Counting and Classification of Moving Vehicle

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Abstract

In a video the moving object detection, counting and classification was a substantial field of computer vision. The proposed system had several main steps that applied to detecting, counting and classification of the moving vehicle in the input video. The first step was applying the proposed preprocessing to every frame in an image sequence that contains RGB converting into grayscale, Gaussian filter, moving object detection and converting into binary scale. The second step was feature extraction that contains sizes and shapes feature and the last step is the proposed system that contain efficient approach for counting and classification vehicles, the suggested algorithm was classification and counting number of cars according to size of vehicle big one, then medium and small cars. The experiments showed reliable and efficient counting and classification results of the moving vehicles in any traffic sense within 99.14 for classification processes and the accuracy rate for total number of vehicles is 97.43.

المستخلص

في الفديو اعتبر الكشف عن الجسم المتحرك وحسابه وتصنيفه فديويا من الحقول الأساسية في الرؤية الحاسوبية. حيث امتلك النظام المقترح خطوات رئيسية قابلة للتطبيق على الكشف والحساب والتصنيف فيما يخص المركبة المتحركة في الفيديو المدخل. الخطوة الأولى هي المعالجة الأولية المقترحة على كل إطار في تسلسل الصور الذي احتوى على تحويل نظام الصورة من الملونه الى الرمادي ، فلتر كاوسيين، كشف أجسام متحركة والتحويل الى النظام الثنائي. الخطوة الثانية هي استخلاص الصفات التي احتوت على صفات الحجوم والاشكال. أما بالنسبة للخطوة الأخيرة فهي عبارة عن نظام مقترح احتوى على طريقة كفوءة لحساب وتصنيف المركبات، قامت الطريقة المقترحة بتصنيف وحساب عدد السيارات طبقاً لحجمها إلى سيارات كبيرة، وسط وصغيرة. ولقد أظهرت التجارب نتائج حساب وتصنيف فعالة فيما يخص المركبات المتحركة في أي طريق مروري بدقة قدرها و99.14 فيما يخص عملية التصنيف ونسبة الدقة للحساب الكلي للمركبات هو 97.43 .

Keywords: Counting of vehicles, classification of vehicle, object detection, two frame difference, feature extraction.

1. Introduction

Video surveillance system is a research and improvement area captivating a great deal of interest, it is concerned with detecting, classifying, counting and tracking objects in computer vision system and it also aims at describing and understanding object conduct via replacing the old conventional methods of observational cameras by human operators. Detecting objects deals with finding the location of the object existing in a sequence of video frame. Every tracking approach needs methods of object detection either when the object first appears in the video or in each one of the frames [3].

The sufficient tracking and counting of moving objects is an important and challenging function in the area of computer vision. It has a great number of implementations in video traffic, security, surveillance rules infringements and human–computer communication. Recently, a significant number of tracking systems have been proposed. Car classifying and counting is significant in Combat traffic jams and to follow track of cars using state-aid highways. Moreover, in large urban areas, there is a great need for data concerning any vehicle which uses a certain highway. A model such as the one suggested in this study that is capable of offering a valuable and an sufficient classification and counting tool for monitoring vehicles density at highways (or in other words, Objects are distinct as cars that move on the roads) [7].

The goal of this study is to build up a smart system that can detect objects in various scenes without minding to the dynamic change and redesigning the background model accurately and in reasonable time, improve the outcome and lessen calculation time with similar quality for tracking. The proposed system can also detect different sorts of patterns from element moving object, extract numerous interleaved patterns in order to detecting object, classification and counting moving vehicle.

2. Literature Review

There are approaches that have been reported in the literature which are related to automatic video object extracting, counting and classification. The literature is very extensive; thus, a number of the recent studies that have helped in the development of this system are supplied. A survey of recent researches in this field is given below:

K.Suganya Devi, et al, 2013 [3] Demonstrated motion detecting with the use of background frame coordination. This method is an especially proficient approach of looking at the values of picture pixel in consequent still frames taken after every 2 seconds from the camera. Two frames are needed for identifying change.

