MOTION TRACKING TECHNIQUES: A SURVEY

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Abstract: *Smart video surveillance system requires robust and adaptive foreground detection and tracking approach. Usually, an intelligent and vigilant surveillance system determines the location and behaviour of the moving objects and also to identify the apprehensive activities carried out by the moving objects in the video sequences. This paper exhibits the comprehensive literature review of various tracking methods pertaining to the robust surveillance in indoor and outdoor environment. Motion detection or foreground detection is really an important task but to track the foreground in presence of many constrains is really a challenging task. Exact tracking requires the correct position and information of the moving objects in consecutive frames. Our objective is to provide the rigorous and comprehensive study of the various object tracking approaches under challenging environments. Our aim is to present the tracking feature descriptors for the better tracking. The tracking accuracy and performance of the tracking algorithm is ultimately depends on the robust background estimation and exact background information. This paper describes the various state of the art object tracking approaches, usually classifieds in to various categories such as mathematical approach, point tracking, kernel tracking and silhouette tracking approaches. The aim of the study is to handle the various datasets and real time video sequences challenges. In spite of all the literature survey still some of the challenges like object abrupt motion, too slow and too fast moving objects, object complex silhouette, object appearance and camera motion are challenging issues for the researchers.*

Keywords: Visual Surveillance, Feature Descriptor, Tracking, Point tracking, Kernel Tracking.

1. Introduction

Background subtraction, background estimation and background initialization are popularly used in various visual surveillance applications. Usually, most of the video sequences are taken from the static cameras. Smart and intelligent video surveillance system requires the exact location and behaviour of the moving and static foregrounds. For accurate tracking of the moving objects, exact background estimation and information are required. Once the foreground is correctly detected with the help of detection algorithm, it is the task of an object tracking algorithm is to track the moving objects in consecutive frames. For the every individual surveillance application, tracking algorithm is needs to generate the moving object trajectory. The role of the tracking algorithm is providing the necessary location and movement of the moving objects as well as to provide the entire region engaged by the moving object. Earlier the researcher have made certain assumptions for the tracking of an objects, such as no abrupt motion of the objects, for the entire tracing time moving objects travelled with the constant velocity, in every frame objects provide prior information regarding their location and behaviour, object size and object shape or the appearance. Now a day's, for the intelligent and vigilant object tracking approaches requires tracking the very fast and non-rigid objects without any assumptions and meets every single criteria.

Object tracking is done for the indoor and outdoor environments but broadly we can categorize [1] according to the surveillance application such as, motion-based tracking forthe human identification and automatic object detections, automated surveillance for detecting the abnormal activities and events, video indexing for the automatic annotation and multimedia database, traffic monitoring for the real time statistics and traffic maintenance, navigation for the satellite and GPS using various filters.

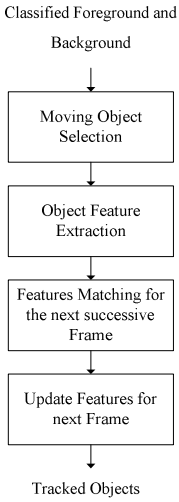

Figure 1.General Object Tracking Approach

Figure 1 shows the general object tracking approach. Once again it shows that the tracking depends on the exact classification among the foregrounds and backgrounds. Once the object detected select the objects, extract the objects, identified the features matching for the every consecutive frame and update the objects features in successive frames for the better tracking accuracy. For every visual surveillance system tracking is the process in which, track the objects over the time by evaluating the location in each frame of the dataset [2]. An improvement in accuracy and performance evaluation of the tracking algorithm depends on the objects recognition. Many researchers have focused their study in tracking and categorized it in such as contour based tracking, region based tracking or feature based tracking. Tracking model selects the motion types and shape limitations. Generally, object tracking approaches are being proposed and many more researchers have focused their research on the basis of the environments such as indoor tracking or outdoor tracking. Usually, the tracking algorithm or the tracking strategies depends on object representation, object motion, image features, object silhouette and exterior, object connected region, object environment, background estimation and foreground detection approach. Challenges are imparted with the outdoor object tracking like high illumination, non-stationary backgrounds, fast- and slow-moving objects and dynamic backgrounds. Again the challenges are also imparted with the indoor object tracking such as low illumination, similar appearance, occlusions and highly reflective surfaces made it more challenging. Object tracking is the method in which either objects detecting and try to match the tracking list in all the frames or once detect the moving foreground and extract the one or more moving object features of the objects and track the objects using those

extracted features. Easiest way to define the object tracking is to estimate the moving object trajectory.

