Object tracking and classification under illumination variations

Ushma Joshi[1], Khyati Patel[2]

Student of Masters of engineering, Assistant Profesor
[1]Silver Oak College of Engineering & Technology, Gujarat, India
[2] Silver Oak College of Engineering & Technology, Gujarat, India

***Abstract* - The aim of object tracking is segmenting a region of interest from a video scene and keeping track of its positioning, occlusion and motion. The object detection and classification are main steps for tracking an object in sequence of images. Object detection is used to check objects' existence in video and to precisely locate that object. After that detected object can be classified in various categories such as vehicles, humans, birds, swaying tree, floating clouds and other moving objects. Object tracking can be performed using monitoring objects' spatial and temporal changes during a video sequence, including its position, size, shape, presence, etc. Object tracking is used in various applications like video surveillance, traffic monitoring, robot vision, Video inpainting and Animation. This paper presents a brief survey of different object detection, object classification and object tracking algorithms are available in the literature. It includs analysis and comparative study of different techniques used for various stages of tracking.**

***Index Terms* - Object Detection, Object Tracking, Object Classification, Image Processing, background substraction**

I. INTRODUCTION

Videos are nothing but sequences of images, each of which called a frame, displayed in fast enough frequency so that human eyes can percept the continuity of its content. We all know that all image processing techniques can be applied to individual frames. Two consecutive frames' contents are usually closely related [1]. To identify regions of interest is the first step in many computer vision applications including video surveillance, event detection, and robotics. A general object detection algorithm may be desirable, but it is extremely difficult to properly handle unknown objects or objects with significant variations in shape, color and texture. Therefore, many practical computer vision systems assume that the camera environment is fixed, which makes the process of object detection much more straightforward [3]. An image, usually from a video sequence, which is divided into two complimentary pixels sets. The first pixel set contains the pixels which identical to foreground objects while the second set contains the background pixels. This output or result is sometimes represented as a binary image or mask. It is difficult to specify an absolute standard with respect to what should be marked as background and what should be identified as foreground because this definition is somewhat application specific. Generally, foreground objects are moving objects like people, boats and cars and everything else is background. Many times shadow is marked as foreground object which gives wrong output.

II. FOLLOWING ARE THE BASIC STEPS FOR TACKING AN OBJECT, AS DESCRIBE IN MANY LITERATURE

A. The Object detection:

Object Detection is to identify objects of interest in the video sequence and to cluster pixels of these objects. Object detection can be done using various techniques like frame differencing, Background subtraction and Optical flow.

B. Object Classification:

Object can be classified as birds, vehicles, floating clouds, swaying tree and other moving objects. The approaches to classify the objects are Motion-based classification, Shape-based classification, Color based classification and texture based classification.

C. Object Tracking:

Tracking can be defined as the problem of approximating the path of an object in an image plane as it moves around a scene. The methods to track the objects are point tracking, kernel tracking and silhouette. Here are some of the challenges that should be taken care in object tracking as described in:

1. Loss of evidence occured by estimate of the 3D realm on a 2D image,
2. Noise in an image,
3. Difficult object motion,
4. Imperfect and entire object occlusions,
5. Complex objects structures.

In paper [2] multiple human object tracking approach is used which based on motion estimation and detection, background subtraction, shadow removal and occlusion detection. Video sequences have been captured in the laboratory and tested with the proposed algorithm.

III. OBJECT DETECTION METHODS

Rectangle features can be computed very rapidly using an intermediate representation for the image which we call the integral image.

A. Frame differencing :

The presence of moving objects is determined by calculating the difference between two consecutive images. Its calculation is simple and easy to implement. For a variety of dynamic environments, it has a strong adaptability, but it is generally difficult to obtain complete outline of moving object, responsible to appear the empty phenomenon, as a result the detection of moving object is not accurate

B. Optical Flow Optical flow:

method [1] is to calculate the image optical flow field, and do clustering processing according to the optical flow distribution characteristics of image. This method can get the complete movement information and detect the moving object from the background better, however, a large quantity of calculation, sensitivity to noise, poor anti- noise performance, make it not suitable for real-time demanding occasions.

C. Background subtraction:

First step for background subtraction is background modelling. It is the core of background subtraction algorithm. Background Modeling must sensitive enough to recognize moving objects [2]. Background Modeling is to yield reference model. This reference model is used in background subtraction in which each video sequence is compared against the reference model to determine possible Variation. The variations between current video frames to that of the reference frame in terms of pixels signify existence of moving objects. Currently, mean filter and median filter [2] are widely used to realize background modeling. The background subtraction method is to use the difference method of the current image and background image to detect moving objects, with simple algorithm, but very sensitive to the changes in the external environment and has poor anti- interference ability. However, it can provide the most complete object information in the case background is known.

