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A Review of Video Detection and Tracking Methods for Moving Objects

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ABSTRACT- Object detection and tracking are widely utilized in today's society, especially for motion detection of different objects. The initial stage in object detection is to recognize objects in the video stream and cluster their pixels. The classification of an item is the next crucial step in tracking it. Computerized video surveillance, traffic monitoring, robotic vision, gesture recognition, human-computer interaction, military surveillance systems, vehicle navigation, medical imaging, biological image analysis, and many more areas may all benefit from object tracking. The goal of this project is to depict the different stages involved in object tracking in a video sequence, namely object detection, categorization, and tracking. This article compares different approaches for different stages of tracking and discusses several object identification and tracking methods.

KEYWORDS- Computer, Object Discovery, Tracing, Organization, Visual Treating.

I. INTRODUCTION

Object tracking is very important in image processing applications. Object detection and tracking are two of the most active research areas, with a wide range of applications that include computerized video surveillance, robotic vision, traffic detection, vehicle navigation, object recognition, and more[1,2]. A video is a series of pictures, each of which is referred to as a frame. In the series of pictures, there are both moving and immobile objects. Moving objects, such as people, birds, and vehicles, are referred to as foreground objects, whereas static objects are referred to as background objects. The goal of moving object detection is to find the semantically relevant moving item[3]. We must first detect an item before we can track it. The purpose of tracking is to check for the existence of an item in videos. Object tracking may be broken down into three stages: an object's detection, categorization, and tracking shown in Figure 1.

Figure 1: Steps for Object Tracking

A. Object Detection

Object revealing is used in the cinematic categorization to recognize items and collection pixels of these things [3-4]. Frame differencing, background removal, and optical flow are some of the methods used for object identification [5-9].

B. Object Classification

After an item has been detected, it may be classified based on its form, colour, motion, and textur [10]. Color-based that usually depends on color, shape-based that depends on shape, texture-based, and motion-dependent classification techniques are only a few examples of classification methods.

C. Item Tracing

Item tracing is the act of locating an item of notice in an audio-visual and obtaining relevant information by tracking its velocity, orientation, and occlusion, among other things [11]. Kernel following, idea chasing, and outline centred tracing are some of the ways for tracking things [12-16]. There are many methods for tracking objects, and categorization is completed constructed on those algorithms. Perhaps, techniques aimed at tracing objects may be classified into discriminative and propagative tracing, depending on their presence.

II. DISCUSSION

A. Object Detection Methods

Identifying the items of interest in a video sequence and clustering the pixels of these objects is the first stage in the object tracking process. As illustrated in Figure 2, different approaches may be used to detect the user's region of interest, together with the edge alteration method, ophthalmic flow scheme, and contextual removal technique.

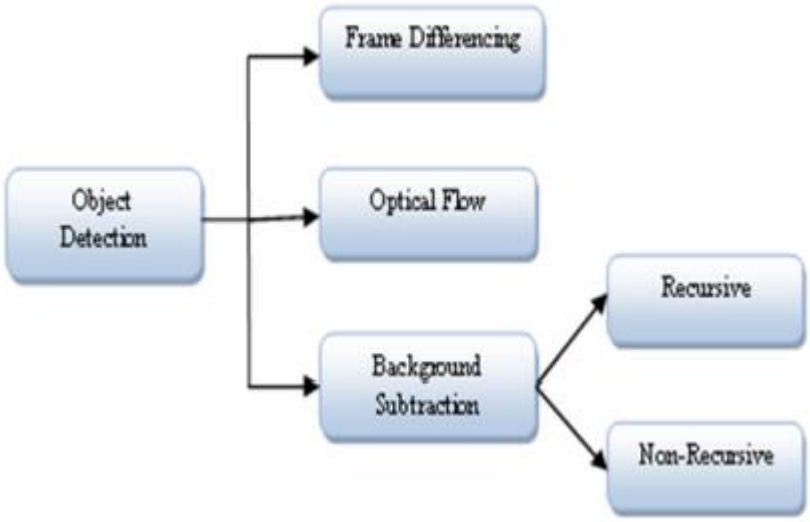

Figure 2: Categorization of Object tracking [17]

1) Frame Differencing

Frame differencing is an object identification approach in which the difference between two successive frames is used to evaluate the moving item. It's straightforward to put into practice and calculate [18-22]. Because of the great adaptability of moving objects in dynamic situations, it is typically impossible to get a full outline. Accordingly, it's not that precise for moving entity recognition.

