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Moving Object Tracking System Using Morphological Image Processing

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***Abstract*—** Image processing is a classical domain of research and development. A number of different applications in medical sciences, education and engineering the techniques of image processing are frequently used. The image processing techniques are used for discovering the objects, contents or images and lightening effects in digital images and video frames. In this presented work an application of image processing technique for recognizing the image objects is proposed for design and implement. More specifically it is tried to track and identify the moving objects. Therefore the video based object recognition technique is proposed to work. In order to design such technique video processing techniques and morphological image processing technique is used. The morphological image processing is a technique of image processing on which the pixel level structures are analysed and tracked. In addition of that for identifying the objects a threshold based technique is implemented. That technique computes the area of covered object and based on the count of pixel coverage and threshold the moving object in camera frame is detected and identified. The implementation of the proposed object detection technique is performed on MATLAB technology. Additionally the experiments on this technique are performed for finding efficiency and accuracy of the proposed system. The experiments based results demonstrate the proposed technique efficient and accurate for object tracking.

***Keywords*—**Vehicle Detection, Image Processing, Digital Image, Video Frame, Morphological.

I. INTRODUCTION

Image processing is a domain of handling digital images. The image processing techniques involve the correction on images, managing the color movements, lighting effects, and removal of the unwanted pixel data. Therefore the image processing techniques are widely accepted in various real world applications such cancer pixel detection, content based image retrieval, face recognition and others. Basically the images are the kind of real world information that are represented using the pixels numerical values. The values of these pixels are help to defining the objects and the events in the given images. Therefore different mathematical operations and methods can be useful for analyzing the image contents and nature of objects in the given image. In this presented work the main aim is to work for the problem of object detection.

The object detection in traffic scenario is the main aim of the proposed work. That work can be used to track the movement of objects in camera frames or the video frames. Therefore the application of this technique can be performed on the video surveillance and traffic tracking. In order to develop such traffic tracking technique for moving object detection the morphological image processing technique is used. The morphological technique first subtracts the background of the video or camera frame and then the pixel level analysis is performed on the video frames for identifying the pixel structures. The detected or tracked objects are handled using the thresholding scheme to identify the target object types in a given video.

II. PROPOSED WORK

This chapter provides the detailed discussion about the proposed technique required for detecting the moving object in a given video frame. Therefore different existing technique in image processing is utilized for obtaining the required objects.

A. System Overview

The main aim of the proposed work is to identify the moving objects in the given video frame. Therefore that technique can be used for traffic analysis and video based traffic surveillance systems. In addition of that it is also tried to identify which kind of vehicle is moving in the given video frames (i.e. car and big vehicles). Therefore the proposed work consumes the ability of video processing technique, image processing technique and threshold based (constraint

based) processes for obtaining the required objectives. There are a number of different approaches are available that are used for object recognition. Among the content based analysis, statistical analysis and machine learning approaches are primary techniques.

In all these techniques first images are preprocessed and then features are computed. and in final stage the machine learning algorithms are implemented that help to recognize the similar objects on which the algorithms trained before. Basically the machine learning techniques first works on the training samples to understand the target object patterns in images and after that these methods are capable to recognize the similar objects in video frames. Therefore these methods are computationally expensive and complex in development. Therefore in this presented work an efficient technique is tried to design and develop that directly works on the video frames and perform the pixel structure analysis. By using such kind of analysis of pixel structures the tracking of image objects and similar object detection on images can be easily performed. This section provides the basic overview of the proposed work and in next section the detailed methodology of system design is reported.

B. Proposed Methodology

The proposed system architecture for finding objects in video frames is demonstrated in figure 2.1. Using this diagram the internal process involved in the system is described.

