Critical Comparative Analysis of Object Detection and Tracking Algorithms

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Abstract: In present days, Lively Environment considerations has nailed down towards an immense contract as a part of Visual Surveillance Systems. Its expansion tends towards extensive research scaling functioning as admittance curb, Person's disclosure and its recognition, Traffic Monitoring, Vehicle Navigation, human computer interaction, motion behavior, video analysis, path planning etc. So, to detect and to track object in a space is one of the current research hot spots. In this paper we have presented a study on related research and different object detection and tracking algorithms can be used in surveillance applications.

Keywords: Object Detection, Object Tracking, Image Processing, Surveillance System

1. Introduction

Video can be described as agglomeration of image frames in progression. Maneuver object detection and its unique record in video progression have been targeted in computer perception research because of large scale in real world applications [1] [2]. Camera is generally embarked with ability of extension in its Focal point boundaries due to field of view of camera is restricted. If one needs to erect scalable boundary surveillance system, then more-then-one targets has to be tracked by camera within its restricted Focal-point boundaries with the emerging high computational data processing capabilities and progression of tracking theory. [3].

Three primary steps essential in Video evaluation is to discover, recognize and examine the act of objects in video: discovery of maneuvering objects, tracking of identified objects in progressive frames and eventual identification of objects behavior. Tracking of Object is undoubtedly essential in various critical areas such as maneuvering based recognition, automated surveillance, human-computer communication, video indexing, traffic watchdog etc. [1] [2].

Tracking is essentially a primary function for evaluating the maneuver route of an object in subsequent frames of video. Primary needs entails two essential steps firstly dealing with detection of objects and second with object tracking in which Object tracking is formerly a challenging task in particular, when dealt with objects of complex architecture with complex

maneuvering and its occlusions. There are four detection ways namely Background diminution, point disclosure, segmentation and managed classifiers, where in point disclosure deals with finding necessity points in images which have an expressive texture in their respective areas. In order to find the altering areas, current frame is eliminated from the background frame and this is what background subtraction is defined. Segmentation deals with scrutiny the image into intuitive identical areas. Administrative study mechanism for Object detection is carried out by studying distinct objects that are explored from a set of illustration. Tracking approaches delegates namely Point tracking, Kernel tracking and Silhouette tracking. In Kernel tracking identified objects are viewed by geometric shapes. In Point tracking, the identified objects are expressed by points while Silhouette tracking expresses the same by their authentic shape [1] [2].

2. Object Detection

Examination of Object identification tends to find whether or not object is present and is it's not absent, and then determine its position and size of each object. Background diminution approach is the straight forward method to identify an object. Considerable background elimination algorithms are available.

Table.1Object Detection Techniques

Category	Representative Work
Point Detectors	Moravec's Detector 1979
	SIFT 2004
	Affline Invariant Point Detector 2002
Segmentation	Mean Shift 1999
	Graph Cut 2000
	Active Contour 1995
Background Modeling	MoG 2000
	Eigen Background 2000
	Dynamic Texture Background 2003
Supervised Classifiers	SVM 1998
	Neural Network 1998
	Adaptive Boosting 2003

Contrasting Background Elimination approach is carried out in the Literature survey [4]. Yilmaz [1] presents a summary on different object detection approaches. The analysis gives an important knowledge about various methods of object representation, feature extraction and object detection. [1] [4].

A. Geometric invariant moment object CT detection

Geometric moment invariant Yields of feature vectors, which are invariant under shifting and rotation. Pattern recognition researchers have generally chosen to extract the attributes as it provides robust discrimination. Proposed algorithm provides very high recognition rate with the implementation of the preprocessing, post processing and segmentation technique [5].

B. A contour-based object detection

This approach deals with using lines that are computed by a gradient-based optical flow and an edge detector. Focusing on building systems for detection and tracking are not much considered as gradient based flow and edges are well mated for definite computation of velocity which is known among researchers. Silhouette of objects are achieved by deployments of snake to clustered lines. Discovered objects are tracked and each tracked object embarks state for handling occlusion and interference [6].

C. Dynamic object detection

The Interpretation of Characteristic and Context of the described domain will be benefited greatly by the recognition of dynamic objects. As an Illustration, it can be a reference for the background extraction. The detection of dynamic objects can be used to ignore the replacement of the objects (visual features) in the environment as Perception-based navigation methods could be affected at an ease with appearance alteration in the environment [7].

Table.2 Background Subtraction Algorithms

Algorithms	Models	Remarks
Heikkila and Olli	$\lvert I_i - B_i \rvert > Th$ $Bi + 1 = \alpha I_i + (1 - \alpha) B_i$	▪ Predefine Constant Threshold ▪ For background correction α must be very small constant
Adaptive Mixture of Gaussian	$P(I_i) = \sum_{j=1}^{k} W_{j,i} * F(I_i; \mu, \sigma_2)$	▪ Each time background updated before the foreground detected ▪ Initial constant threshold required
W [4]	$\lvert Min - Ii \rvert > Th$ $\lvert Max - Ii \rvert > Th$	▪ Morphological operations as erosion and dilation of the regions are required
Cutler	$\sum_{c \in RGB} \lvert Ii(c) - Bi(c) \rvert > M\sigma$	▪ Some a prior knowledge required ▪ σ : offline noise standard derivation ▪ Basically used for template matching
Wallflower	$B(i) = \sum_{k=1}^{p} a(k) B(i-k)$ $I(i) = \sum_{k=1}^{p} a(k) I(i-k)$	▪ a(k) are updated each time for each frame ▪ Two autoregressive background models has been used ▪ Required huge storage area for images

D. Background difference object detection

This Background distinction approach deploys a technique of identification of maneuver area by distinctly contrasting between the current image and background image. In this approach, an image is isolated into foreground and background. Casting of background is done and it is correlated with the current frame pixel by pixel. Pixels Conferred with Background

Casting are tagged as background whereas others are tagged with foreground. Usually in Static background, Background diminution is most familiar approach in dynamic object identification. This approach involves tiny complexity in which captured background images are nurtured perspective to scene alteration induced by increase in brightness and extraneous surrounding as time goes on. Mass fake C dots can appear, which tends to influence object disclosure. This technique of invigorating background frames requires addition in under unsupervised environment. Besides, it doesn't fit camera motions or fit with conditions with huge background Grey changes. [8].

