mixture model they had assumptions that background is clear more often than foreground objects.

L.A. Marcomini and A.L. Kunha [15] give the comparison between background subtraction algorithms for segmentation and detection of vehicles in traffic videos. In this they compared the three background subtraction algorithms such as guassian mixture model (GMM), mixture of Gaussian model (MOG) and MOG2 were available in openCV and coded by python. Comparison is done by taking 35 ground–truth images and from those take five from each video. Then compare the algorithms with the help of their precision rate, accuracy rate and processing time of each algorithm. All three algorithms produce better accuracy and precision rate for segmentation and detection of vehicles but compared to all the MOG2 is best algorithm to use for segmentation because of its superior precision rate and low processing time.

Another video based vehicle counting and classification system was given by shreeraz memon [13]. In this detection and counting of vehicle in highway traffic is done by using background subtraction with Gaussian mixture model of MOG2 algorithm.MOG2 has better illumination handling capability.

System was more useful for detection of vehicles when day times. Here SVM classifier and good CV techniques are used for vehicle classification, it will give the better classification. Classification is done by extracting features like area, size, aspect ratio, centroid and solidity for vehicles.

Nilesh J. [17] proposed the system of vehicle detection while they are in motion for traffic count measuring using openCV. System was implemented in python programming language. Python have very good libraries like scipy, numpy and matplotlib etc, these helps to save the time of the processor. Computer vision based systems are used to make the system more portable, inexpensive for detection of moving vehicles in traffic. Another computer vision based vehicle counting, detection and classification of vehicles was proposed by A. Suryatali and V.B Dharmadhikari [12]. Here classification of vehicles were made into light and heavy weight and vehicle detection is totally based on background subtraction algorithm and kalman filter was used for removal of noise content in images. Here also openCV library is used for detection in processed frame.

Naresh singh chauhan and Rahul sarker [16] was proposed the system of detecting the vehicle, counting and tracking using LQE method. System uses the simple approach for vehicle count and detection. Here vehicle detection and counting is made by using background subtraction and linear quadratic techniques. Detection is done by subtracting the video into mask and morphological operations like dilation and erosion was used to filter the clutter from video. Use of linear quadratic technique in this system is to predict path of vehicle and count the number of detected vehicles. System produces the less complexity and high accuracy for detection. Ye Tian and Yangli Wang [14] was proposed by Accurate vehicle detection and counting algorithm for traffic data collection. System uses the intelligent transportation systems. In this vehicles could be detected from use of two features such as gradient and range features. Virtual line based sensors were set on road lanes for detection. This system works excellent in case of traffic jams and also on various conditions such as day time, night times, rainy and cloudy. System can also have ability to solve occlusions present and produces high accuracy.

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III.PROPOSED METHODOLOGY

The first step in our system is to take the video from a camera installed on road. After that frames in that video has been processed for detection, tracking and counting of vehicles. Proposed system is based on background subtraction algorithm with Gaussian mixture model to detect moving vehicles on road. The entire methodology is represented in flow diagram.

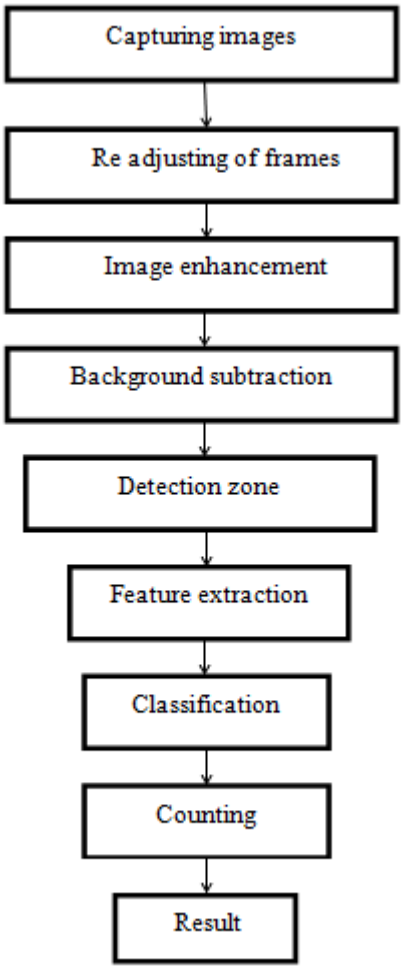


Fig 1: Flow chart of the system

A. Background Subtraction

After extraction of images from video, video is converted from RGB to gray level. Then apply the Background subtraction method. It is technique of obtaining the foreground images or to detect moving objects. It detects vehicles mainly based on shadows and differentiates between foreground and background objects. Moving objects are considered as foreground and background is defined by static objects. After that subtract only background objects so that foreground objects are visible. Apply image enhancement techniques like dilation and erosion methods, noise filtrations, after background subtraction to get proper foreground objects.

```
fgbg=cv2.BackgroundSubtractorMOG()

fgmask=fgbg.apply(edges)
cv2.imshow('background subtraction',fgmask)
if cv2.waitKey(30) & 0xFF == ord('q'):
    break
```

Fig 2: Code for background subtraction

B. Morphological Operation

Dilation and erosion are commonly used methods for morphological operation, to filter noise content present in frame and to take original structure of an object. Dilation is the process of add the pixels to the boundaries of an object and erosion is remove the pixels on object boundaries. Number of pixels adding and removing is depends on shape and size of element used for processing of image. State of any object in output can be determined by applying this rule to current pixels as well as neighbouring pixels in input image. These morphological operations enhance the detected objects boundary after background subtraction method. Fig 3 shows the noises present in the video as holes. In fig 4 represents video after morphological operation.