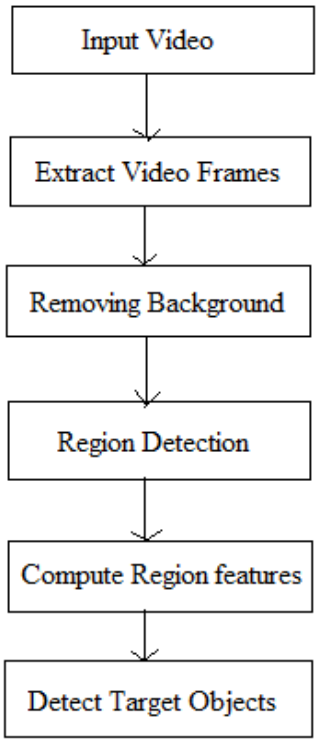

Figure 2.1 proposed system

Input video: that is the initial input of the system therefore the provision is made to accept the video data as input file to the system or direct camera interface by which the video can be captured through the system.

Extract video frames: basically the videos are the collection of image objects. The image objects in a video organized in the time domain by which by a fixed rate the images are continuously can be extracted from the video. The different image extraction from the video data is termed as the video frame extraction process. In this context the time interval and the number of video frames are provided as input to the system. The method is applied to capture and extract the images from that particular time in a given video.

Removing background: in order to remove the image background here the gray threshold method is used. That method computes a global threshold, level, that can be used to convert an intensity image to a binary image. The graythresh function uses Otsu's method, which chooses the threshold to minimize the intraclass variance of the black and white pixels.

Region detection: after removing the background information from the images (captured video frames) the region detection operation is performed. In this context the morphological image processing technique is used. That technique is basically used for detection the similar pixel organization or structures in given image. Morphological picture handling is a gathering of non-straight tasks identified with the shape or morphology of highlights in a picture. Morphological tasks can likewise be connected to greyscale pictures with the end goal that their light exchange capacities are obscure and subsequently their supreme pixel esteems are of no or minor intrigue. Morphological procedures test a picture with a little shape or layout called an organizing component. The organizing component is situated at all conceivable areas in the picture and it is contrasted and the comparing neighborhood of pixels. A few tasks test whether the component "fits" inside the area, while others test whether it "hits" or crosses the area.

A morphological activity on a paired picture makes another twofold picture in which the pixel has a non-zero esteem just if the test is effective at that area in the information picture.

- The matrix dimensions specify the size of the structuring element.
- The pattern of ones and zeros specifies the shape of the structuring element.
- An origin of the structuring element is usually one of its pixels, although generally the origin can be outside the structuring element.

Compute region features: after calculating the regions from the images the located regions from the images are evaluated for finding the essential properties of the regions. These properties or features are area of the target region, cetroid and box size.

Detect target objects: after locating the regions in the given image and computation of region features. The object detection process is initiated. In this context the located area based threshold is prepared and the objects are recognized.

There are two basic thresholds are applied for identifying the target objects.

1. if the identified area has the pixels less the 200 pixels then the object is not a vehicle
2. Additionally to detect the car objects and large vehicles therefore all the region detected mean high is computed this mean height of regions is used for differentiating the vehicle type as a car object or large vehicle.

C. proposed algorithm

This section explain the proposed methodology in form of algorithm steps therefore the processes involved in the system is listed as the steps using table 2.1.

Input : video file F, number of frames N
Output : objects per frame O
Process:

1. $V = readVideoFile(F)$
2. $I_n = extractFrames(V, N)$
3. $B = Computebackground(I_n)$
4. $for(i = 1; i \leq 1; i++)$
   a. $I_i^{'} = I_i - B$
   b. $[area, centroid, box] = MorphologicalFeature.Compute(I_i^{'})$
   c. $if(area.pixel \leq 200)$
      i. $O = no\ Object$
   d. Else
      i. $M_{threshold} = mean(Box.heigh)$
      ii. $if(box.heigh \leq M_{threshold})$
         1. $O = car\ Object$
      iii. Else
         1. $O = large\ Vehicle$
      iv. $end\ if$
5. $end\ for$
6. Return O

Table 2.1 proposed algorithm

III. RESULT ANALYSIS

Relevant The given section includes the performance analysis of the implemented approach for the proposed Vehicle Number Plate Recognition. Therefore some essential performance parameters are obtained and listed with their evaluated performance.

