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Study and Analysis of Methods of Object Detection in Video

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Abstract— Object detection is generally performed in the context of higher-level applications that require the location and/or shape of the object in every frame. In the recent years various object detection methods have been proposed over by many researchers and both the apprentice and the proficient can be confused about their benefits and restrictions. In order to overcome this problem, this paper presents an analysis of some important methods and presents innovative classification based on time, memory requirements and accuracy. Results of Such an analysis can efficiently guide the researcher to select the most suitable method for a given application in a proper way. This research paper includes various approaches that have been used mostly by different researchers for object detection.

Keywords— frame difference, approximate median, mixture of Gaussian.

I. INTRODUCTION

The field of automated surveillance systems is nowadays of immense interest because to its implications in the prospects of security. Surveillance of vehicular traffic and human activities offers a context for the extraction of significant information such as scene motion and traffic statistics, object classification, human identification, anomaly detection, as well as the analysis of interactions between vehicles, between humans, or between vehicles and humans [1].

II. APPROACHES OF OBJECT DETECTION

The proliferation of high-powered computers, the availability of high quality and inexpensive video cameras, and the increasing need for automated video analysis has generated a great deal of interest in object detection and tracking algorithms[13]. Detection of moving objects in video streams is the first relevant step of information extraction in many computer vision applications, including video surveillance, people tracking, traffic monitoring, and semantic annotation of videos. There are various approaches for object detection. Background subtraction is a widely used approach for detecting moving objects in videos from static cameras [2,6,7]. The rationale in the approach is that of detecting the moving objects from the difference between the current frame and a reference frame, often called the "background image", or "background model"[14]. However, there is a wide variety of techniques and both the expert and the newcomer to this area Final Stage

A. Frame Difference

Frame difference is generally the simplest form of background subtraction. The current frame is simply subtracted from the previous frame, and if the difference in pixel values for a given pixel is greater than a threshold Ts, the pixel is considered part of the foreground [4]:

$$|frame\ i - frame\ i-1)| > Ts \text{.........(1)}$$

B. Approximate median

In median filtering, the previous N frames of video are buffered, and the background is calculated as the median of buffered frames. Then (as with frame difference), the background is subtracted from the current frame and thresholded to determine the foreground pixels [11]. Median filtering has been shown to be very robust and to have performance comparable to higher complexity methods. However, storing and processing many frames of video (as is often required to track slower moving objects) requires an often prohibitively large amount of memory. This can be alleviated somewhat by storing and processing frames at a rate lower than the frame rate— thereby lowering storage and computation requirements at the expense of a slower adapting background [12].

C. Mixture of Gaussians

Among the high-complexity methods, MoG is more robust, as it can handle multi-modal distributions. In MoG, the background isn't a frame of values. Rather, the background model is parametric. Each pixel location is represented by a number (or mixture) of Gaussian functions that sum together to form a probability distribution function $p(x_t)$. Stauffer and Grimson in [9] describe the probability of observing a certain pixel value, **x,** at time ***t*** by means of a mixture of gaussians that sum together to form a probability distribution function as

$$p(x_t) = \sum_{i=1}^{k} \omega_{i,t} . \eta(x_t - \mu_{i,t,} \Sigma_{i,t}) \text{........(2)}$$

with each of the K Gaussian distributions deemed to describe only one of the observable background or foreground objects. In practical cases, K is set to be between 3 and 5.The mean μ of each Gaussian function, can be thought of as an educated guess of the pixel value in the next frame. $\omega_{i,t}$ is an estimate of the weight of the i^{th} Gaussian in the mixture and $\mu_{i,t}$ is the mean value of the i^{th} Gaussian in the mixture, at time t. A robust video processing system should be capable of dealing with movement through cluttered areas, objects overlapping in the visual field, shadows, lighting changes, effects of moving elements of the scene (e.g. swaying trees), slow-moving objects, and objects being introduced or removed from the scene [15]. This algorithm is simple and of low computational complexity.

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However, the object is hard to be precisely detected when both of the background and the foreground are complicated. Holes come with the object detected as well. Background subtraction is very adaptive to stable environments, but is extremely sensitive to dynamic scene changes due to lighting and extraneous events.

III. IMPLEMENTATIONS

The three methods mentioned above are implemented on video dataset. The implementation has been done using matlab and accordingly results are mentioned in the following paragraphs.

A. Frame Difference Method

Frame difference method is simple and easy to implement. Fundamental logic for detecting moving objects from the difference between the current frame and a reference frame, called "background image" and this method is known as Frame Difference Method. For implementation we consider first frame to be the background frame and compare the next frames against the background frames and keeping the threshold value =25.

Fig. 1 Object detected using frame difference.