2) Optical Flow

The optical flow approach can be effective for tracking moving objects. This approach is utilized to compute the ophthalmic movement arena of a picture and conduct assembling dispensation based on the optical flow distribution features of the image. This fundamental approach is referred to as optical flow in this context. We can obtain entire moment information using the optical flow approach, but it necessitates a huge number of computations.

3) Background Subtraction

The first stage in the background subtraction approach is background modelling. It is accomplished by the creation of a backdrop model. Background modelling is used to create the reference model. The reference model is important in background removal because it compares each video sequence to a reference frame to detect probable changes in the frame. Changes in pixels between current video frames and the reference model identify the presence of moving objects. Background subtraction has a simple algorithm. It becomes more sensitive when the external environment changes. There are two types of algorithms for background subtraction.

i. Recursive Process

When using a recursive method, there is no need for a buffer. A single backdrop model is updated for each input frame. This implies that an inaccuracy in the current model might be caused by frames from the distant past. This saves storage space by eliminating the need for RAM to shield the records. More or less recursive processes include filtering techniques that includes median and Kalman, as well as Gaussians Mixture.

ii. Non-recursive Process

In a process that usually are not recursive, a slipping window method is effective for estimating a backdrop. Frame differencing, median, and linear predictive filtering are examples of non-recursive processes.

B. Entity Grouping Approaches

Grouping of an entity might be prepared as per the silhouette, gesture, texture and color shown in Figure 3.

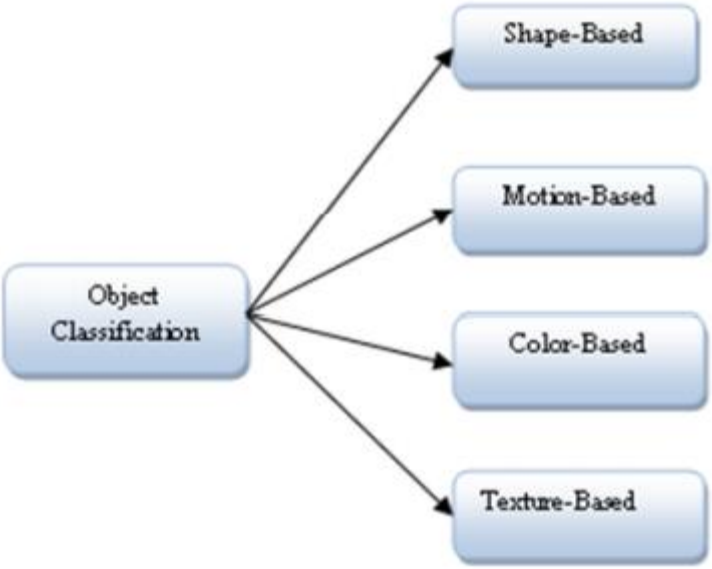

Figure 3: Classification of object [23]

1) Shape-Based Classification

Matching a pattern is what shape-based categorization entails. The varied descriptive information on the outline depiction of packet, themes, and blob are kept for categorizing moving objects. The accuracy and performance of shape feature measurements are investigated.

2) Motion-Dependent Grouping

Motion-based classification is used to recognize moving objects. Optical flow is also beneficial for object categorization. Residual flow can be utilized to analyze the stiffness and periodicity of moving things.

3) Color-Based Classification

Colour is easily obtained, and colour remains generally consistent even when the viewpoint shifts. Colour is not an effective approach for identifying and tracking an item. The histogram-based method is used to detect and track cars instantaneously. Colour are generally utilized as an instantaneous tracking system. An image sequence based moving object tracking using surveillance system was presented to monitor the items.