IV. OBJECT CLASSIFICATION METHODS

The extracted moving region may be different objects such as humans, vehicles, floating clouds, birds, swaying tree and other moving objects. Hence we use the shape features of motion regions. As per literatures, methods for classifying the objects are as follows:

A. Shape-based classification:

Different descriptions of shape information of motion regions such as representations of points, box and blob are available for classifying moving objects. Input features to the network is mixture of image-based and scene-based object parameters such as image blob area, apparent aspect ratio of blob bounding box and camera zoom. Classification is performed on each blob at every frame and results are kept in histogram.

B. Motion-based classification:

Non-rigid articulated object motion shows a periodic property, so this has been used as a strong cue for moving object classification. Optical flow is also very useful for object classification. [3] Residual flow can be used to analyze rigidity and periodicity of moving entities. It is expected that rigid objects would present little residual flow where as a non rigid moving object such as human being had higher average residual flow and even displayed a periodic component

C. Color-based classification:

Unlike many other image features (e.g. shape) color is relatively constant under viewpoint changes and it is easy to be acquired. Although color is not always appropriate as the sole means of detecting and tracking objects, but the low computational cost of the algorithms proposed makes color a desirable feature to exploit when appropriate. To detect and track vehicles or pedestrians in real-time color histogram based technique is used. According to a Gaussian Mixture Model [4] is created to describe the color distribution within the sequence of images and to segment the image into background and objects. Object occlusion was handled using an occlusion buffer.

D. Texture-based classification:

Texture based technique counts the occurrences of gradient orientation in localized portions of an image, is computed on a dense grid of uniformly spaced cells and uses overlapping local contrast normalization for improved accuracy.

V. OBJECT TRACKING ALGORITHMS

Number of algorithms for video object tracking has been proposed. According to the different methodologies for object tracking algorithms, we categorize the existing tracking methods into four forms, including Matching-based tracking, Filtering based tracking, Class-based tracking and Fusion-based tracking. Then we will introduce each type of the tracking algorithms respectively

A. Matching-Based Tracking :

Matching-based tracking algorithms are established for object model based on matching before tracking, depending on the matching relation to select the best matching point as the tracking result in the current video sequences.

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B. Region-Based Tracking:

This method can be applied to affine motion or non-rigid object tracking. The fundamental thought of region-based tracking algorithms is: the initial object region of the image as the object template, matching the object template with all the possible location of the candidate images, the highest matching degree of the position is judged to be the best match point, and the region identified by the point is the object region. The most common of correlation matching criterion is Sum of Square Difference (SSD). Region-based tracking algorithms use global information of the objects, such as gray information, texture features and so on. So they have high credibility, even if minor deformation of the objects does not affect the tracking performance. Unfortunately, they are time-consuming when the search regions are large.

C. Feature-Based Tracking:

The fundamental thought of feature-based tracking algorithms is: Using the feature to identify the object, and match the object in the video sequences based on image feature. This algorithm usually has two main steps which include feature extraction and feature match. Feature-based tracking algorithms don‘t use global features of the objects. Although the objects are partial occlusions, they can use other visible features to accomplish the tracking task [4]. But the algorithms can‘t deal with full occlusions and overlaps effectively. Selection of the right features plays very important role. To clearly distinguish the objects in the feature space we should find the object visual feature uniqueness.

A. Color features:

To increase the discriminative power of intensity based descriptors color feature descriptors are used. Two physical factors primarily influenced the apparent color of an object:

1 The spectral power distribution of the illuminant

2 object’s surface reflectance property

To describe the color information of an object RGB color space is usually used. But RGB color space is not a perceptually uniform color space [4]. However the HSV (Hue, Saturation and Value) is an approximately uniform color space [4].

B. Gradient features:

Gradient features are important in detecting humans in video sequences. To represent objects like human body, shape of the human body is used in gradient based methods

C. Edges features:

The change in intensities of an image is strongly related to boundaries of an object because after just after the object boundary the intensity instantly changes. To identify the instant change edge detection techniques are used.

D. Biological features:

Biological features are important for describing the biological characteristics of human. Attention Regions (ARs) and Biologically Inspired Model features the recent used biological features. Humans biological vision mechanism can be described by these biological and hence to achieve robust recognition.

E. Spatio-temporal features:

In recent times local spatio-temporal features are mostly used. These features provide a visual representation for recognition of actions and visual object detection. Salient and motion patterns characteristics in video are captured by local spatiotemporal features.

D. Deformable Template-Based Tracking :

The fundamental thought of deformable template-based tracking algorithms is: Using the surface or curve which has good elasticity, it also has deformation property of the contour or edge of the moving object as object bounding contour, and updating this contour to match the object. In the situations of noise interferences, occlusions, and edge blur, it is very difficult to get accurate contour by the above models. Importing the prior knowledge of color, texture, and shape, and use them to constrain the contours to obtain exact objects edges.

