Vehicle Counting System

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***Abstract*—Vehicle Counting System is software which is used to determine the number of vehicles passing through a segment of a road. The main reason behind counting the vehicle is to collect the numerical data for the respective authorities who can then find appropriate methods for managing the traffic problem. The system can be placed in different routes, passes, segment of roads, stations, parking lots etc for counting the number of vehicles going and coming through it. Various decisions can also be made from the collected data. This system will serve as a statistics provider for the stakeholders, traffic police, government, security personals etc. Counting is done by image processing, object detection techniques and different algorithms such as Gaussian mixture model, background subtraction, clustering is used. This system is to design and develop a low-cost system to count the number of vehicles and hence to give the statistics for maintenance of the roads and vehicle congestions. First the image beyond ROI is removed after this, Gaussian blur is done then background subtraction is applied, this process creates background frame. The difference between current frame and background frame gives the foreground image. Then cluster is detected and considered as vehicle. When it crosses the detection line, vehicle count is increased.**

Keywords—Gaussian Mixture model, image processing, clustering, ROI, Gaussian Blur

I. INTRODUCTION

Due to the result of the increase in vehicle traffic, many problems related to traffic management have appeared. For example, traffic accidents, traffic congestion, traffic induced air pollution and so on. Traffic congestion has been a significantly challenging problem. It has widely been realized that increases of preliminary transportation infrastructure, more pavements, and widened road, have not been able to relieve city congestion. As a result, many investigators have paid their attentions on Intelligent Transportation System (ITS), such as predict the traffic flow on the basis of monitoring the activities at traffic intersections for detecting congestions. To processes the information and monitor the results as better understand traffic flow, an increasing reliance on traffic surveillance is in a need for better vehicle detection at a wide-area. Automatic detecting and counting the vehicles in video surveillance can be a very good option to consider for managing such congestion problem.

Vehicle detection and counting is important in computing traffic congestion on highways. The main goal vehicle detection and counting is to develop methodology for automatic vehicle detection and its counting. Intelligent visual surveillance for road vehicles is a key component for developing autonomous intelligent transportation systems. In this system, we describe a computer vision system used for counting vehicles moving on roads. The system involves analyzing a sequence of road videos which represent the flow of traffic for the given time period and place.

With the advances in technology, monitoring traffic through image processing techniques yield a wide range of traffic parameters such as flow of traffic, vehicle plate number, number of vehicles, classification of vehicles, density of vehicles etc. Since the vehicle can be tracked over a selected segment of a roadway, rather than at a single point, it is possible to measure the “true” density of vehicles for each lane. Image processing techniques can also be applied to traffic video surveillance to detect the vehicles in motion, number plate identification, etc. Traffic monitoring through image processing techniques can lead to better control of the flow of traffic as well as to identification of reckless users and speed violators. In the past, many research studies have been conducted on automated vehicle detection using image processing techniques. The focus of this system is to test the performance in identifying the moving vehicles from a traffic scene and to count and classify vehicles within a given time period.

II. RELATED WORKS

Various works has been done in the field of automatic vehicle counting. The tools developed in this area are industrial systems developed by companies like Citilog in France,[2] or FLIR Systems Inc.,[3] or specific algorithms developed by academic researchers. According to S.

Birchfield, W. Sarasua, and N. Kanhere [4], many commercially available vision-based systems rely on simple processing algorithms, such as virtual detectors, in a way similar to ILD systems, with limited vehicle classification capabilities, in contrast to more sophisticated academic developments. C. C. C. Pang, W. W. L. Lam, and N. H. C. Yung [5], M. Haag and H. H. Nagel [6] this study presents the description of a vision-based system to automatically obtain traffic flow data. This system operates in real time and can work during challenging scenarios in terms of weather conditions, with very low-cost cameras, poor illumination, and in the presence of many shadows. Unzueta et al. [7] published a study on the same subject. The novelty of their approach relies on a multi-cue background subtraction procedure in which the segmentation thresholds adapt robustly to illumination changes.

Even if the results are very promising, the datasets used in the evaluation phase are very limited.

III. Related Theories

A. Region of Interest

Region of Interest (ROI) is a particular portion of an image on which an operation is to be performed. ROI gives the flexibility to just work with in a particular region instead of manipulating the whole image. Once the video is started, the user has to select the four coordinates of interest on to activate the input mode.

