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Traffic Management System Through Vehicle Detection and Counting

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Abstract: This research initiatives with the primary purposes of detecting, tracking and classifying automobiles; however, it is also applied to driver behavior detection, lane recognition and other coherent applications. This framework is used in a variety of domains including public safety, accident revealing, automobiles detection, parking lots, theft finding and human identity recognition. Due to a growth in the number of automobiles; highways and roadways are becoming overcrowded. As a result, the frequency of the accidents and violations of traffic laws has skyrocketed. For this reason, vehicle detection and counting become essential to the traffic management. This study ensures the balance traffic system by detecting and counting the vehicles through real time video capturing. The proposed model is mostly based on a video-based technique for vehicle recognition and counting that employs the Python programming language OpenCV. The code editor "Visual Studio Code" is used to create and implement the framework for the empirical part. Moreover, to achieve real-time instinctive automobiles counting and detecting, software is combined with Intel's OpenCV video streaming system. This structure can quickly recognize and track automobiles as well as assists in the counting of the objects. This research can also be used to locate criminals on the road and traffic rule violators so that traffic controllers can take immediate action.

Keywords: Traffic Management, OpenCV, Subtractor MOG Algorithm, Object Detection, Vehicle Counting, Vehicle Classification

1. Introduction

It is all over known that the traffic problem is a big problem in all type of cities. There are many reasons such as urbanization, growth of population and the vehicles increasing for the factors causing traffic problems in cities. However, the street limit has become generally lethargic and got lacking. This causes an irregularity between the quantities of vehicles and streets, bringing about street gridlock, particularly in enormous cite areas. An insufficiency of public transportation frameworks likewise causes a similar issue. The primary goal of this study is to detect and count moving vehicles with correct efficiency and to have the option to do such as on streets, highways and in little paths. However the advances in storage capacity, computational power, video encryption methods, OpenCV analysis and recognition systems are becoming less expensive and more effective [7]. Humans typically evaluate the videos stored by these surveillance devices, which is a time-consuming task. A more comprehensive, automatic video-based solution is necessary to address this problem [9]. Hardware and software are commonly found in a traffic management system. The hardware component of the system is a roadside camera that captures video feeds, while the software component deals with analysis and processing. These systems might be portable with a microcontroller attached to the camera for real-time processing and analysis, or they could simply be cameras that send the video stream to a centralized computer for processing [8].

2. Related Works

Computer vision research has recently focused on the tracking of moving cars in video streams. The information contained in photos and videos can be understood and modified using computer vision. Its basic goal is to comprehend objects and then offer the necessary information. Numerous studies have been conducted on traffic management systems that include vehicle detection and counting [6]. Various relevant studies discussed in this article.

The authors Nilesh J Uke and Ravindra C Thool developed and implemented a real-time autonomous vehicle detection and counting system using Visual C++ software and Intel's OpenCV video stream processing technology. The system is built with OpenCV image development kits, and real-time video from a single camera is used to demonstrate the findings. Background subtraction, image filtering, image binary and segmentation approaches were employed to construct this highway traffic counting process. This model can also count moving cars using pre-recorded data from video [1].

Karthik Srivathsa D S and Kamalraj R suggested a Python-based technique for detecting and counting vehicle in the street. Through highway recordings as input, computer vision techniques are used to recognize the vehicle and count the number of vehicles passing on a certain roadway. Finally, when the vehicles entered the virtual detection zone, they are recognized and counted. Experiments revealed that the proposed vehicle counting system has a precision of 96% [2].

Sowmya Kini Ma and et al suggested a system that uses the computer vision platform and is implemented using OpenCV Python as a tool. The recordings were gathered from traffic camcorders with a variety of sources for analysis. All of the recordings can be regarded pre-recorded videos that can be obtained for research purposes from the traffic department. The basic approach is created to select the relevant location to be broken down, and then picture preparation strategies are used to calculate vehicle tally. There used two ways to assess the algorithms' accuracy while tracking the vehicles. As a result, it may be argued that blob - based tracking outperforms the other approach [3].