A. Accuracy

The performance of the correctly classified vehicle detection among total number objects detected in video to process algorithm in terms of accuracy is given in this section. The performance evaluation of proposed vehicle detection is evaluated using MATLAB operation. The accuracy of the number plate recognition can be evaluated using the following formula:

$$\text{Accuracy } (\%) = \frac{\text{No. of Correctly Detected Objects in Video}}{\text{Total Number of Detected Objects in Video}} X100$$

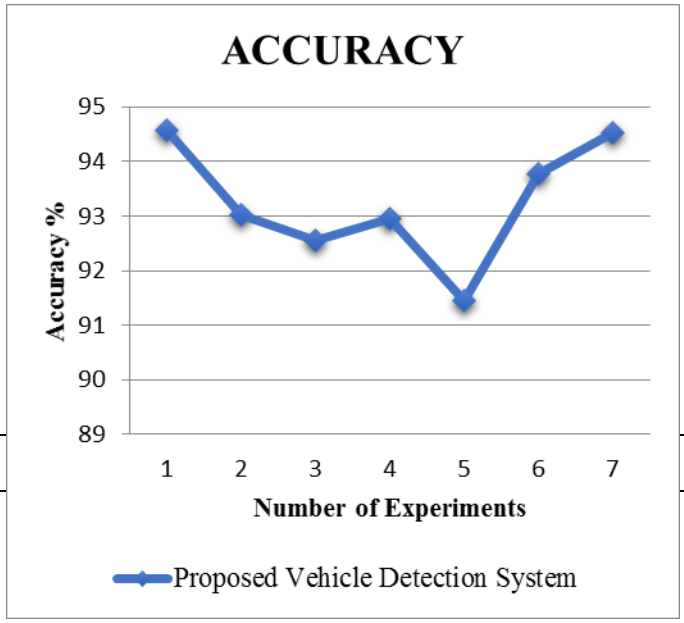

Figure 3.1 Accuracy

The accuracy of the implemented proposed system of moving vehicle detection system is represented using table 3.1 and figure 3.1. The given graph figure 3.1 contains the accuracy of the implemented algorithms. The X axis of the diagram shows the different experiments and Y axis contains the obtained performance in terms of accuracy (%). To demonstrate the performance of the proposed technique is representing using blue line. This technique is evaluated on the basis of video frames. The input frames contain vehicle object which we are detecting and ignoring surrounding areas outside the vehicle. Therefore, we have measured the accuracy of the system by the rate at which it correctly identified the vehicle. According to the obtained results the performance of the proposed model provides more accurately recognized vehicle. Additionally the accuracy of the model is increases as the amount of instances for the learning of algorithm is increases.

Table 3.1 Tabular Values for Accuracy

Number of Experiments	Proposed Vehicle Detection System
1	94.56
2	93.02
3	92.55
4	92.96
5	91.45
6	93.78
7	94.52

B. Error Rate

The amount of data misclassified individual images or an image from video files during recognition of algorithms is known as error rate of the system. This can also be computed using the following formula.