E. Model-Based Tracking:

Model-based tracking algorithms are not easily affected by observation perspectives, so they are intrinsically robust to various motions. The algorithms have high precision by using the information of 3D. The models can be divided into: hierarchical model , 2D models and 3D models.

F. Filtering-Based Tracking:

Filtering-based tracking algorithms regard the tracking problems as state estimation problems The states of the objects can include all motions characteristics of our concern objects. The key of the objects tracking is how to infer the posterior probability density of the objects state and effectively represent them under the condition of giving the observation data.

Two filters are used for this method:

1. Kalman Filter:

Kalman Filter is an effective method for estimating the states, which predicts the object states by state model, and estimates the posterior probability density function by observation model [5]. Kalman Filter usually use Gauss noise to represent the uncertainty of state model and observation model, and use the uncertainty to automatic balance the effect of observations and predictions to tracking results.

2. Particle Filter:

Particle Filter is a sequential Monte Carlo Filter, which is used to solve the Bayesian estimation problem under the condition of non-linear and non-Gauss. Particle Filter is widely used in the practical applications: radar target tracking, machine learning, computer vision, wireless communication, speech enhancement, robots, etc. A large number of studies show that tracking in complex environment, Particle Filter has better performance than Kalman Filter.

G. Class-Based Tracking:

Class-based tracking algorithms have high tracking accuracy. Unfortunately, there are two drawbacks: on the one hand, constructing the classifiers needs vast positive and negative samples that become the difficulty of how to study and select the samples; on the other hand, the need to search for objects in a large range area.

H. Fusion-Based Tracking:

Fusion-based tracking algorithms are proposed to achieve good tracking effects. The algorithms often combine variety of tracking algorithms or different sources of information to improve the accuracy of the tracking results.

Fusion-based tracking algorithms can be divided into the following three basic parts:

The first method is based on multi-features fusion, which is the most common approach. It cannot be stable tracking in a long time by using single feature information, due to the complex of the tracking scenarios or objects. Therefore, many scholars use multi-feature information fusion technology to improve the video object tracking performance. They give different weights by the ability of features to describe the moving objects. The method advances the tracking accuracy by the reliability of objects description. The method shows that tracking with multiple features provides more reliable performance than single feature tracking.

The second method is based on multi-model fusion. This method integrates object models in different time of video sequences or combines object models with various angels of multiple cameras. It improves the robustness of tracking, on account of adapting the changes of the object and characterizing the effective features of the object.

The third method is based on multi-algorithm fusion. Different object tracking algorithms have their own advantages for certain scenes. The method makes full use of the strengths of various algorithms by integrating the appropriate algorithms, so it can overcome the weaknesses of individual algorithm.

VI. CONCLUSION

In this paper various phases of object tracking system viz. object detection, object classification and object tracking has been described. Methods available for these phases have been explained in details and a number of limitations were highlighted in every techniques. Different methods for object detection are frame difference, optical flow and background subtraction. Object tracking can be performed using various methods like Region-Based Tracking, Feature-Based Tracking, Deformable Template-Based Tracking, Class-Based Tracking, Fusion-Based Tracking, Model-Based Tracking. In Filtering-Based Tracking. In filtering based tracking, Kalman Filter and Particle Filter are mention. It can be observed that background subtraction is a simplest method providing complete information about object compared to frame difference and optical flow for detecting objects. Advance study may be carried out to include find efficient algorithm for reducing computational cost and to decrease the time required for tracking the object for variety of videos containing diversified characteristics.

REFERENCES

[1] Abhishek Kumar Chauhan, Prashant Krishan " Moving Object Tracking using Gaussian Mixture Model and Optical Flow," International Journal of Advanced Research in Computer Science and Software Engineering, Volume 3, Issue 4, April 2013

[2] Fuat Cogun and A. Enis Cetin "Object Tracking under Illumination Variations using 2D-Cepstrum Characteristics of the Target" IEEE 2010

[3] Mojtaba Asgarizadeh, Hossein Pourghassem, Ghazanfar Shahgholian, Hossein Soleimani "Robust and Real Time Object Tracking Using Regional Mutual Information in Surveillance and Reconnaissance Systems," IEEE 2011.

[4] Yong-Beom Lee , Bum-Jae You, Seong-Whan Lee "A Real-time Color-based Object Tracking robust to Irregular Illumination Variations," IEEE, International Conference on Robotics & Automation Seoul

[5] Sheldon Xu and Anthony Chang "Robust Object Tracking Using Kalman Filters with Dynamic Covariance" Cornell University.