First one is known as reference frame and the second one called as the input frame includes the item on the move.

Nishu Singla, 2014 [4] Suggested a method for the recognition of moving items from a static background scene depending on frame difference. Initially, the first frame is captured via the static camera and after a series of frames has been captured at general interims. Then, the absolute difference is calculated between the successive frames and the difference image is stored. Afterwards, the difference image is converted into gray level image and then into a binary image. Lastly, morphological filtering is performed for the sake of noise removal.

Nuha Jameel Ibrahim, 2014 [9] Suggested a system which performs a detection and recognition of objects via the extraction of object properties with various activities in each one of the frames in a sequence of images. They suggested detection method for detecting the foreground pixels with the use of the foreground detecting approach by utilizing multiple properties (color, texture and edge) for extracting items in every frame. The obtained properties from every one of the detected items is made with the use of the information concerning color, texture, size and shape in addition to statistical properties for the sake of facilitating the classification of objects with the use of a combination of 3 classification approaches (SVM, Linear regression and M5 rules). The final stage in the suggested method is the use of the obtained properties for object identification, those properties are sub-divided on the region of the object for finding the percentage of every feature to region and perform a comparison with the percentages of every obtained human object for identifying human objects and producing the report for item movements.

Mingpei Liang, et al, 2015 [5] Suggested a method for the classification and counting of interstate vehicles according to regression analyzing. This method needs no distinctive segmenting or tracking of individual vehicles. Therefore, this method is specifically useful in the case where there's extreme occlusions or when the vehicle resolution is low, in which obtained properties are very problematic.

There are mainly two commitments in this suggested method. Initial, a distortion method is implemented for identifying the forefront portions that include unclassified vehicles. The common used tracking and modeling (such as Kalman filtering) of specific vehicles aren't needed.

Second, they perform an extrication of an arrangement of low-level properties for each one of the foreground region portions and generate a cascaded regression approach for classifying and counting vehicles that have not been used in the part of intelligent transportation frameworks.

Md.Zakir Hussain, et al, 2016 [4] Proposed a method for moving item detection via the use of the Background Subtraction and Frame Differencing methods. An object on the move might be found via the utilization of various methods, such as calculating the difference between two Images.
A background Subtraction and two frame difference approaches are implemented. The output of those two approaches are afterwards compared with pseudorandom number generator and observed that the two frame difference approach is capable of detecting the region of the moving item successfully, even in a complicated background, compared to the Background Subtraction methods.

3. Preprocessing operation

The pre-processing methods, approaches, and operators are utilized for performing primary processing which eases the initial data reducing and analyzing task. Those mechanisms include processes that are concerned with the extraction of areas of interest, and the reduction of data in each of resolution and brightness.

3.1 Converting Current Color Frame to Grayscale

Most of the benefits of converting a color image to grayscale domain are that to have less data because the grayscale domain has one channel rather than three channel of RGB domain which leads to fast processing during other phases (feature extraction and training phase) and less influence by the brightness which is considered in many cases as a noise. Algorithm (1) describes how to convert color frame to gray frame:

In the proposed work, the luminance method is used to convert color image to grayscale as explained in equation (1) [11].

$$(i,j)= (0.2989 * \ )+ (0.5870 * G)+ (0.1140 * B \ldots.(1)$$

Where R=read, G=green, B =blue

Algorithm (1) Converting Color frame to Gray frame

Input *Color frame //captured color frame*

Output *Gray frame // converted color frame to gray frame*

Begin

Step1: Read color frame

Step 2: Convert color frame to gray frame

For i= *0 to* n−*1* *// n is the width of the frame*

For j=*0 to* m−*1* *// m is the height of the frame*

*gray frame(i,j)=0.2989*R(i,j)+0.5870*G(i,j)+0.1140*B(i,j);*

End for j

End for i

Step *3: Return gray frame*

3.2 Image smoothing

Image smoothing is used for two primary purposes: to give an image a softer or special effect and to eliminate noise. Image smoothing is accomplished in the spatial domain by considering a pixel and its neighbors and eliminating any extreme values in this group. This is done by Gaussian blur filter.