Error Rate (%) = 100 − Accuracy

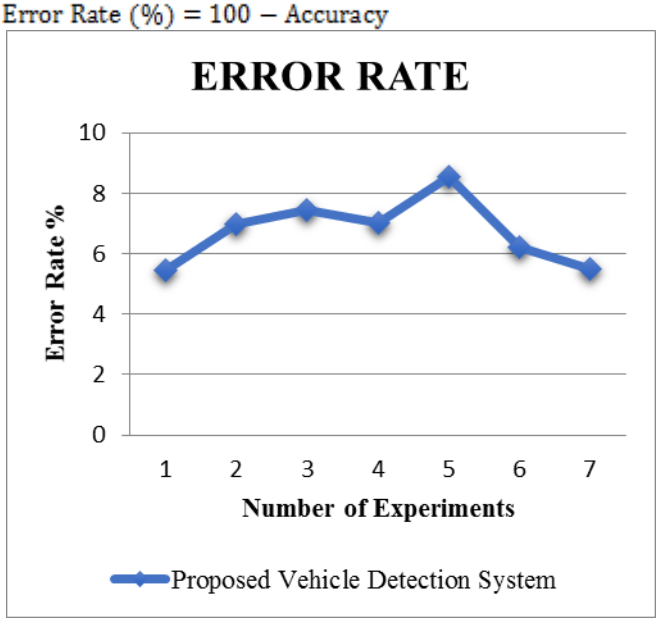

Figure 3.2 Error Rate

The figure 3.2 and table 3.2 shows the error rate of implemented proposed Vehicle detection system. In order to show the performance of the system the X axis contains the different experiments and the Y axis shows the performance in terms of error rate in percentage (%). The performance of the proposed detection approach is given using the blue line. The performance of the proposed model is effective and efficient during different execution and reducing with the amount of frames increases. This overall system is very modular in that each functional block can be examined and analyzed independently of the others. This proves to be very convenient for profiling and optimizing the overall system. Our analysis of the system is done on a per-frame basis.

Table 3.2 Tabular Values for Error Rate

Number of Experiments	Proposed Vehicle Detection System
1	5.44
2	6.98
3	7.45
4	7.04
5	8.55
6	6.22
7	5.48

C. Memory Usage

Memory consumption of the system also termed as the space complexity in terms of algorithm performance. This can be evaluated using the following formula:

Memory Consumption = Total Memory − Free Memory

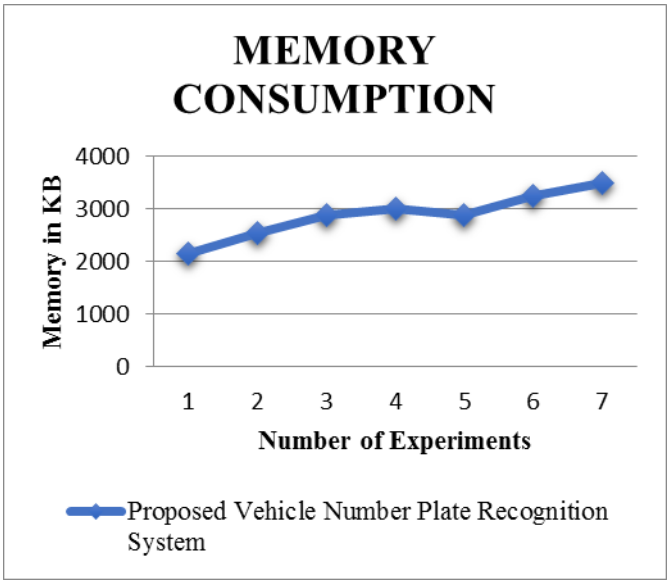

Figure 3.3 Memory Consumption

The amount of memory consumption depends on the amount of data reside in the main memory, therefore that affect the computational cost of an algorithm execution. The performance of the implemented vehicle detection model for traffic surveillance given using figure 3.3 and data is numerically show by table 3.3. X-axis of figure contains the different amount of code execution and the Y axis shows the respective memory consumption during execution in terms of kilobytes (KB). According to the obtained results the performance of algorithm demonstrates similar behavior with increasing or random of images, but the amount of memory consumption is decreases/stable with different number of frame. This consumed memory represents the required space by which algorithm of vehicle recognition of system is executed and produces efficient output.

Table 3.3 Tabular Values for Memory Consumption

Number of Experiments	Proposed Vehicle Detection System
1	2154
2	2552
3	2887
4	3002
5	2887
6	3241
7	3500

D. Time Consumption

The possibility of converting the vehicle detection system into a commercial application of traffic surveillance depends heavily on the running time of the algorithm. Hence here we can define time complexity of the approach that the time requirement to execute entire algorithm to process frame one by one of Thresholding basis. This can be calculated by using following formula:

$$\text{Time Consumed} = \text{End Time} - \text{Start Time}$$

The time consumption of the proposed algorithm is given using figure 3.4 and table 3.4. In this diagram the X axis contains the program execution of the system and the Y axis contains time consumed which is measures in milliseconds. According to the evaluated performance of the proposed technique is process to identified correct and accurate vehicle. For processing algorithm consume time which is illustrated in table 3.4 in numerically. But the amount of time is increases in similar manner as the amount of frames for analysis is increases.