Fig 3.Gray scale video

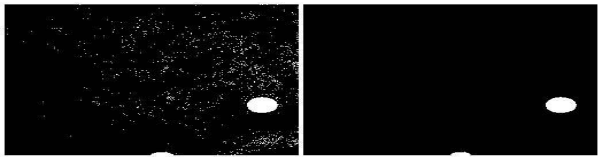


Fig 4.Morphological operation

C. Vehicle Detection

There are several algorithms introduced for vehicle detections. Some background subtraction algorithms are implemented on openCV which uses the Gaussian distributions for the creation of background model in an image. Algorithm used in our proposed system is backgroundMOG2 which uses defined amount of Gaussian distributions, so that it gives the better representation of complexity of colours in image. Algorithm is also has better illumination handling capability. This algorithm helps us to define whether objects shadow is detected or not by comparing the weights of the current pixels in frame to values defined in model.

```
cv2.createBackgroundSubtractorMOG2(
                                    history=200,
                                    varThreshold=16,
                                    detectShadows=True
                                )
```

Figure 5.MOG2 constructor with default values

D. Vehicle Classification and Counting

In proposed system vehicles are divided as type1, type2 and type3 categories. Type1 includes motors; type2 includes minibuses and type3 includes trucks and buses. In classification process starts with extraction of width and length of the each vehicle passing on video. Area of each bounding boxes in pixels helps to determine the passing vehicle belongs to which category. In this Different vehicles are represented with different rectangular colour.

In counting process, counters can be used for counting of vehicles passing in specific direction on road. Counting can also be done by taking the width and length of vehicles. In this only vehicles inside the detection zone are to be counted and classified according to their respective categories. It is been need to take the two imaginary lines to check whether vehicle moving up or down. If the Vehicles centroid touches or crosses the imaginary line in ROI, then it counts the vehicle. Based on the area of each vehicle, vehicles can be counted in their respective categories, when vehicle crosses the imaginary line.

IV. RESULT

After analysing the input video with the background subtraction method, then output of the video shows the single vehicle detection and mask player video is shown in fig 6 and 7 respectively and multiple vehicles detection and count is shown in fig 8 and 9 respectively. Here we taking the different videos based on luminosity changes, then analyse videos for detection and counting the vehicles in different conditions. Accuracy for our proposed system is 97.22%.

Fig 6: Single vehicle detection in video

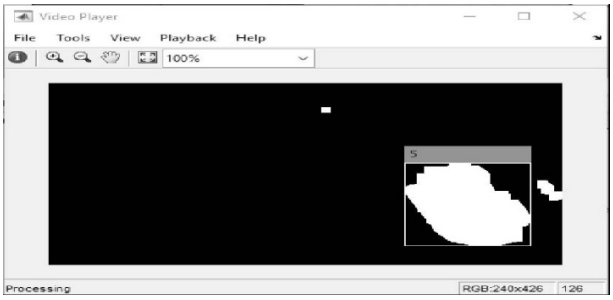
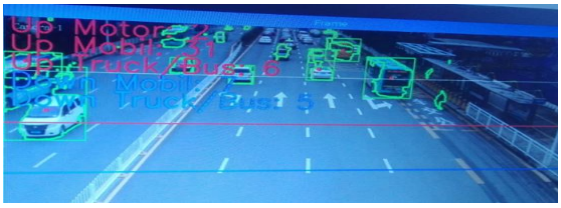


Fig 7. Single vehicle detection after applying mask



8.Counting of vehicles in up and down stream

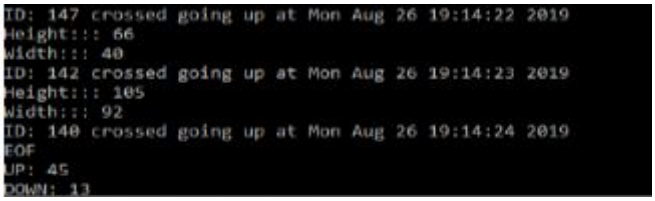


Fig 9.Information about number of vehicles crossed

V. CONCLUSION

The proposed system uses python programming language for implementation, using openCV building. Python uses special library like numpy, scipy, matplotlib, which can take important part in the detection, counting and vehicles classification and more useful for saving the time of engineer. Mainly this system has been developed to detect and count the traffic for dynamic vehicles on highway efficiently. System uses MOG2 algorithm, it gives better performance in detection by producing superior precision rate and low processing time. Processing of data and finding the accuracy and processing the frame in finite period of time is hard task for transportation in highways. System is effectively combines the knowledge about vehicle classes and performing measures to identify the target vehicles in partial occlusions by effectively rejecting the background clutter. Computational complexity is linear in size for the system. As we considering the highway traffic there is no question of shadow exist, but due to occlusions two vehicles are merged as single entity.

