Watershed Segmentation for Vehicle Classification and Counting

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***ABSTRACT*: - A robust video based system for the traffic surveillance system on the highway for vehicle detection, vehicle classification and counting for effective traffic analysis using only a single standard camera. The key goal of the proposed work is to successfully detect, track, classify and count the vehicle in partial occlusion and connected together by shadow on the highways. Marker-controlled watershed segmentation method is initially used for the extraction of the foreground regions from the highway scène. For tracking Gabor filter is applied which is used to measure vehicle path in video sequences. For effective vehicle classification support vector machine is utilized. An experiment result shows the considerable performance of watershed segmentation in vehicle detection in the occluded and connected together by shadow in the highways environment.**

Keywords: Watershed Segmentation, Vehicle Classification, Vehicle Tracking, Support Vector Machine

I. INTRODUCTION

Safety development of transport develops by computer vision. Nowadays it's widely used in several applications like transportation, military. Especially it is more useful in intelligent transportation. For the video based traffic analysis some of the parameters need to be performed they are vehicle detection, vehicle tracking, vehicle classification and counting .while performing such task there exist some issues like intensity changes, partial occlusion, missed vehicle due to darker region, connected together by shadow. Some of the existing techniques like magnetic loop detector, radar, laser, GPS are used for the intelligent transportation but the outputs are not much effective and also too high cost. Accuracy of the output also depends on the camera. Issues arise over camera are camera calibration, camera cost, and camera quality. Some of the approaches does not works fine in real time applications.[1]

From the cameras the road lanes are need to be supervised to perform the process to analyze the traffic .For this, stationary camera is used in the purposed work. One single stationary camera is used and detect the vehicles provide the considerable result. From the camera the videos are captured and the frames are extracted into frames which are then converted to gray scale image and used for the further process [2]. The important process of the vehicle detection is segmentation .Initial process of computer vision in intelligent transportation is background subtraction. Background subtraction has two approaches they are static and adaptive. In the static approach, dynamic changes cannot be updated but in adaptive approach issues like intensity changes, partial occlusion, missed vehicle due to darker region, connected together by shadow can be detected. Background subtraction approaches like Mixture of Gaussian, Frame Difference, and Appropriate Median results are compared with watershed transform segmentation algorithm results are shown in experiment results.

For better result in segmentation another technique is sobel edge detection .In the binary images edges are found and connected together for efficient vehicle detection .It is used to detect the vehicles only in traffic scene because in traffic jam there may exists the pedestrians and also to avoid the misdetection of vehicles due to occlusion and shadow .There are two types of approaches in computer vision technology in intelligent transportation they are commercial approach ,sophisticated approach[2] the propose work merges these two approach with considerable cost and considerable output.

Vehicle tracking is used to measure the current position of the moving vehicle in the path. And also it used to reduce noise which helps to improve the performance.Kalman filter, neural network, fuzzy measure also used for vehicle detection. The drawback of Kalman filter is misdetection of the vehicles in occlusion. In neural network it cannot find the global minimum. The changes in intensity cannot be adopted by fuzzy measure. Gabor filter is used in proposed work for effective vehicle tracking. Efficient background subtraction, vehicle tracking is used for the further process of vehicle classification and counting.

For classification, support vector machine is used for the vehicle classification. In the proposed work the vehicles are classified as light vehicle and heavy vehicles. Light vehicles include the two wheelers and car. Heavy vehicles include truck, bus. When compared to other classification technique like SOM, MCMC, 3D classification and other manual classification techniques SVM classifies the vehicle effectively. For counting process the binary images is scanned. In proposed work two variables are used such as count, count reg. The process of vehicle detection, vehicle classification, vehicle counting is used to analysis the traffic and also it is

used to find the abnormal events such as accident traffic rules violation. Section two describes the literature review of the proposed work. Section three describes the proposed method framework. Section four describes the methodology. Fifth section describes the performance analysis. Sixth section describes the conclusion and future work.