Usually, image processing software will provide blur filter to make images blur. There are many algorithms to implement blur [6], one of them is called Gaussian Blur algorithm. It utilizes Gaussian distribution to process images. The Gaussian blur theory can be understood as taking a pixel as the average value of its surrounding pixels.

For the sake of reducing the noise of the image and reducing details as show in figure (1) below.

(a) Before Gaussian bluer (b) after Gaussian bluer

Figure (1): Gaussian blur filter effect.

3.3 Two frames difference

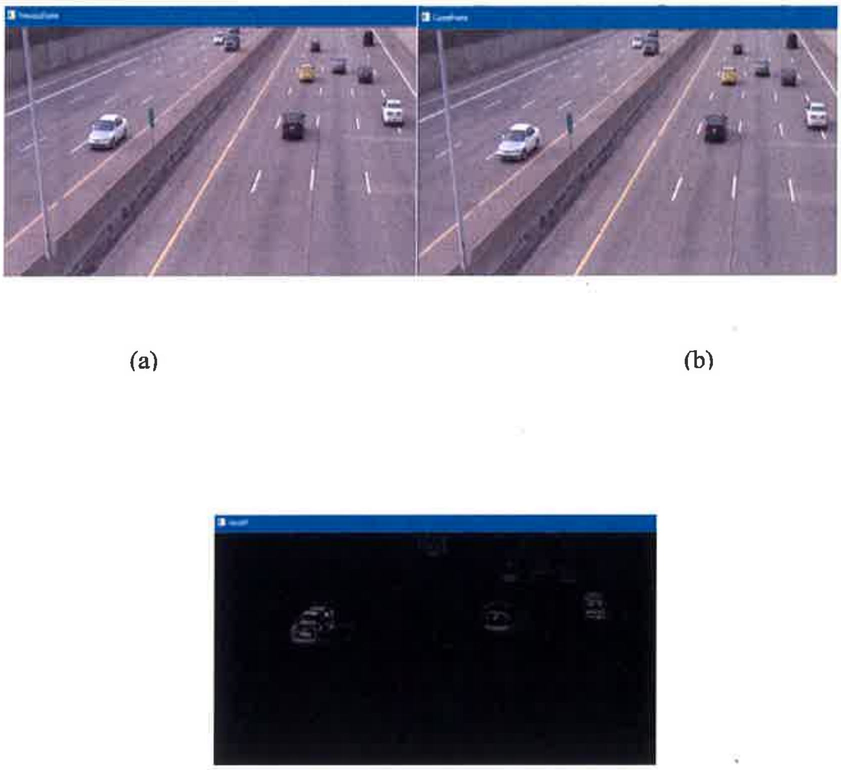
Detecting the moving item from a series of frames acquired by a still camera is done with the use of frame difference approach. The aim of the method is detecting the moving items via the calculation of the difference between the current frame and the reference frame. This approach is the widely used approach of motion detection. It adopts pixel-based difference for the sake of finding the moving item.

The two frame difference is known as the Inter frame difference as well; in addition, it is known as the Basic frame difference approach as well. For detecting the moving item, considering two successive frames, for example, current frame and preceding frame, obtained from the continuous video stream. At first, compute the absolute difference between the two frames, which is represented by equation (2), and known as the difference image. Then, applying optimal value of threshold to the difference image. This value is the binary threshold for the image. In case that the value of pixel of the difference image is larger than or identical to the threshold, then it would be considered as a Foreground Pixel, Region of Interest (Binary „1" would be given to the foreground object), otherwise as a Background Pixel (Binary „0" would be given for the background element), as in equation (3), thus detecting the moving object. Figure (2) show the frame difference method [12].

$$\text{Diff\_image} = |(\text{Curent\_frame}) - (\text{Previous\_frame})|\,| \quad \dots\dots\dots (2)$$

$$\text{Region\_of\_Interest} = \begin{Bmatrix} 1(if\,|Diff\ image| >= Threshold \\ 0 \quad else \end{Bmatrix} \dots\dots\dots(3)$$