B. Gaussian Blur

Gaussian Blur is utilized to reduce the noise in the video frame. Gaussian blur algorithm is used which will scan over each pixel of the image, and recalculate the pixel value based on the pixel values that surround it. The area that is scanned around each pixel is called the kernel. A larger kernel scans a larger number of pixels that surround the center pixel. Gaussian blurring doesn't weigh each pixel equally, however. The closer a pixel is to the center, the greater it affects the weighted average used to calculate the new center pixel value.

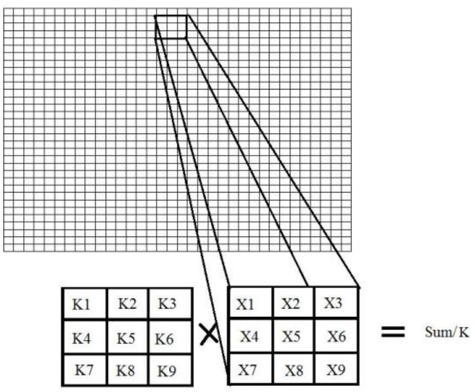

Fig. 1 Gaussian Blur

C. Background Subtraction

When the current background frame is subtracted by the background model then foreground mask is obtained. If the value in eq. 1 is '1' then the current pixel is considered as background else the current frame is considered as foreground. Where x is the pixel value of current pixel, μ is the mean of the pixels and σ is standard deviation. In the initial case, the first frame is considered as background frame and then the frame is gradually improved with the help of next coming pixels.

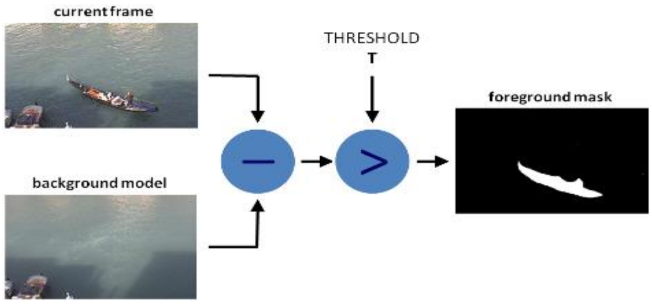

Fig.2 Background Subtraction

D. Gaussian Mixture Model

Gaussian Mixture Model (GMM) is an improvement of the Gaussian Model which models each pixel with mixture of Gaussian. The number of Gaussians must be adjusted according to the complexity of the scene The Gaussian cruve is updated for each iteration using the formula given below. They improve the method by controlling the training rate according to the activity in the scene. However, its response is very sensitive to sudden variation of the background like global illumination changes. A low training rate will produce numerous false detections during an illumination change period, whereas a high training rate will include moving objects in the background model. This method provides very promising results in terms of counting capabilities. Nonetheless, the method needs the camera to be calibrated and the process is time-consuming. The formulas used are given below.

$$M_b = \begin{cases} 1 & \frac{x-\mu}{\sigma} \le 2.5 \\ 0 & otherwse \end{cases} \tag{1}$$

If $M_b \le 2.5$ then current Gaussian is updated else new Gaussian is created, where x is the pixel value, μ is the mean of the pixels and σ is the standard deviation

The formula for updating the weight is given by is given by:

$$w_t = (1-\alpha)w + \alpha \quad (2)$$

Where ∝ is the learning rate, assumed to be 0.01

For Mean

$$\mu_t = (1-\rho)\mu_{t-1} + \rho \times x \quad (3)$$

Where

$$\rho = \eta(x; \mu, \sigma) \quad (4)$$

and

$$\eta(x; \mu, \sigma) = \frac{1}{\sqrt{2\pi}\sigma} e^{-\frac{(x-\mu)^2}{2\sigma^2}} \quad (5)$$

For standard deviation:

$$\sigma_t = (1-\rho)(\sigma_{t-1})^2 + \rho(x-\mu)^2 \quad (6)$$

E. Cluster

Here cluster is the group of white pixels obtained after background subtraction white pixels near to each other is considered as a vehicle when it has value above the specified threshold. Cluster is detected where there is more intensity of the white pixels. When the vehicle moves, the cluster also moves because the background is updated continuously. Now when the cluster crosses the detection line, then the vehicle count increases.