II. RELATED WORK

In the development of computer vision technology over video based traffic monitoring is the emerging area. Initial step is video processing for vehicle detection it overcomes the bad illumination and light shadow. Region based, active contour based and also it include Kalman and particle filter are used for tracking 3D .Issues over these work is shadow removal and vehicle occlusion.[2].New method for vehicle counting is used in[3]the distance is used for the computation of detection of vehicle .The distance is acquired from camera geometry view .the input video is capture at different time instance in city Istanbul.

In [4]the propose work the vehicle tracking process is in ongoing and so it is used to provide the low budget approach in order to estimate the traffic parameters like vehicle detection. Using the low cost video camera vehicle is detected. Detection and tracking of uncalibrated CCTV camera in [5] they used Gaussian background is used for the background extraction. Tracking is performed by using the shape and motion by Kalman filter to avoid the occlusion.

In[5] background subtraction process based on changing values of intensity of the pixel is used. Basic background subtraction methods are unimodal kernel density, codebooks these methods cannot adopt to background changes due to environment changes. For segmentation [5] utilize the adaptive multi cue background subtraction which includes histogram and gradient values of image. For tracking Kalman filter is used and also Markov chain Monte Carlo also is used for tracking .For classification three dimensional wire frame model is used. The results include the misdetection of vehicle due to occlusion and connected shadow component.

III. PROPOSED METHOD FRAMEWORK

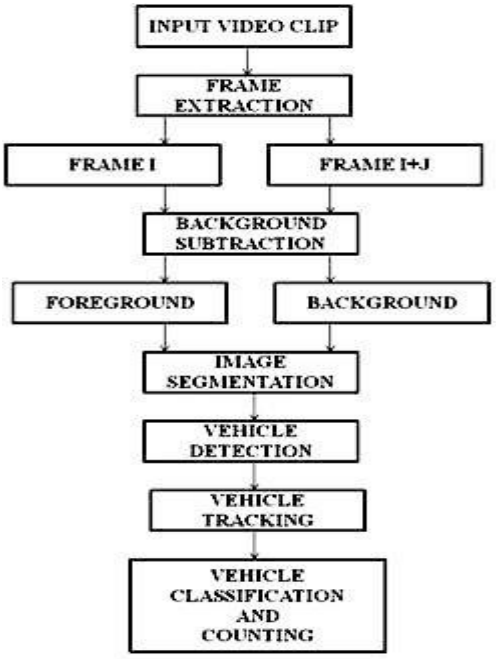

Fig.1 Represent the proposed algorithm work flow diagram.

The proposed algorithm work flow framework is explained below:

- Input Video**:** Select the video and load the video
- Frame Extraction**:** Videos are converted into frames and extract the frames for further process like vehicle detection,classification,counting.frames are converted to gray scale images .frame I is the initial frame used for initial process frame (i+j) are the next successive frames where the actual process starts by taking the initial value obtained at frame I and values are modified
- Background Subtraction**:** Foregrounds are represented in white color other backgrounds are represented in black color. Marker controlled watershed segmentation is used for extraction of foreground from images.

- Image Segmentation**:** Image segmentation is the object of interest. The main purpose of image segmentation is to extract the features of object and also to reduce the data which varies from input pattern
- Vehicle Detection**:** Find the edges of the current image and the background image then subtract background from the current image in order to find the moving vehicle
- Vehicle Tracking**:** Vehicle tracking is for measuring the vehicle path in video then to locate the current position of the object and also to reduce the noise in image. Gabor filter is used in this propose work.
- Vehicle Classification and Counting: Major role in the traffic analysis is vehicle classification in this paper vehicles are classified using support vector machine. Vehicles are classified as light vehicle and heavy vehicles. And for counting binary images are scanned for counting process here for counting two variables are used they are count, count reg.