Table 3.4 Tabular Values for Time Consumption

Number of Experiments	Proposed Vehicle Detection System
1	1938
2	2193
3	2011
4	2398
5	2736
6	2374

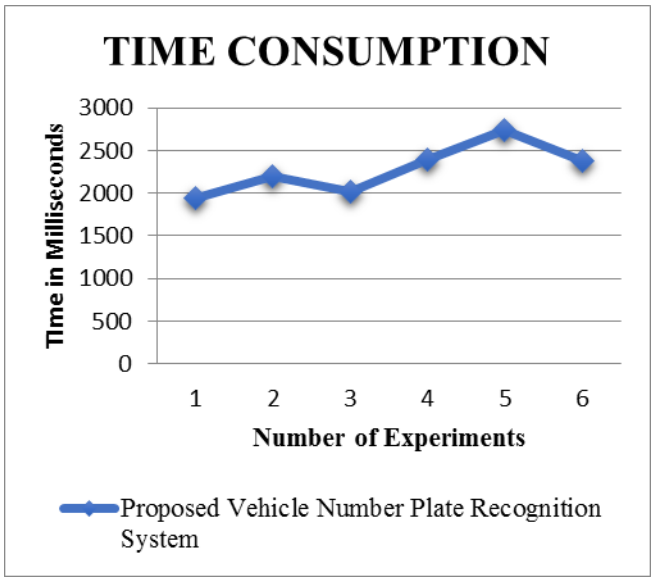

Figure 3.4 Time Consumption.

IV. CONCLUSION

ItThis chapter provides the summary of the research effort performed for developing the morphological technique based moving object detection system. in addition of that the future extension of the work is also presented in this chapter.

A. Conclusion

The proposed work is intended to investigate about the different techniques and methods that can be used for moving object detection and tracking. Therefore a number of techniques are observed that successfully identify the objects into the video frames. But most of the techniques are not much efficient and computationally expensive. Therefore an efficient technique using the morphological image processing technique is proposed for implementation and design. The proposed technique is targeted to identify the two main kinds of objects in the video or camera frames. First the objects that are moving in the video and secondly the moving object are the type of four wheeler objects such as cars and other vehicles.

Thus the proposed method is developed that can recognize the objects in real time video frames. The technique first extracts the number of frames from the input video data. These frames are basically the images which are captured from the video data. In next step the background of the captured frame is removed. After removing the background from the computed frames the morphological image processing technique is utilized. That method is used to compute the pixel regions that are similar in structure. After calculating the image regions the region properties or features are computed such as box size, area covered, number of pixels in area. These features are further used for identifying the objects in the images. Now the threshold based constraint are applied. Here two threshold values are used for identifying image objects first if the region's number of pixels coverage is less than 200 then objects is not a vehicle. Secondly a mean value of box height is computed. If the box height is less than a computed threshold then the object is car object otherwise it is a big vehicle.

The implementation of required technique is provided using MATLAB technology. After implementation of system the performance of the system is measured in form of accuracy, error rate, time consumption and memory usages. The performance obtained is summarized using the table 4.1.

Table 4.1 performance summary

S. No.	Parameters	Remark
1	Accuracy	The accuracy of the proposed technique is acceptable and provides in range of 89-95% accurate results
2	Error rate	The error rate of the system is reducing and produces the error rate between 05-11%
3	Time consumption	The time consumption is increasing according to the rate of frames but if the per frame detection is similar in amount
4	Memory usages	The memory usage of the system is consistent and increases as the amount of video file size increase

According to the performance summary the proposed technique is an efficient and accurate model for moving object tracking and detection. Therefore that is promising approach for working in different real world applications.

B. Future Work

The main aim of the proposed investigative work for designing and developing the car tracking system design is implemented successfully. Additionally the experimental results demonstrate the proposed technique is efficient and accurate for object tracking. The following extension of the work is proposed:

1. The given system currently differentiate among two objects namely cars and big vehicles in near future the method is extended to recognize more kinds of vehicles
2. The given system provides the method using morphological technique in near future machine learning techniques are explored for improved model development

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