B. Approximate Median Method

Assuming that the background is more likely to appear in a scene, we can use the median of the previous n frames as the background model [12].

$$B(x,y,t) = median\{I(x,y,t-i)\}\ldots\ldots\ldots \quad (3)$$

$$|I(x,y,t) - median\{I(x,y,t-i)\}| > Th\ldots\ldots\ldots \quad (4)$$

$where\ \ i\epsilon\{0,\ldots,n-1\}.$

The implementation of approximate median method is as shown

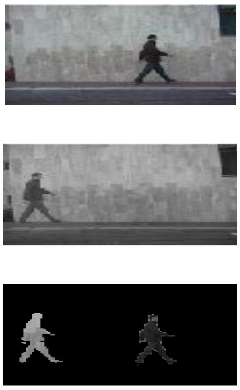

Fig.2 Object detection using approximate median

C. Mixture of Gaussians Method

Mixture of Gaussians method maintains a density function for each pixel. The algorithm works as [15]:-

1. Model the values of a particular pixel as a mixture of Gaussians.
2. We determine which Gaussians may correspond to background colors-Based on the persistence and the variance of each of the Gaussians.
3. Pixel values that do not fit the background distributions are considered foreground until there is a Gaussian that includes them.
4. Update the Gaussians.
5. Pixel values that do not match one of the pixel's "background" Gaussians are grouped using connected components.

The result of implementation on a given video using mixture of Gaussians is as shown:

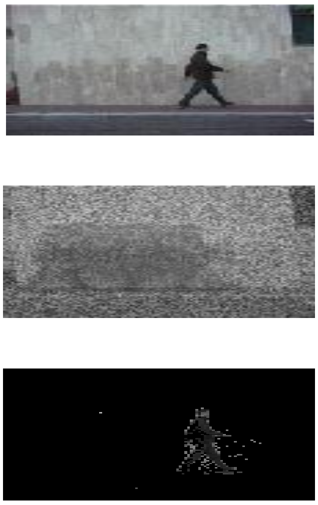

Fig.3 Object detected using mixture of Gaussian

IV. PERFORMANCE ANALYSIS

After implementation of all the methods mentioned above; analysis is been done based on some parameters that are speed or time needed for computation of algorithms, memory needed for the variables used and accuracy in terms of quality of the result.

A. Time

In this paper, time is divided into three levels, which are slow, medium and fast. If the same object appears twice in the overlapping area between the consecutive frames, the relative speed is slow. The fastest amongst the methods reviewed is certainly the frame difference, where, for each pixel, the classification is just a thresholded difference and the background model update adapts just one or two parameters. The fastest amongst the methods reviewed is certainly the frame difference, where, for each pixel, the classification is just a thresholded difference and the background model update adapts just one or two parameters. For frame difference method the time complexity can be defined as O(1). The median filter has a similar classification cost, but model update can be approximated as linear in the number of samples, ns,(ns is usually sub-sampled from the full sample set,$\boldsymbol{n}$. The corresponding complexity can be stated as O(ns). The Mixture of Gaussians method has O(m)complexity, with m the number of Gaussian distributions used, typically in the order of 3-5**.**

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Table 1. Performance Analysis of object Detection Methods

Method	Time (in ms)	Memory (in bytes)	Accuracy
Frame Diff. [1,4]	5.6719 (Fast)	691	H
Appro. Median [11,12]	5.9688 (Fast/Medium)	691	M
Mixt. Of Gaussian [9]	48.7969 (Slow)	968	L

B. Memory requirements

Space complexity is computed as combination fixed parameters having constants, instructions and also variable parameters having a recursive function which uses stacks. All our methods we uses simple looping and if else function and not any recursive functions hence computations for memory requirements have been done in terms of bytes used for the necessary parameters as mentioned in table 1.

C. Accuracy

Here the accuracy has been restricted to analyze visual characteristics in terms of results of implementations achieved and categorize each approach as providing limited, intermediate, or high ***(L, M, H)*** accuracy in terms of quality or visibility of object detection. The quality of results was good as it is shown in fig. 1 and 2.In fig.2 object shadows of the object can be seen. But in fig.3 it is been clearly seen occlusion in a image and accuracy is low.

V. DISCUSSION & CONCLUSION

Moving object detection from video sequences is an important research portion, since it can be used in many regions such as intelligent video surveillance, motion analysis, human-machine interface applications, and so on. Moving object detection is the basis of moving object identification and tracking. In this paper, we have presented a review of the most relevant background subtraction methods. This original review allows the readers to compare the methods' complexity in terms of speed, memory requirements and accuracy, and can effectively guide them to select the best method for a specific application in a principled way.

Amongst the methods reviewed, simple methods such as the frame difference or the median filter offer acceptable accuracy while achieving a high frame rate and having limited memory requirements. Methods such as Mixture of Gaussians proved to be with low accuracy and slow speed and high memory requirements.

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