IV. PROPOSED SYSTEM

A. WATERSHED SEGMENTATION BACKGROUND SUBTRACTION

Separating the intersecting object in frame is one among the difficult task in image processing operations. Watershed transform is used to separate the intersecting objects in the frame. It finds the watershed rigid lines, catchment basin in image by considering it as surface where light pixel as high and dark pixel as low. The advantages of the method the boundaries of each region are continuous.[8] To avoid the over segmentation, marker is used, Marker is the connected component corresponding to the image. This marker includes the internal and external marker whereas internal marker corresponds to the object of interest and external marker corresponds to the background .Internal marker point in the image form the connected component which has the same intensity value. The points are the highest point in the neighborhood. Each external marker consists of internal marker and performs the segmentation over the images. In watershed segmentation there exists three types first is watershed segmentation without marker, second is watershed segmentation with automatic marker and third is watershed manual marker. Third type provides the considerable result when compared to first type. Marker controlled watershed segmentation solves the over segmentation problem [9].The basic procedure of marker is listed below:

1. Read the color image and convert to grayscale.
2. Calculate the gradient magnitude from the grayscale image which is the segmentation function.
3. Perform sobel edge detection and get edges
4. Connect the edges with border
5. In edges fill the missing pixels
6. Name the label function on edges
7. Mark the foreground objects(automatically or manually)
8. Calculate the background markers (automatically or manually)
9. By altering values of the gradient magnitude image we acquire the optimum values in pixels.
10. Apply the water shed transform to the modified gradient image

In the earlier process the automatic marking of background uses the thresholds of original gray scale image is consider. The initial step in segmentation is extract the frames from the input video clip and second step to convert the RGB images to gray scale image. In third step by utilizing the mathematical morphology for the automatic marking of foreground object. Computation of regional maxima and noise removal yields the foreground marker. Edge detectors make combination of gradient and transform. The gradient magnitude image is modified. Because of its considerable results over the occlusion, and detection of darker region watershed segmentation is widely used in image processing, pattern recognition.

B.VEHICLE TRACKING

Vehicle tracking is improved by using the Gabor filter techniques. [10]The color space used is RGB color space. Instead of using the feature like color, shape ,motion for tracking texture information is used for better performance of tracking in this propose work online feature selection framework is utilized .Gabor contains two types of element they are Gaussian envelope and sinusoidal carrier. Representation of two dimensional Gabor filters is as a Gaussian function by a sinusoidal signal. As online feature selection is used based on object and background subtraction. Object is highlighted by rectangle dimension as Height *weight and the background is beyond the rectangle which helps to show the direction of object. Histogram feature value of the object is utilized. Histogram of the object and histogram of the background is considered by normalizing the values we acquire likelihood image with this feature tracking can be attained [11].

C.VEHICLE CLASSIFICATION

Support vector machine is one among the artificial intelligence which is used to extract the useful information from the images. It belongs to the supervised learning. It use the recursive based approach for known and unknown classes and so It can provide the probabilistic framework with minimum error decision rule.[12] It performs classification using linear decision hyper lanes in the feature space. a set of SVM classifier trained are

the basics step while training hyper lanes are computed to separate the data with different labels. If training data does not belong to the linear in space then kernel function is used for the transform. Support vector machine classifies independently.[13]. SVM is the iterative process. It scan the dataset to find the violator[16].

The fast iterative SVM algorithm is explained below:

1. Find the closest pair point from the opposite pair
2. Add that points to the support vector
3. Check whether there exits the violating point
4. If so reduce the violation
5. Repeat the process until all points are reduced

In the purpose work SVM implemented in MATLAB.SVM classifier is trained using SVMTRAIN function. The most common syntax used to train SVM is

SVMstruct = svmtrain (data, groups,'Kernel_Function','rbf');

The inputs are data are collection of matrix data in matrix each row contains one observation and each column contains one features. In kernel function default value is linear which separate data by hyper lanes the computed value produce the value that assigned to the SVM struct which will be parameter to used for the classification. When classifying the new data using SVM classify function the structure of SVM classify is