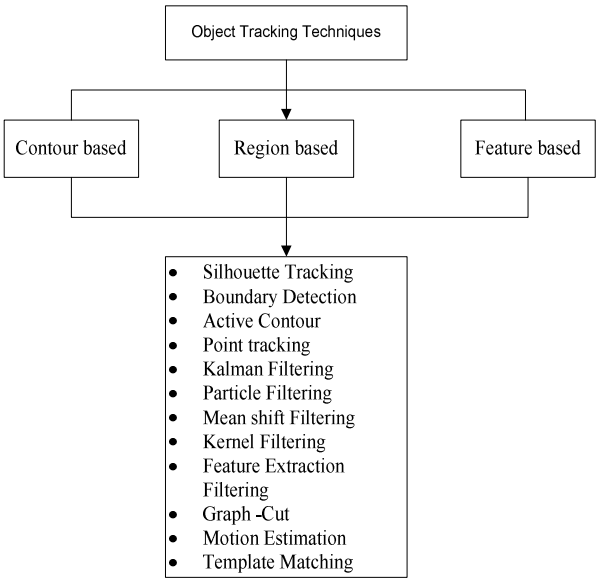

Figure 2. Object Tracking Approaches

The tracker used to provide the labels to individual tracked object in the video sequences and on the basis of tracking applications; tracker provides moving objects information like location, behaviour and silhouette. Tracking is done couple of assignments such as, initially build the suitable model for the moving assignment and finally identifies the location of the object in the previous frame and predict the same for the current frame. Suitable approach repeats the first and second state and continuously updating the tracking model.

Tracking challenges:

In a space tracking is a crucial task performed by the tracker to estimate the target trajectory. The role of the tracking algorithm is providing the necessary location and movement of the moving objects as well as to provide the entire region engaged by the moving object. Under various challenges and circumstances tracking becomes more challenging. Frame/Image noise and dataset outliers, abrupt and complex motion, nonrigid and complex silhouette, occlusions with the static and moving foreground and backgrounds, sudden illumination variations, loss of information during transformation, real time processing object features, unique track of objects with the multiple cameras, environments and foreground background classification approach make it a vital, complex and challenging task [3].

Tracking Feature Selection:

Accuracy and efficiency of the tracker algorithm depends on the exact estimation of the background modeling and also very much depending on the feature properties. The correct feature selection made easy to estimate and predict the next tracking step in feature space. Proper selection of the feature properties leads to correct representation of the moving object. To distinguish moving object in histogram

appearance technique colour is the perfect feature selection while edge is correctly suitable for the contour based tracking approach.

Color: colour feature uses the power distribution of the intensity and the reflectance property from the surface of the object. Many researchers have used RGC or HSV color space model as per their surveillance application.

Edge: Edge feature detection is used to identify the intensities variations. Usually, edge feature is less prone to illumination variations as compared to the colour feature. Easy to implement and simplicity makes it more popular compared to other features.

Centroid: Centroid is defined as centre of the mass, here the image region having centre of the mass and which specified by the matrix dimensions. Once the Centroid for the moving object is obtained needs to track and predict the object location in next frame.

Optical Flow: It is generally used with the motion-based detection and tracking algorithm. It deduced using the brightness constraint and predicts the states on the basis of the corresponding pixel brightness.

Texture: Numerous of texture features are used to track the objects. It depends on the intensity variations of object surface. It also depends on the smoothness and regularity of the pixel value.