Figure (2): (a) Preceding frame, (b) Current frame, (c) frame difference



(a) (b)

(c)

3.4 Conversion to Binary Image (Using a threshold)

Following the frame difference procedures of every one of the pixels in various frames containing grayscale image is producer which has to be converted to binary image via the use of a threshold value and then the moving item has been recognized. When the pixel corresponds to the moving object is set to 1 and the remaining is the background which is set to 0, as shown in Algorithm below:

Algorithm (3) Convert Grayscale to Binary image.

Input: Gray frame, T= (30) // T = Threshold
Output: Binary frame

Begin

Step1: For m = 0 to N // N: number of frames // high image =h, Width image = w

Step2: For i= 0 to h

For j= 0 to w

Step3: If image [i,j]> T then

Image [i,j]= 1 // For object

Else

Image [i,j]= 0 // For background

Step4: Return and number of frames

3.5 Detecting Connected Areas

The filtered pixels of objects are grouped into connected areas (blobs) and labeled from detection algorithms that were depicted in previous sections generally include noise and thus are inappropriate for further processing without special post-processing. Individual blobs corresponding to items are found; the dimensions of those areas are found. In this approach, it is important to detect all objects since foreground pixels map that contains the foreground pixels, it may contain one object or more than one moving objects. This is done by making scan to the pixels map vertically line after line until get line that don't contain any foreground pixels, then labeled object that is scanned as new object with new number. Figure (3) shows this operation.

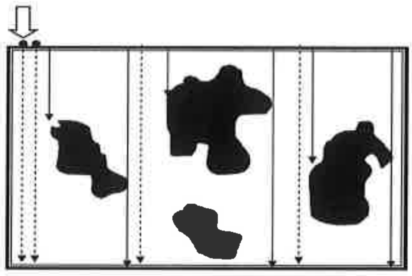


Figure (3): Scanning foreground region to detect multi-object vertically.

Then the system makes scanning horizontally to ensure there is no object in the same line and if there it gives it new number see Figure(4).

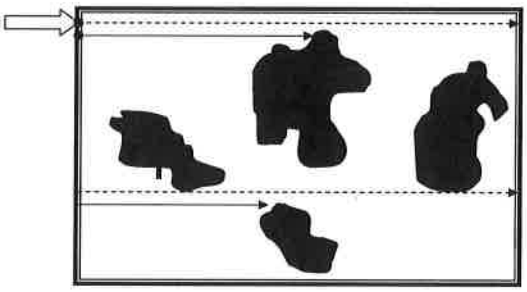


Figure (4): Scanning foreground region to detect multi-object horizontally.

4. Features Extraction [1]

Once the system has segmented into regions it extracts features of the corresponding objects from the current image. The proposed system detect objects features by get features that reflect to size and shape information in addition to statistical features. The combined set of features is usually very effective to distinguish object and provide more reliability.

Several features are extracted from the binary images which depend on the shape of the moving objects.

4.1 Width and height

The first extracted features are width and height of the objects. Width of the vehicle in the sub-image is determined via successively penetrating every one of the columns in the sub-image to locate the first and last pixels in the image and store their column numbers.

The width of the image is found via the subtraction of the column number of last pixel from the column number of first pixel, see figure (5) below:

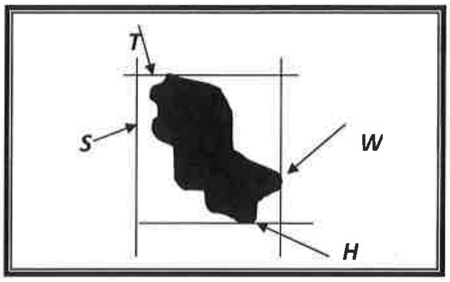


Figure (5) the dimensions of object.

However, height of the object in the sub-image is calculated via consecutively probing every one of the rows in the binary image. The 1st and last pixels of the image are located and the corresponding row numbers are stored. The image's height is found via the subtraction from the row number of last pixel to the row number of 1st pixel.