E. Background subtraction object detection

For isolating out objects from the input video frames, Distinct Background trimming methodologies are used. Analysis of various distinctive approaches of background diminution is represented in this paper. There was a remarkable discussion of Wallflower, W4, Cutler, Halevy etc algorithms. For comparing the foreground and background pixels, distinctive algorithms and this mathematics models are used as show in the Table.

F. Adjacent frame difference object detection

In accordance to disparity between two or three subsequent frames, maneuvering object is extracted in adjacent frame difference method. This approach is very simple and straight forward in which modifying sections in video can be rapidly detected. However, it only detects objects creating relative motions. As the time delay among the two images is tiny illumination alterations have tiny effect on difference images, leading to optimal and steady detection. The approach technique including frame differences can better accommodate to environment in accelerated variations which can simply detect those pixels generating images to alter specifically when the target maneuvers. But still it is incompetent for dots with insignificantly altered pixels. For contrasting between simple background and tiny surrounding intrusions, this approach is highly used. [8].

G. Histogram matching object detection

Histogram is the representation of the gray levels of the image and it also exhibits the collection of the colors. In simple background subtraction approach, such as consecutive frame difference algorithm, histogram analysis emphasis the presence of the moving objects. Afterwards, the thresholding, a very popular and lost cost segmentation approach simplifies the intensity variations by means of the thresholding of the gray levels and also represents the intensity variations. Such an approach requires less memory and computational cost [10]

3. Tracking

The means of Object tracking is to record the object actions over array of images. Widespread Research in computer optics involves object tracking to be one of hot research topic embarking it to be its main vision and used in several applications namely Action analysis, human computer communication, visual monitoring and administration, Vehicle Navigation etc. Major dilemma in distinctive disclosure of objects is due to unexpected object maneuvering, modified appearance patterns of objects and the scene, Non solid object,

occlusions among objects or between background surface & objects and camera motion. Most commonly, tracking is carried out in the context of higher-level applications where the location and/or shape of the object in every frame is desirable.

Investigating large number of papers and journals, but established that there are few beliefs commonly scrutinized for object detection obstacles(i) Consistency of object motion (ii) Consistency of illumination (iii) Minimum number of occlusions etc. In order to plot trajectory, tracking operations gets the input from the detected components after the process of object detection and then setup the orbit of an object at any instant of time in each and every frame of video sequence [4]. Detailed analyses of distinct algorithms are shown in table below. [1] [4].

Table.3 Object Tracking Techniques

Category	**Representative Work**
Point Tracking	
Deterministic methods	MGE tracker 1990
	GOA tracker 2001
Statistical methods	Kalman filter 1986
	JPDAF1988
	PMHT 1994
Kernel Tracking	
Template and density based appearance models	Mean-shift 2003
	KLT 1994
	Layering 2002
Multi-view appearance models	Eigen tracking 1998
	SVM tracker 2001
Silhouette Tracking	
Contour evolution	State space models 1998
	Variational methods 2000
	Heuristic methods 1994
Matching shapes	Hausdorff 1993
	Hough transform 2004
	Histogram 2004

The concept of moving object detection uses frame differencing and tracking the detected object using dynamic template matching. For the accurate segmentation, threshold selection would become vital. Local or global selection of the threshold is depending on the image types. PTZ camera should in mount in such a manner that it can capture the entire motion or interested space accurately. For ensuring the security in a large space can be easily achieved with multiple PTZ and moving cameras. Care should be taken while installing multiple cameras are such as synchronizations among cameras, area selection under the space and huge amount of memory for the forensic investigation. Thus, we can do continuous grabbing and tracking of object [11].

To track the object, we use Discrete Kalman filter technique which as discussed by G. Welch and G. Bishop [12] is a recursive method to predict the object using present and past state. Kalman filter is a set of mathematical equations which first predict the state of object before the object makes its next move and then corrects this prediction using Kalman gain. It

investigates the objects location by embarking two sets of equations. Forecasting the object in accordance to its past state is done by one set of equation named as prediction equation while another set of equations called correction equations tends to alter and redress our forecasting and this is obtained from the preceding set of equations to provide a improved evaluations to track the object [10].

4. Conclusion and Future Work

After the analysis of different object detection algorithms and object tracking algorithms, we conclude that for real time application instead of manual detection automatic detection and tracking gives better detection and tracking accuracy in real time applications. We also conclude that background subtraction and histogram matching techniques also provides better result for object detection. While SIFT and Kalman filter approaches provides better result for tracking accuracy with single and multiple objects for real time video sequence.

Enhancing tracking performance can be achieved by cutting down the tracking faults with a reasonable reduction delay in tracking. So, by analyzing various algorithms we can create a capable and dominant ample-area surveillance system with almost essential real time enhancements.

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