Among all these features literature also exhibits some of the other important features are Spatio-Temporal features, multiple feature fusion and Biological features for the robust recognition. For the robust tracking approach many of the researchers have studied and implemented the tracking approach each shall be with their own strengths and weaknesses. Some of the important and commonly used approaches have studied are described as follows,

Contour Based Tracking:
Obtain object outlines from an image with the help of Active contours [4]. Proposed approach traced the object by using their outlines in the form of boundary contours known as contour tracking algorithm [5]. Contours are updated dynamically in consecutive frames. Point distribution of the discrete contour model limits the object silhouette. The crucial task of the proposed approach is cannot start tracking automatically, needs to initialized. [6] developed a contour-based tracking approach, they have utilized a active contour and Graph-cut classification approach for the accurate detection. [7] uses the neural fuzzy based active contour approach for the object tracking. Proposed model used contour model to take out -the moving object features. [8] Utilized multi feature technique for evaluating the exact location of the object in a frame. Some of the features have extracted using the region-based approach. [9] Proposed Gaussian Mixture model for the background modeling and modified contour-based approach for the indoor tracking.

Model Based Tracking:
Model based tracking used scene information to generate the projected model. Object prior information is used for the production of the projected model. Computer vision is the generalized approach for the estimation of the project model.

[10] explained a two-dimensional model to detect and track multiple people by detecting their body parts. Zhao et al. [11]developed a unique tracking approach for the multiple objects in presence of complex environment. Global and motion features used to detect and track the people.

Region Based Tracking:
It tracks the multiple objects using the colour distributions of the moving objects [12]. Proposed approach does not track multiple objects as it computationally efficient and efficiency degrades as no. Moving objects in a space increases. Tracking accuracy and efficiency depends on the foreground detection approach and fails to track occluded objects. [13] introduces novel region-based classification approach for the tracking. Proposed approach works on some important stages like region extraction, region based motion estimation and classification with some important pre and post processing for the connected regions. [14] explained the technique for better classification of the foreground and background using region descriptors. [15] utilized couple of tracker approaches such as pixel wise tracker and region wise tracker. Pixel wise tracker is used to select the colour feature selection using the Ad boost and frame regionalization and clustering made with the help of region wise tracker.

Feature point based Tracking:
Feature point based tracking describes the moving objects in some of the important stages [16,17]. Initially, object attributes are recognized then cluster those attributes to some higher features and finally match those available attributes and extracted features in consecutive video frames for the accurate detection and tracking. Feature extraction and feature correspondence are the important steps of feature based object tracking. [18] Developed tracking algorithm using the corner feature and adaptive Kalman for the object tracking. [19] Proposed self adaptive tracking algorithm based on target and its location in a space with NMI features. [20] Explained the importance of the background estimation, utilized the background motion information and feature extraction with the block matching is used for the detection and tracking.

Point Tracking:
Points are used to detect the objects in successive video frames, object position, location and behaviour is associated with the other points. An external mechanism requires detecting the objects in consecutive frames. Point tracking can be evaluated using the association of the foregrounds within the frame. Sometimes point association creates difficulty in tracking in presence of occlusions, false positives and entering and leaving objects in frames. Usually, point based tracking approaches broadly classified in to two categories: deterministic and statistical (probabilistic) [3]. Deterministic approach uses the qualitative motion to associate the problem while statistical approach uses measurement and uncertainty to associate the point problem.

Kernel Tracking:
Kernel tracking is usually performed by evaluating the object motion and the motion is represented by a primitive object region in a consecutive frame. In every frame the object motion is described as a parametric motion [3]. Generally, every kernel approach is divided in to two categories: Template (Uses appearance representation) and density based appearance model (Multiview appearance) model. The kernel

tracking is used to track single o multiple objects efficiently and the ultimate goal of the tracker is to estimate the object motion in every frame. Kernel tracking approach able to handle partial as well as fully occluded objects with the trade off's, it is requires training and tracking did not start automatically.