NewClasses = svmclassify (SVMstruct, new Data)

[14]In traditional SVM there exist two class for multiclass SVM multiclass problem are converted to two n class problem as n(n-1)/2. let us consider D_i is the decision of variable x. $\mathbf{D_{i(x)=0}}$ is the optimum. $\mathbf{D_{i(x)=1}}$ solution for separating the hyperlane.and SVM belong to the class. And remaining belongs to $\mathbf{D_{i(x)=-1.}}$

D.VEHICLE COUNTING

For vehicle counting the binary mask image from the input video is used for counting. The binary image is scanned from top to bottom to find the object for counting. [15]Two variables are labeled as count and count reg. The count variable contains the registered image. The count reg contains newly detected image which is not in the count variable .This technique is applied over entire image for the counting process. Steps for vehicle counting is explained below

1. Scan the First Frame to find the Object
2. If Any Object Found Check with the Count Variable Values If Not Register with Count Reg
3. Scan the upcoming frames to detect the sudden changes.
4. Repeat Until Full Image Scanning Gets End.

V. RESULTS AND DISCUSSION

Experiments are performed using the MATLAB software because it's an efficient tool for image processing .For the performance analysis videos are chosen in traffic scene. Video is in AVI format. Where table 1 has the results acquired. Video has width*height of 320*240 pixels, duration of 58 seconds, 15 frames per second.

The below shown fig 2 represents the output of a segmentation result of frame in various methods such as frame difference, appropriate median, mixture of Gaussian, watershed segmentation.

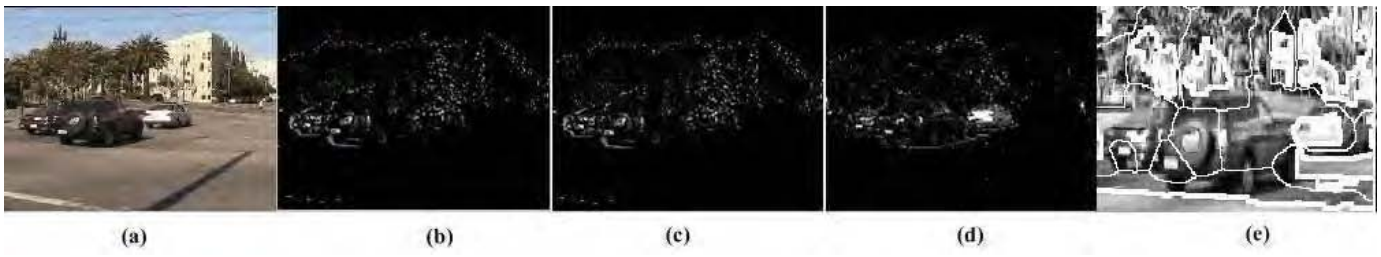

Fig2 (a) Original Frame (b) Frame Difference (c) Appropriate Median (d)Mixture of Gaussian (e)Watershed Segmentation

The below shown fig3 represents the difference without marker watershed and with marker watershed

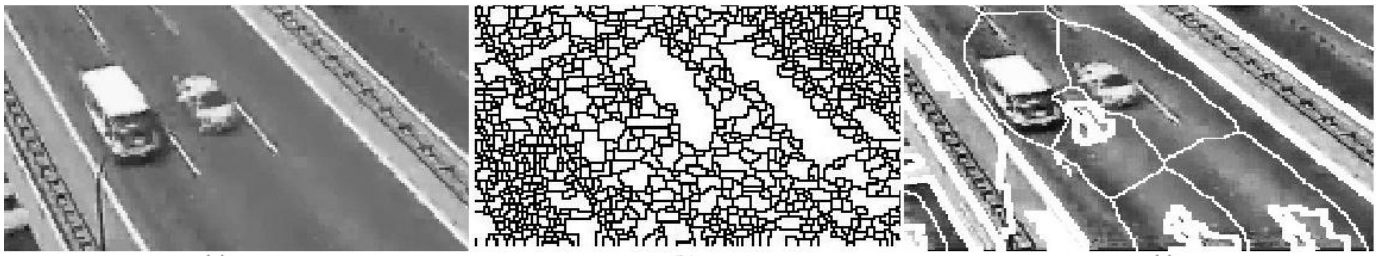

Fig 3 (a) Original Frame (b) Without Marker Watershed (c) With Marker Watershed.