4.2 Aspect ratio

The second extracted feature is the aspect ratio of the objects, this is done by using equation (4) in the binary image by finding the width and height of the objects. The aspect ratio of all the sub-images is stored as features.

Aspect ratio= W/H...... (4)

4.3 Centroid

The third extracted feature is the centroid. The centroid represents the center of mass of the objects in sub-image depending on the width and height whose centers represent the centroid point.

For the sake of calculating the center of mass point, ***Cm*** = (***XCm***, ***YCm***), of an object ***O***, the system uses the following equation:

$$\text{Center of mass} = \frac{X\min + X\max}{2}, \frac{Y\min + Y\max}{2} \quad \text{........ (5)}$$

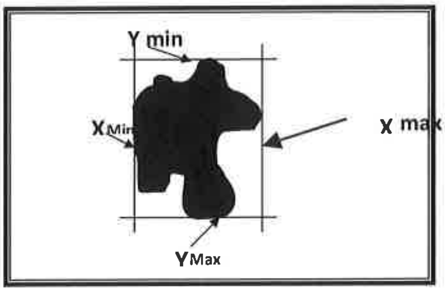


Figure (6) the dimensions to find center of mass of object.

4. Area

The fourth extracted feature is the area. The area feature is used to measure the actual size of the object by calculating the number of pixels and indicating the relative size of the object for recognition.

In order to provide general equation for area, a function fi (r, c) is defined such that

$$f_i(r,c) = \sum_{0}^{1} \begin{matrix} if\ f(r,c)=i\ \ th\ \ object\ \ number \\ otherwise \end{matrix} \quad \text{........ (6)}$$

Now the area of the i Th object can be defined as

$$Ai = \sum_{r=0}^{N-1} \sum_{C-0}^{N-1} fi(r,c) \quad \text{........ (7)}$$

4.5 Perimeter

The five extracted feature is the perimeter. In order to compute the perimeter, the number of "1" pixels that have "0" pixels as neighbors are counted, and the result is represents the perimeter. In the case of the sub-image having more than one objects segments, the perimeter is found by the summation of all the results from each segment. Then all information of that object is saved in the record which the system can access when it needed. The size of the object is just counted by calculating the number of pixels that the object have.

Algorithm 4 shows the steps of extracting the proposed features.

Algorithm (4) Features extraction

Input: Binary image (sub-image)

Output: Set of Features

Begin

Step1: Read the input sub-image (I)

Step2: Find the width I_w and height I_h of the object in the sub-image (I).

Step3: Calculate the Aspect Ratio (AR) by using (Equation 4) of the objects in sub-image (I)

Step4: Find the Center of mass (Cm)of the object in sub-image (I) by using (Equation 5).

Step5: Find the Area (Are) of the object in sub-image (I) by using (Equation 7).

Step6: Find the Perimeter (Pr) of the object in sub-image (I).

Step7: Combine all the extracted features and save it in one feature vector [I_w, I_h AR,Cm, Are, Pr]

Step8: Return (set of shape features) //vector

End

5. The proposed System

The proposed system has been developed in order to be implemented on car detection and traffic monitoring, this system is proposed to be used for counting number of cars that is passed in the road and classification it according to its type which are small, medium and big cars. The video must be divided into frames, and then each frame will be converted from the original RGB format into gray level format. This operation is performed in order to minimize the size of the data and focus on the valuable details. Then Gaussian blurring algorithm will be applied to each frame in order to smooth the images.

Afterwards, the frame difference operation is applying in order to detect the moving objects in the frame, thereby detecting the cars.

After that the threshold of value will be applied in order to remove unnecessary data that might be in the detected object.

Then to obtain and prediction possible blobs to make counting operation must make scan to the pixels map vertically line after line until get line that don't contain any foreground pixels, then labeled object that is scanned as new object with new number.