D Agustiani and et al. proposed a method for processing picture data using computer vision and machine learning approaches. The goal of this paper is to keep track of every car that enters the parking lot. Every vehicle entering the parking lot will be photographed by a camera stationed at the entrance. The approach for classifying and counting it when it passes through the parking gate is the same as for classifying and counting it on the road. The video sample for this study is a video of automobiles following on the road at varying speeds with various types of vehicle [4].

Sheeraz Memon and et al. suggested a system that could be used to detect, recognize and track cars in video frames, as well as classify the identified vehicles into three sizes based on their size. The system is made up of three modules: background learning, foreground extraction and vehicle categorization. Background subtraction is a common technique for obtaining the foreground image, or detecting moving objects [5, 12].

3. Proposed Method

This research goal is to detect and count the vehicle to reduce traffic, and managing the traffic system to ensure clear and safe road and also control parking management. However, there is used OpenCV algorithm in order to solve the arising problems. The figure 1 shows the block diagram of the proposed system consisting some steps such as capturing RGB video clip, converting RGB into binary, object detection, recognizing and classifying, vehicle counting and finally display the output. OpenCV subtract MOG and R-CNN algorithms are used to recognize and classify automobiles from video frames respectively.

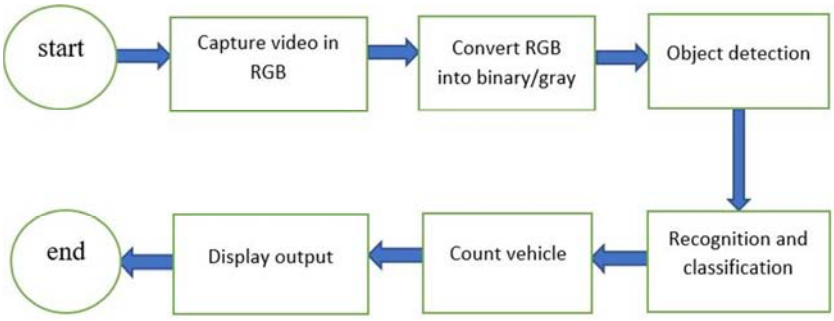

Figure 1. *Block diagram of proposed vehicle detection and counting.*

In the system flow diagram there is sketched the system working principles. In this system it builds with two components such as vehicle detection model and user interface. In very first the video footage from the road side is imported the system. All of the vehicles are detecting from the footage. After that the system counting the number of vehicle and however, there are much traffic on the road, the system will give the signal. Then the authority observes the frame in which road heavy traffic or not.

The user interface makes the system very interactive for the authority to utilize. Authority can monitor the traffic footage and find the traffic jam. However, the overview video footage analysis is a big factor because when inputted multiple videos in the system users can analysis the video

and get the result very fast. Due to multiple videos are imported, it encoded the system. System will detect the image and count the vehicle when encoding is finished. In this study there is built some system and applied OpenCV subtract MOG algorithm. The parameter N represents the number of vehicles as a predefined threshold values.