VI. FUTURE SCOPE

The limitation of this system is it is not efficient to detect the occlusions present in video, hence we could use the color based classification for occlusion detection. System needs human supervision to define the ROI and also to define imaginary lines for counting and classification, so the accuracy of counting and classify the vehicles in system is totally depends upon the human supervision. This can be solved by using the camera calibration techniques. System supports vehicle detection in both day and night time but only in light vision, so this can be solved by using night vision cameras. System could also be improved by using efficient image segmentation techniques and some artificial intelligence operations.

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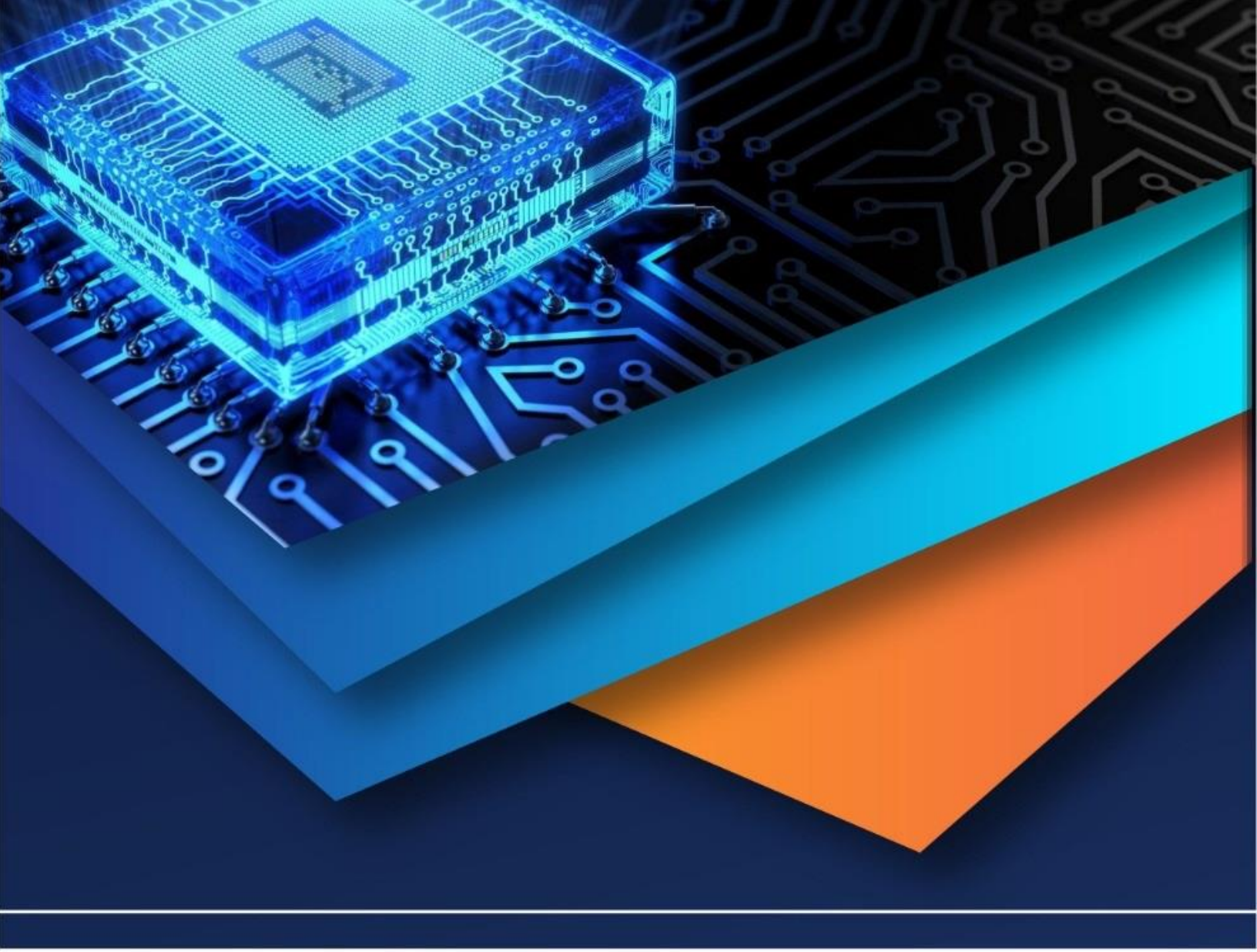

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