By getting shape and size features to each detected vehicle (length, area, center of mass and aspect ratio) and draw horizontal line as threshold line to consider it as a passing point to each blobs if blob's center position reach threshold line then vehicle is recorded and the counter will be incremented by 1, else it treats as a portion of a previously present object and the presence of object is ignored

At the end classification process is done to classify each objects to small, medium and big vehicle by get each object's features that will be extracted and then compared to previously defined values that have been set for each car size which will determine the category each car belongs to.

5.1 Object counting

Transportation research involves counting number of vehicles on road as well as finding the density of traffic in a particular area. There are many methods of detecting vehicles on road such as motion detection, installing lasers on both sides of the road, etc., which is tedious and involves large number of hardware. The propose method uses image processing techniques to count the number of vehicles on road and classify it. The number of vehicles found can be used for surveying or controlling the traffic signal.

This proposed system of counting vehicles involves comparing the difference between two frames to detect the moving object. When comparing two images the distinction between images could be obtained, based on the obtained distinction, the vehicles can be detected and hence the number of vehicles as well as count can be calculated.

In order to track and then count any detected object in the input image, a hypothetical or fictitious line is supposed to be existing across from Y-AXIS off the image frame. So when a moving object such as a car crosses this line, it's recorded and the counter is increased.

One variable preserved, in other words, count which keep track of then number of cars and when a different object is encountered, immediately after it crosses the line, then counter is increased, else it treats as a portion of a previously present object and the existence of this object is ignored. This idea applies to the entire sense and the final count of the objects is saved in the variable count. So it is a very well precision that carried out for the object counting. Occasionally due to occlusions a very important problem has to be avoided in which two objects treated as a single entity and are merged together, as show Figure (7) illustrate the vehicle counting.

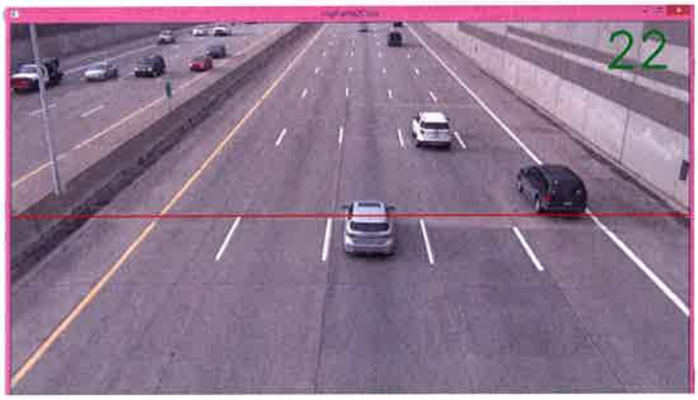


Figure (7): Vehicles counting

5.2 Object Classification

Moving areas found in a video could be corresponding to various items in real world like people, vehicles, clutter, and so on. It is highly important recognizing the kind of a found item for the sake of tracking it competently and properly analyzing its activities. There are two main methods for moving item classification, which are shape-based and motion-based approaches.

The first one benefits of the objects' two-dimensional spatial data, the latter uses temporally tracked properties of items for the classification solution.

In this paper, Classification is done by classifying the vehicles, according to its size into three classes small, medium and large. Because it is easy to get the vector's length, to categorize vehicles the length has been taken as the parameter according to the defined sizes. The table below shows the vehicle classes that used in this work.

Table 1: Vehicles classes

Large	Lorries, Buses, Containers
Medium	Cars, Pickups, Vans
Small	Motors, Bicycle, Three wheelers

Algorithm (5) Car Counting and classifications

Input: Road video.

Output: Total cars counter, classified cars.

Start

Step1: Initialize Total car counter = 0 // use to count total number of cars in video

Step2: Initialize Small car counter=0. // use to count number of small cars

Step3: Initialize Medium car counter=0.// use to count number of Medium cars

Step4: Initialize Big car counter=0. // use to count number of Big cars in

Step5: Upload video

Step6: Initialize horizontal line points:

Start point P1(x_0.h,y_0)

End point P2(x_0.h,y_1)

Draw line (P1,P2).