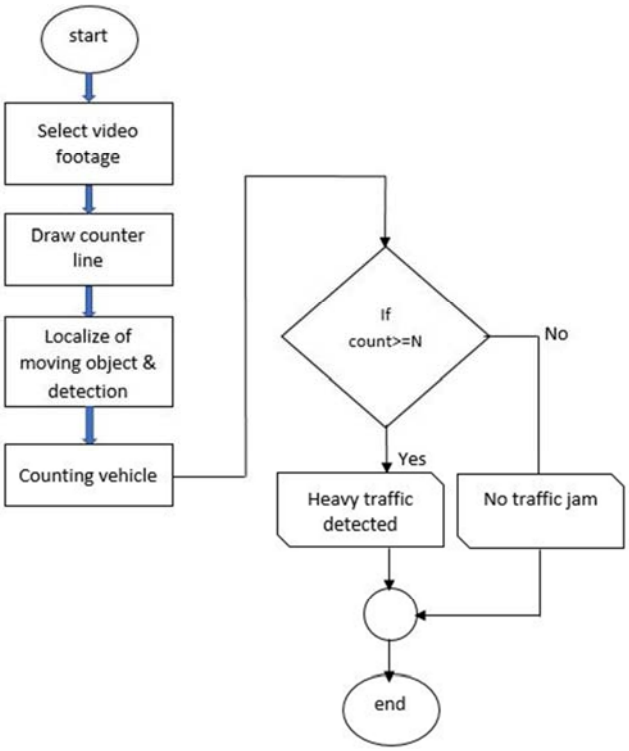

Figure 2. *Flow diagram of traffic system.*

4. Implementation and Procedure

4.1. Computer Vision

OpenCV is an open source computer vision and machine learning software library that is utilized for image processing in this study. Subtraction MOG algorithm is using for this research for detection and R-CNN is for classifying the category of the vehicles. Initially, the administrator must open a video to begin using the project film created with the item 'Open' that can be found under the thesis file. The system will obtain a preview of the video clip after it is opened from storage. A frame from the provided video clip appears in the preview. The preview is used to locate roads and to create a traffic line across them. The administrator's traffic line will be used as a traffic line. Select the 'region of interest' item from the 'Analyze' option to enable the line drawing capability. After that, the administrator must choose two spots from which to draw a line that denotes a traffic gridlock.

However, someone selects a region of interest, the traffic detection system begins to run. The coordinates of the drawn line will be displayed on the console. After the line is drawn, the object detection system will begin instantly. The weights will be loaded first. The system will then detect objects and look for traffic. The output will be displayed frame by frame on the screen.

Figure 3. *Region of Interest (ROI).*

4.2. Background Subtractor MOG Algorithm

Background subtraction is a common technique for obtaining the foreground image, or detecting moving objects [11]. Background Subtractor MOG_2 is the algorithm employed in the implementation of the proposed system. Most essential part of this algorithm is that an automated way to pick an appropriate number of Gaussian mixtures for the pixel when the number of distributions for the background model are defined. From the given video in the code segment, at first, there is a while loop to read the video infinitely and then show it. To subtract the background images there is used the subtractor algorithm. Before applying the algorithm, there is converted the video from RGB to GRAY and then blur the moving objects. Thus, the video has to convert into many more single images or frames. Subtractor MOG algorithm is applicable on each frame. Dilate method points the moving blur objects and combines all the neighborhoods pixels to give them a structure. By "get Structuring Element" method all the shapes of the combined pixels have taken to the Subtractor algorithm. Morph_Ellips method combines those shapes into ellipse and morphologyEx method gives shapes all the multichannel images. Find Contors function accepts all the binary images and explains their algorithm. After that it shows the black and white images which is shown in figure 4.

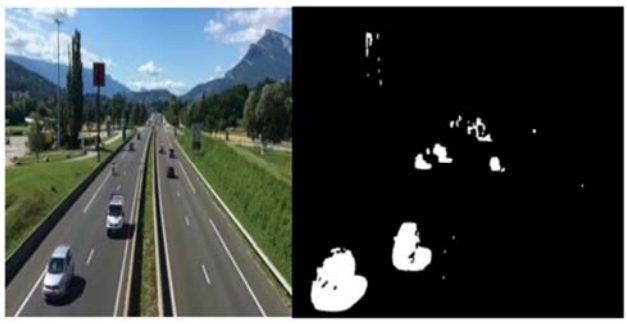

Figure 4. *Black and white images through subtractor algorithm.*

4.3. Counter Line

Basically, contours are the shape's boundaries where are employed in object detection and recognition. The procedure

of locating the contours can be extremely precise. Contours is a function provided by OpenCV a method for locating the contour. When the counter line is ready it has to create to position, then it needs to insert the value of this position line. After inserting the value there is declared the color of the frame and thickness. However, creating the counter line, it demands to create bounding box for vehicles. Figure 5 shows the counter line crating on the display.