IV. METHODOLOGY

A. Video Source

To develop the vehicle counting system incorporated with camera

- Specify the source from which video is taken
- Source can be live camera or from local storage

B. Select Video Parameter

- Video parameters include detection line, Region of Interest (ROI) and threshold.
- All the parameter is given by the user while selecting video

C. Frame Extraction

- Video is the group of image displayed in very quick succession.
- Take individual frame from video for further processing

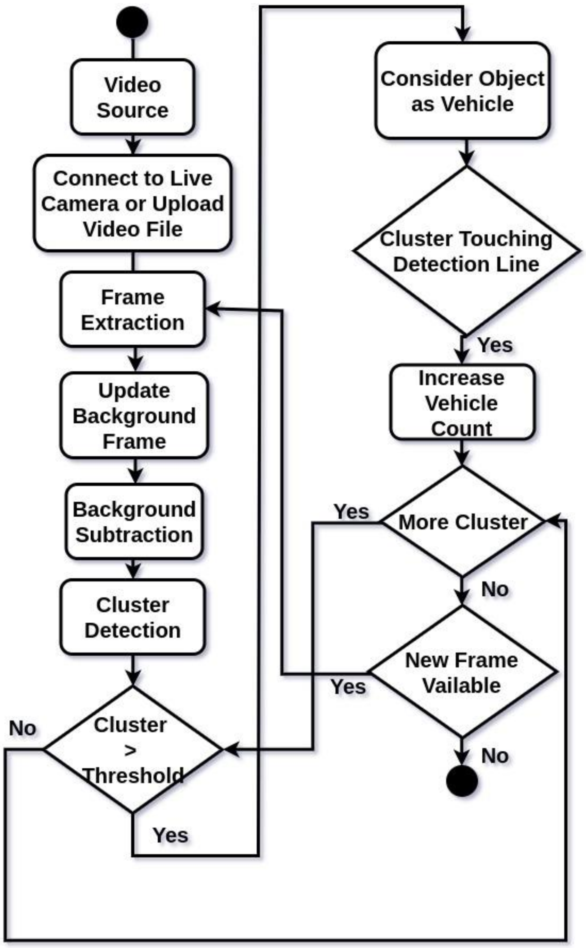

Fig. 3 System block diagram

D. Gaussian Blur

- Remove the random variation of pixel
- Average pixel near to each other is taken

E. Background Modeling

- Background is modeled by mixture of Gaussian
- It is iterative process
- Each Gaussian has its own weight, mean and standard deviation
- Effect of each Gaussian is measured by its weight.

F. Background Subtraction

- Finding the foreground pixel

- If the pixel do not match the background model, it is considered as foreground

G. Cluster Detection

- Finding the cluster of foreground pixel
- Foreground pixel above threshold is considered as vehicle
- Cluster is represented by rectangular bracket

H. Vehicle Count

- Increasing vehicle count
- If the rectangular block comes near the detection line then the count is increased

V. Result and Discussion

At the end of the system, the system is able to detect and count the number of vehicles passing through the section of road successfully.

The figure in the right is the detected foreground pixel. The figure in the left is detected vehicle, detection line and vehicle count. The object inside the green box is vehicle. The green line is the detection line. The number left to the detection line is the count of the detected vehicle.

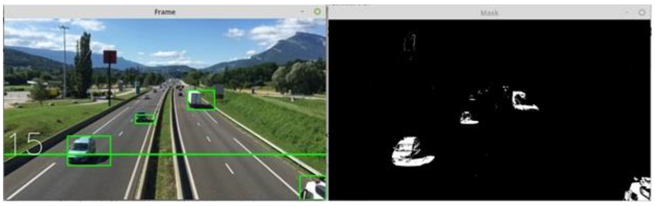

Fig. 4 Detection and counting of vehicle

Fig. 5 Detection and counting of vehicle

VI. Conclusion

After processing through all the phases of system development lifecycle, the VCS system was carried out in a proper way. As a result, finally an idea took its form into a working system. We met all our objectives and purpose which is to detect the vehicles and count their numbers which can be installed on any roads or streets on any location. Speed measurement and night mode can be improved in the existing system.

- Is affordable and extremely accurate
- Robust in a range of lighting and weather
- Can be implemented at any road or street or any section of roads.
- Easily integrates into existing enterprise systems.

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