The below shown fig 4.represents the output of a of Gabor it also includes the kernels and magnitude of Gabor

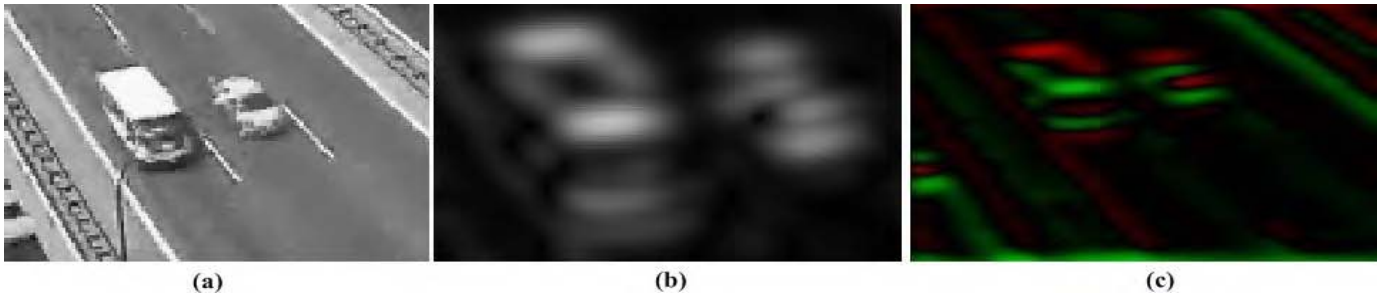

Fig 4 (a) Original Frame (b) Gabor Magnitude(c) Gabor Kernels.

The below shown fig 5.represents the output of support vector machine. The bounded box show the detected car vehicle from the highway

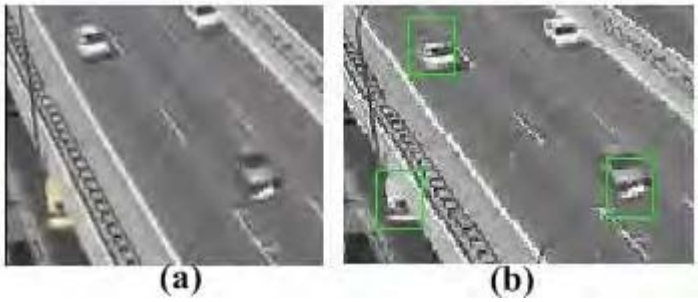

Fig 5 (a) Original Frame (b) SVM Output

In the Table1 contains the segmentation counting output of various methods

METHODS	FRAMES	ACTUAL NO OF VEHICLES	DETECTED NO OF VEHICLES	ACCURACY %
FRAME DIFFERENCE	15	10	3	30%
APPROPRIATE MEDIAN	15	10	5	50%
MOG	15	10	6	60%
WATERSHED	15	10	8	80%

TABLE 1.Performance Analysis

VI. CONCLUSION AND FUTURE WORK

In this propose work marker controlled watershed segmentation for background subtraction which provides the considerable results when compare to frame difference, approximate median, mixture of Gaussian. Watershed overcomes the partial occlusion, shadow removal. The performance analysis shows the accuracy of watershed segmentation over other existing method. For vehicles detection Gabor filter is utilized. For vehicle classification support vector machines is used to classify vehicle as light vehicle such as two wheeler ,car and heavy vehicle such as bus, truck as the future work to increase accuracy of vehicle detection at night time because of the headlight reflection the intensity value changes and so vehicles are missed for the detection.

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