Step7: Convert RGB frames to gray scale by using algorithm (1).

Step8: Apply Gaussian blur to each frame.

Step9: Detect moving objects frame by frame by using absolute difference by using algorithm (2).

Step10: Convert gray scale frame to binary frame by using algorithm (3).

Step11: Scan pixels map vertically and horizontally line after line until get line that don't contain any foreground pixels, then labeled object that is scanned as new object with new number.

Step12: length, width, area, center of mas (Cm), aspect ratio and perimeter is compared to predefined values for small, medium and big cars to identify object by using algorithm (4).

Step13: 13.1If Cm of detected car reach the horizontal line

13.2 Increase Total car counter by one.

13.3If detected car is small then Small car counter increase by 1.

13.4 Else if detected car is medium then Medium car counter increase by1

13.5 Else if detected car is big then Big car counter increase by 1.

End if

6. Results and Discussion

The system is implemented by using C++ visual studio where is a very effective tool for image processing. The implementation is evaluated by using 4 measurements of accuracy which are accuracy rate, precision, recall and F-measure.

The Precision is defined as the ratio between the number of TP and the total number of TP and FN as in Equation 8[10].

$$(\text{Precision}) = \frac{TP}{TP + FP} \quad (8)$$

While the Recall is obtained by Equation 9 [12]

TP: is true positive
FP: is false positive
FN: false negative

$$(\text{Recall}) = \frac{TP}{TP + FN} \quad (9)$$

These two measures are employed for class discrimination as focused in this paper. The recognition rate (accuracy) can be defined as in Equation 10 [12].

$$Recognition\ rate = \frac{\text{TP}}{\text{Total number of test images}} * 100\% \quad (10)$$

However, the error rate can be defined as in Equation 11[12].

$$\text{Error}\ rate = \frac{\text{FP}}{\text{Total number of test images}} * 100\% \quad (11)$$

Finally, the F-measure (F1) is used for computing the test accuracy based on the precision and recall in Equations 8 and 9 F1 can be found using Equation 12 [12].

$$F1 = 2.\frac{(\text{Recall})(\text{Precision})}{\text{Recall} + \text{Precision}} \quad (12)$$

And similarity is:

$$Similarity = \frac{TP}{TP + FP + FN} \quad (13)$$

as show in figure (8) the first counter for count the number of big cars and the second counter for count the number of medium cars and the third counter for count the small cars, and at the end the total number of cars also calculated.

In the figure below the number of big cars are equle to 4, medium cars are equle to 9 and the number of small cars are equle to 4.

(a) (b)

Figure(8):a. Classiffication vehicle where the total number of counter is 17

b. Classiffication vehicle where the total number of counter is 45

in the end of video the total number of big cars are reach to 15, medium cars are reach to 23 and the number of small cars are reach to 7 as shown in figure above.

The implementation of the Program that count and classify the cars accurding to its size to big car (BC), medium car (MC) and small car (SC), the result show in table (2) below: Table (2): car classification

Input Video	Video time	Time duration	No. of BC	No. of actually BC	No. of MC	No. of actually MC	No. of SC	No. of actually SC	Total No. of car	Actual No. of cars
V1	1.42	3.8	15	15	23	23	7	7	45	45
V2	1.8	1.10	1	1	18	18	0	0	19	19
V3	0.33	1.29	0	0	12	13	0	0	12	13

Table (3) Accuracy of big car classification

Input Video	TP	FP	FN	Precision	Recall	F1	Similarity	Accuracy rate	Error rate
V1	15	0	0	1	1	1	1	100%	0
V2	1	0	0	1	1	1	1	100%	0

Table (4) Accuracy of medium car classification

Input Video	TP	FP	FN	Precision	Recall	F1	Similarity	Accuracy rate	Error rate
V1	23	0	0	1	1	1	1	100%	0
V2	18	0	0	1	1	1	1	100%	0
V3	12	0	1	1	0.92	0.95	0.92	92.3%	0