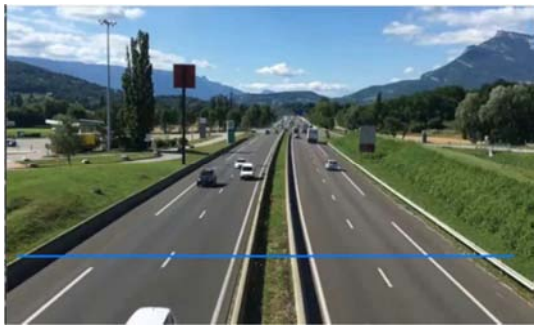

Figure 5. *Counter line creating on the display.*

4.4. Vehicle Detection

In preview of counter line now it demands to detect the vehicles. Nevertheless, object is detected, the algorithm is applied in the bounding box and, at first counter shapes are created, and then it declares the height and weight for the bounding box. However, vehicle are coming towards the line algorithm identify the rectangle shape with their height and weight. After coming the vehicle to the frame then they are identifying their own frame and pixels and, then there is created a bounding box around each object (red box). The object detector computes every frame in the video. Figure 6 shows the bounding box and rectangle creating.

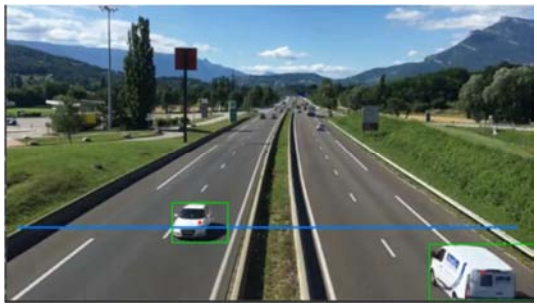

Figure 6. *Bounding box and rectangle creating.*

4.5. Counting Vehicle

Final part of this study is vehicle counting. Actually, it has to define the center points for all the bounding box. However the center point touches the counter line it starts counting. All the values of the counter are inputted into the detect array. Moreover there will display vehicle counter on top of the display and show the number of vehicles are detected. At last, there will display vehicle with counter on top of every bounding box. Management can count every vehicle on the road and maintain traffic on busy read. This is the essential part of the proposed framework. Therefore the authority can find a good way to handle traffic by this way. The figure 7 shows the vehicle detection and counting.

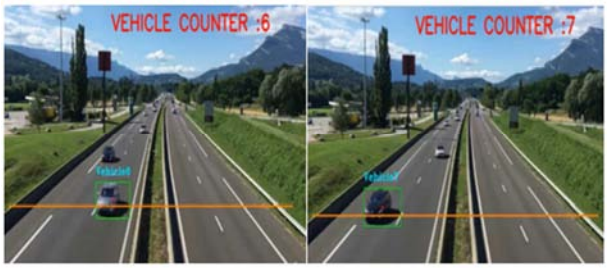

Figure 7. *Vehicle detection and counting.*

4.6. Classification

In the system's implementation, the categorization is done utilizing two alternative methods such as (1) Classification using CC and (2) BoF and SVM.

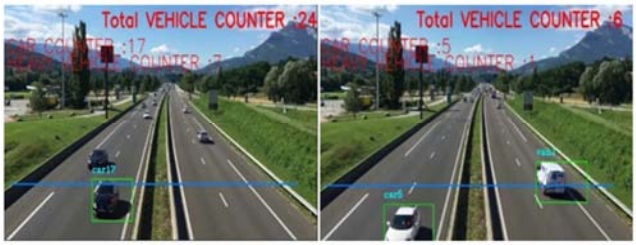

Figure 8. *Vehicle detection, counting & classification.*

Contour Comparisons (CC) for Classification:

FindContors() method extracts the contour elements and the area of the contour such as solidity and compares them to the values which were previously established to determine whether the vehicle is bus, car or motorcycle. This method gives structure to the returned elements. It accepts the binary images from the algorithm and analyses the algorithm. Contours are made up of all the pixels in a picture that are connected to one another. Outlines of foreground objects are obtained after doing background removal and recognizing foreground elements. A minimum width and height constraint on the contours is provided, allowing for the option of bigger contours. Following the selection of these contours, a number of their properties are collected, which may then be used to categorize the automobiles. These include features such as area, solidity, aspect ratio, and so more. Particular emphasis is made to contour regions that are compared to the predicted values of the vehicle. Firstly, a bounding box is generated over the contour and its centroid is computed, which identifies the automobiles and initiates the classification algorithm to identify the vehicles when it intersects with the imaginary line [10]. However the area is between 700 and 9000 square kilometers, the vehicle is classified as motorcycle or cycle. The categorizing of car and bus/truck is a two steps process as follows:

1. Depending on the height, the vehicle might be a car or a truck, if the size is between 600 and 134000 square feet.

2. A vehicle is categorized as car if its height is equal to or more than its width (width -30 to width+30); otherwise, it is classified as truck.