Silhouette Tracking:
Accurate shape description is obtained with the help of silhouette-based approach. Silhouette based method provides accurate shapes to those whose shape is complex or not well defined by means of simple geometric shapes. Using previous frame, the main objective of the silhouette method is to evaluate the object region for the tracker. This approach may available in the form of color histogram, object edges and contour. Usually, silhouette is categorized into shape and contour tracking [3].

Template Matching:
Template matching is also known as blob matching is very popular approach for the object tracking. In which image search for the region equal to the object template defined in the previous frame using the brute force method. A similarity measure – auto or cross correlation, computes the exact position of the template. Generally, color features and intensity or illumination features are used to define the templates. Intensity is very sensitive and directly related to the illumination variations and gradients or the first order derivatives are also used as the features for defining the templates. Due to brute force method tracking result requires high computational cost but it can be made limited by using the selected window size [1].

Mean Shift:
Mean shift is a kind of non parametric estimator, which finds the most similar objects in the current frame using density gradient estimation. Current frame is similar to that of the color histogram. It recursively deduced a kernel based search at the previous location of the object. The mean shift filtering or the tracker increases the appearance evaluate similarity by comparing object histogram and location of the object. At the end of iteration the tracker computes the histogram so that it increases the histogram similarity. Tracker requires at least five or six iterations to achieve the complete convergence. Mean shift requires low computational complexity as it did not require brute force method, however the tracker efficiency depends on the histograms descriptions [3].

Particle Filtering:
Kalman filter estimates the next states using the assumption that the state linear variable are Gaussian in nature, however state space variable is no longer followed the Gaussian distribution hence Kalman poorly estimates the state space variable and same can be correctly estimated using the particle filtering. The biggest limitation of the particle filtering is, it can estimate only one object at each time instant. Particle filter cannot handle higher dimensional representation [3].

Kalman Filtering:
Object correct location can be easily and promptly calculated by means of statistical process. Kalman is the statistical approach which uses mathematical equations and successively inputs. Kalman filter is used to approximate the state of a linear system where the state is implicit to be distributed by a Gaussian [3]. The prediction state of the Kalman filter uses the state model to predict the new state of the variable. The Kalman filter estimates the entire process by means of feedback. The Kalman

estimates the process state and obtain feedback in a form of measurement. Time update and Measurement update are the two states of the Kalman. The time update is liable for the analysing the current state and error covariance estimates the prior for the next time step. The measurement updates are liable for incorporating a new measurement into a prior estimate to get an improved posterior estimate [21].

2. Conclusion

In this review, we have presented a survey on the Tracking approaches and applications. This survey also describes the general Object Tracking flow and various Object Tracking Techniques in details. Under various challenges and circumstances tracking becomes more challenging. Frame/Image noise and dataset outliers, abrupt and complex motion, nonrigid and complex silhouette, occlusions with the static and moving foreground and backgrounds, sudden illumination variations, loss of information during transformation, real time processing object features, unique track of objects with the multiple cameras, environments and foreground background classification approach make it a vital, complex and challenging task. In this paper we have provided the important information regarding the Object Tracking approaches such as Contour based approaches, region-based approaches, Model Based approach and feature based approaches for the better tracking efficiency and correct estimation and prediction of the object location in the next frame.

REFERENCES

[1] *Alper Yilmaz, Omar Javed, Mubarak Shah, "Object Tracking: A Survey", ACM Computing Surveys, Vol. 38, No. 4, Article 13, (2006).*

[2] *Koller, D., Weber, J., Huang, T., Ma, J., Ogasawara, G., Rao, B., Russell, S. \Towards Robust Automatic Tra_c Scene Analysis in Real-time". In Proc. of the 12th Int'l Conference on Pattern Recognition (ICPR-94), pp. 126.*

[3] *Porikli, F.; Yilmaz, A." Object Detection & Tracking", TR2012-003, Mitsubishi Electric Research Laboratories, Inc., (2012).*

[4] *Barga Deori, Dalton Meitei Thounaojam, "A SURVEY ON MOVING OBJECT TRACKING IN VIDEO", International Journal on Information Theory (IJIT), Vol.3, No.3, (2014).*