Table (5) Accuracy of small car classification

Input Video	TP	FP	FN	Precision	Recall	F1	Similarity	Accuracy rate	Error rate
V1	7	0	0	1	1	1	1	100%	0

V2	0	0	0	1	1	1	1	100%	0
V3	0	0	0	1	1	1	1	100%	0

Table (6) Accuracy of total number of cars

Input Video	TP	FP	FN	Precision	Recall	F1	Similarity	Accuracy rate	Error rate
V1	45	0	0	1	1	1	1	100%	0
V2	19	0	0	1	1	1	1	100%	0
V3	12	0	1	1	0.92	0.95	0.92	92.3%	0

7. Conclusions

The suggested approach is capable of processing the pre-processing step for detecting moving object, counting and classification vehicle based on its size features that will successfully be applied in all frames of videos. Some important conclusions will be presented as follows:

1. Identifying the threshold is identified for all the samples in the pre-processing process during conversion of the gray scale to binary scale to remove unwanted data and remove shadow. Selecting a low value for the threshold results in keeping some pixels of shadow that can't be found and eliminated, and selecting high threshold value results in misclassifying the object pixels as shadow.

2. Selecting high value of threshold for extracting the moving item (binarization) results in eliminating some pixels that actually belong to the item, while choosing a low value of threshold results in unwanted blobs and the best threshold value is T=30. Which it has been deduced from several experiments.

3. The result of suggested algorithm of object counting and classification to big, medium and small vehicles show that the accuracy average rates of all video samples are 100% for big vehicles, 97.43 for medium vehicles and 100% for small vehicles and the average accuracy rate for total number of vehicles is 97.43.

References

[1] A. J. Lipton, H., and T. Tan. Recent developments in human motion analysis. Pattern Recognition, 36(3):585–601, March 2003.

[2] K. Suganya Devi, N. Malmurugan, M. Manikandan, "Object Motion Detection in Video Frames Using Background Frame Matching", International Journal of Computer Trends and Technology, Vol.4, Issue 6,pp 1928-1931, June 2013.

[3] Ka Ki Ng, "Background Subtraction and Object Tracking with Applications in Visual Surveillance" Ph.D thesis, Purdue University, West Lafayette, Indiana, December 2011.

[4] Md. Zakir Hussain, Mrs. Ayesha Naaz, Mohd Nayeem Uddin, "Moving Object Detection Based on Background Subtraction & Frame Differencing Technique", International Journal of Advanced Research in Computer and Communication Engineering Vol. 5, Issue 5, May 2016.

[5] Mingpei Liang, Xinyu Huang, Chung-Hao Chen, Xin Chen, and Alade Tokuta, "Counting and Classification of Highway Vehicles by Regression Analysis", IEEE transactions on intelligent transportation systems, vol. 16, no. 5, october 2015.

[6] Mark S. Nixon and Alberto S. Aguado. Feature Extraction and Image Processing. Academic Press, p. 88, 2008.

[7] Mrinali M. Bhajibhakare, Pradeep K. Deshmukh," To Detect and Track Moving Object for Surveillance System",International Journal of Innovative Research in Computer and Communication Engineering , Vol. 1,Issue 4, June 2013.

[8] Nishu Singla, "Motion Detection Based on Frame Difference Method", International Journal of Information & Computation Technology. ISSN 0974-2239 Volume 4, pp. 1559-1565, Number 15, 2014.

[9] Nuha Jameel Ibrahim," Intelligent Human Detection and Recognition System" , Ph.D thesis, University of Technology, 2014.

[10] Powers, David M W, "Evaluation: From Precision, Recall and F-Measure to ROC, Informedness, Markedness & Correlation", Journal of Machine Learning Technologies. 2 (1): 37–63, 2011.

[11] Umbaugh, Scott E,"Computer Vision Image Processing", by Taylor & Francis Group, LLC, 2011

[12] Zheng Guo-rong, Xiong Chang-zhen, Zhang Yan "A Method of Embedded Video Surveillance based on OpenCV," Metallurgical Automation. Beijing, vol, s2.pp.683-685, 2010.