5. Result and Discussion

This study predicts the maximum number of vehicles that can enter into that specific area, road or block. The proposed model counts the total number of vehicles that entered into the area. However, it crosses the maximum number of vehicles, then it blocks the area or alert the user or management to turn off the road. After that the traffic control system guides the drivers to entry into another road. Similarly, in parking management system, the system can detect and count the total number of vehicles that entered into the parking spot. The infrastructure prevents to entry into the area if the maximum number of vehicles are already entered into the area. This research is able to classify whether it is car, microbus or any other type of vehicles. Moreover, the parking management does not allow bus, truck or any other automobiles to park, the system will block the gate instantly. There is imported all of the videos for comparison of the original count for the videos. From the video-1, there are found 125 cars, 105 buses and 90 trucks. The video-2 gives the output of 225 cars, 220 buses and 210 trucks. Moreover, from video-3, there is shown 250 cars, 225 buses and 230 trucks. The figure 9 shows the bar chat of vehicle counting comparison. There is analyzed all the videos for simulation result. After simulation it gets the result regarding the specific road for more traffic or free from traffic.

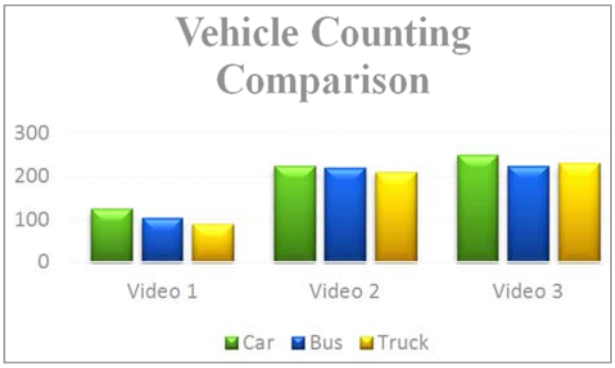

Figure 9. *Bar chart of imported videos.*

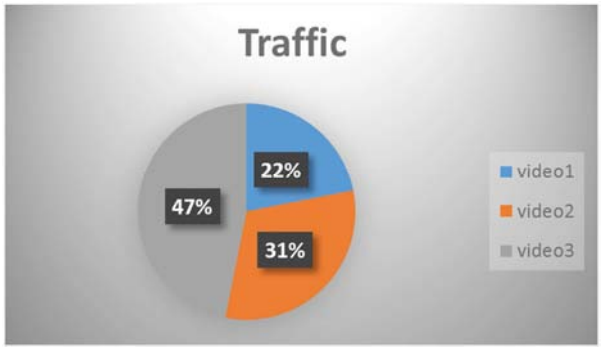

Figure 10. *Pie chart of the traffic status.*

In video clip for road1 there are passing 320 vehicles and 22% traffic count that specifies this road is less busy. For video clip of road2 there are passing 655 vehicles and 31% traffic count that specifies this road is busier rather than first one. Moreover the road3 there are passing 705 vehicles and 47% traffic count that represents the road is much more traffic comparing others. The figure 10 shows the pie chart of the traffic status.

6. Conclusion and Future Work

This study is emphasis based on real time video footage through openCV subtractor MOG algorithm. The empirical part is implemented on Python programming using the OpenCV bindings. Traffic camera footages are used to implement the process for detecting and counting the number of vehicles. The proposed model mainly works with image processing from the captured video footages. It removes the background images and detects the moving objects. This research reduces traffic jam, manages vehicles parking and identifies criminal activates through traffic management control. In the result discussion part there is seen the three video footages ensure the traffic busy 22%, 31% and 47% respectively and then the proposed system allows the vehicles to enter the suitable path. To identify automobiles at night, it will incorporate night vision camera into the proposed system. There will be attempt to get better accuracy using segmentation of multiple objects.

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