4) Texture-Based Classification

The texture descriptors are used to show texture. The histograms of region boundaries and region homogeneity are used to do this analysis. Edge histogram descriptors, texture browsing descriptors, and homogenous texture descriptors are only a few examples of texture descriptors.

C. Object Tracking Methods

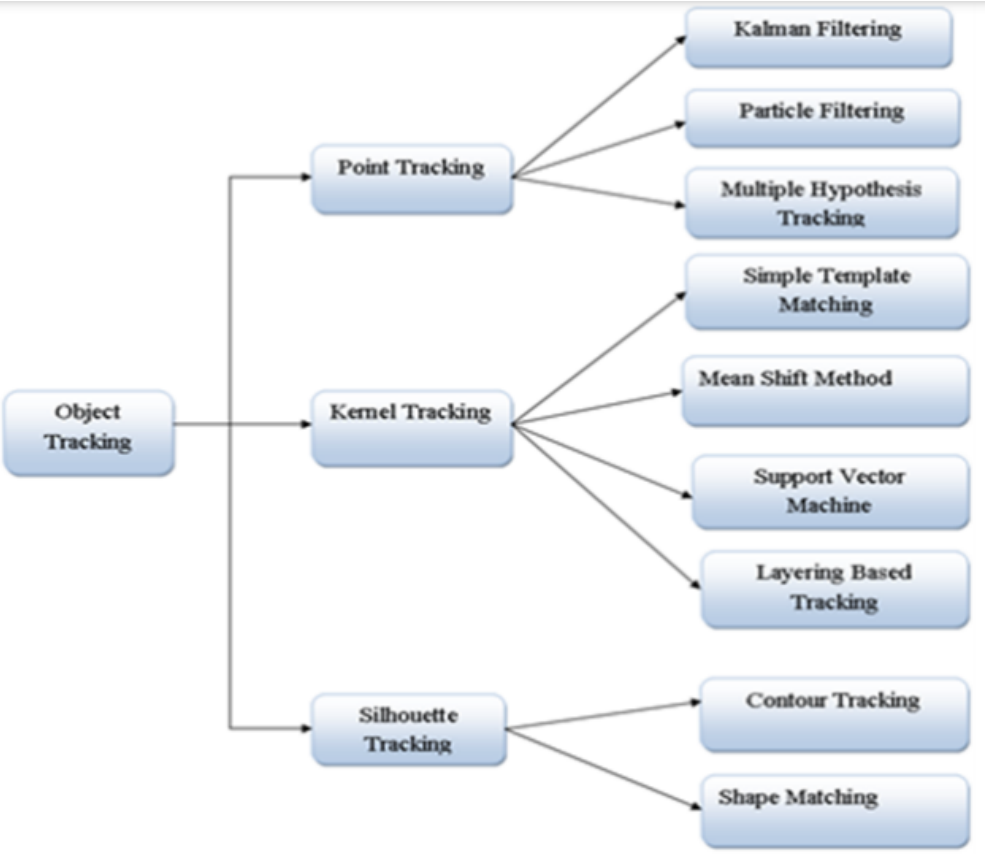

Figure 4: Categorization of Object Tracking [24]

Item tracing is the course of detecting any entity of importance in a video and extracting usable information from it by keeping track of its orientation, velocity, and occlusion, among other things. Below is a detailed overview of the object tracking methods presented. Point tracking, kernel tracking, and silhouette tracking are three common object tracking methods shown in Figure 4.

1) Point Tracking

Moving objects are represented with points in the point tracking approach. When there are occlusions and erroneous detections, object tracking becomes a difficult task. Point tracking is a basic technique that may be used to monitor very tiny things. Kalman filtering and particle filtering are two types of point tracking.

i. Kalman Filtering

The Optimal Recursive Data Processing Algorithm is used by the Kalman filter [25]. The ideal point will be chosen via Kalman filtering depending on criteria. The Kalman filtering technique is used to create estimates of unknown variables from a sequence of measurements measured over times that contain noise. The Kalman filter acts recursively on streams of noisy input data to provide a statistically best approximation of the underlying system state. The Kalman filter algorithm is divided into two parts: prediction and correction. The current state variables are estimated, together with their uncertainties, in the prediction stage. The following step's result is then seen, and the estimations are updated. Because it is a recursive process, only the previous and current values may be estimated in real time. The Kalman Filter deals with noise, provides optimum solutions, and is only suitable for single tracking and also shown in Figure 5.