[5] *D. Serby, E. K. Meier, and L. V. Gool, "Probabilistic Object Tracking Using Multiple Features", IEEE Proc. of International Conf on Pattern Recognition Intelligent Transportation Systems, Vol. 6, pp. 43-53, (2004).*

[6] *N Xu, N Ahuja, 'Object contour tracking using graph cuts based active contours', International Conference on Image Processing, pp. 277-280 vol.3, (2002).*

[7] *T. Chen, 'Object Tracking Based on Active Contour Model by Neural Fuzzy Network', IITA International Conference on Control Automation and Systems Engineering, pp. 570-574, (2009).*

[8] *X. Lu, Li Song, Songyu Yu, Nam Ling,' Object Contour Tracking Using Multi-feature Fusion based Particle Filter', IEEE Conference on Industrial Electronics and Applications (ICIEA), pp. 237 – 242, (2012).*

[9] *H. Rajabi, M. Nahvi. 'Modified contour-based algorithm for multiple objects tracking and detection', 3th International eConference on Computer and Knowledge Engineering (ICCKE), pp 235 – 239. (2013).*

[10] *D.Ramanan, D.A. Forsyth and A. Zisserman, (2005), "Strike a Pose: Tracking people by Finding Stylized Poses", IEEE Comp. Society Conf. on Computer Vision and Pattern Recognition, San Diego, CA, vol. 1, pp. 271- 278.*

[11] *T. Zhao and R. Nevatia, (2004), "Tracking Multiple Humans in Complex Situations," IEEE Trans. Pattern Analysis and Machine Intelligence, vol. 26, no. 9, pp. 1208-1221.*

[12] *L. Li, S. Ranganath, H. Weimin, and K. Sengupta, "Framework for Real-Time Behavior Interpretation from Traffic Video", IEEE Tran. On Intelligen Transportation Systems, Vol. 6, No. 1, pp. 43-53, (2005).*

[13] *Gu Chuang, Lee Ming-Chieh, 'Semantic video object tracking using region-based classification, International Conference on Image Processing (ICIP'98)- Volume 3, pp.643, (1998).*

[14] *Fan-Tung Wei, Sheng-Ting Chou; Chia-Wen Lin, 'A region-based object tracking scheme using Adaboost-based feature selection', IEEE International Symposium on Circuits and Systems, Ipp. 2753 – 2756, (2008).*

[15] *Hyung-Bok Kim, Kwee-Bo Sim, 'A particular object tracking in an environment of multiple moving objects' International Conference on Control Automation and Systems (ICCAS), pp. 1053 – 1056, (2010).*

[16] *Z Zivkovi, "Improving the selection of feature points for tracking", In Pattern Analysis and Applications, vol.7, no. 2, Copyright Springer-Verlag London Limited, (2004).*

[17] *J. Lou, T. Tan, W. Hu, H. Yang, and S. J. Maybank, "3D Model-Based Vehicle Tracking", IEEE Trans. on Image Processing, Vol. 14, pp. 1561-1569, (2005).*

[18] *Ning Li, LuLiu, De Xu, Corner feature-based object tracking using Adaptive Kalman Filter, Signal Processing, 2008. ICSP 2008. 9th International Conference, pp. 1432 – 1435, (2008).*

[19] *Chen Aibin; CaiZixing; Dong Deyi, An Image Tracking Algorithm Based on Object Center location and Image NMI Feature, Fuzzy Systems and nowledge Discovery, 2009. FSKD '09. Sixth International Conference (Volume:5), pp. 359 – 363, (2009).*

[20] *Alvarez, M.S., Regazzoni, C.S., 'Extended feature-based object tracking in presence of data association uncertainty', International Conference on Advanced Video and Signal-Based Surveillance (AVSS), 2011 ,8th IEEE, pp. 136 – 141, (2011).*

[21] *Greg Welch and Gary Bishop. An introduction to the kalman filter, (1995)&(2006).*