Figure 5: Kalman Filter Basic Steps

ii. Particle Filter

Particle filter creates all of the models for that variable before going on to the next variable [26]. When variables are produced dynamically, the method has an advantage since there might be a lot of them. It enables a fresh re-sampling

procedure. The Kalman filter is constrained by the assumption that state variables are regularly distributed. As a result, the Kalman filter provides poor state variable estimates. The particle filtering can get over the Kalman Filter's limitation. Contours, color characteristics, and texture mapping are all used in particle filters. It also includes two steps: As with the Kalman Filtering technique, the first stage is prediction, and the second step is updating.

iii. Multiple Hypothesis Tracking (MHT)

Only two frames are used to recognize motion correspondence, and there is always a risk that the correspondence will be wrong. If multiple frames were seen, we were able to get improved tracking. The MHT algorithm is an iterative process. The parent hypothesis set is the starting point for this method. The parent hypothesis set is the collection of hypotheses from the preceding iteration. Every hypothesis is a collection of disconnected tracks. Numerous hypothesis tracking is concerned with the tracking of multiple objects, as well as the calculation of optimum solutions and the handling of occlusions.

2) Kernel Based Tracking Approach

Kernel tracking is done by calculating the moving object. Kernel tracking is depicted using geometric shapes such as rectangles and ellipses. Object portions will be left outside of the designated form in the Kernel Dependent Tracing method, while background parts will be inside. This is one of the drawbacks of the Kernel Based Tracking technique, which can identify both non-rigid and rigid objects. In the Kernel tracking technique, there are several tracking methods:

i. Simple Template Matching Method

In digital image processing, the template matching method is used to discover tiny portions of video or images that match a template picture. An advanced level approach of prototype comparison is employed in video analyzing (ROI) areas of interest. In template matching, a reference picture is used to verify a frame sequence that has been separated from the video. The author has the ability to only track a single item in the movie using the discussed approach. Solitary motion transformation is possible with this approach. Single object tracking and partial occlusion are dealt with via Simple Template Matching.

ii. Mean Shift Method

Mean Shift Method's goal is to establish an Interested Region from a moving object using segmentation and then follow the object from one frame sequence to the next. A region of interest is defined in an initial frame utilizing the rectangle window. Using this method, the tracked item is isolated from the backdrop. The precision of the target will be increased by using the Chamfer distance transform. Chamfer distance transform also uses the Bhattacharya coefficient to minimize the distance between two colour distributions. The disadvantage of this technique is that it can only track a single item. If an item is travelling at an extremely fast speed within the frame, it cannot be tracked.

iii. Support Vector Machine (SVM)

SVM is a classification technique that generates a set of positive and negative training values. Positive samples are found in tracked image objects, whereas negative samples are found in untracked image objects. However, because to the need for physical startup and training, it can only handle single images. Support vector machines are commonly used for classification and regression. SVM is only capable of tracking single objects and cannot handle partial occlusions.

III. CONCLUSION

The several stages of entity tracing have been investigated in this article. Finding out how the item moves is crucial in object tracking methods. The tracking of moving objects is divided into three categories: point, kernel, and silhouette tracking. The frame differencing and background subtraction approaches, according to our results from the literature, are suitable for object detection due to their ease of implementation. Frame differencing works well for static backgrounds and has a short computing time and excellent accuracy. Motion, form, colour, and texture may all be used to classify objects. The most commonly used methods are texture-based and colour-based, as they give greater accuracy and require less computing effort. Contours-based or kernel-based tracking just requires detection when the item appears first, whereas point tracking requires detection at every frame. Multiple objects are tracked using contour-based tracking. It achieves the best outcome while simultaneously dealing with occlusion. In the future, the moving item can be tracked utilizing block matching motion estimation techniques to compute motion vectors.

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