Asha Rathee et al. 2016, 4:5
ISSN (Online): 2348-4098
ISSN (Print): 2395-4752

International Journal of Science, Engineering and Technology
An Open Access Journal

An Exploration of the Multiple Object Detection Techniques for Smart TV

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Abstract

Undoubtedly this modern era of technology have expanded the human knowledge into the development of various advanced software applications and machines. The latest inventions have shifted the focus of humans from the manual selection of online selection and purchase of items from website to purchasing from smart TV. In this smart TV, one can select the object from moving characters. This concept is similar to detection of objects from moving videos. Smart TV shopping methods have also the need of internet access to enter into the world of smart purchasing. There are various methods and techniques available in the field of online object detection from video. This paper presents a comprehensive survey on the concepts of, Multiple Object Tracking, Single Object Tracking, Unsupervised Learning for Object Detection, and Object Detection is presented. Different authors have used the different approaches for the tracking of moving objects. There were some advantages and some limitation in the each concept. So, the considered concepts with their brief about the concept and key features are discussed. This work also elaborates the use of appropriate methods and future directions in the field.

Keywords: Multiple Object Detection, Feature Detection, Computer Vision, Object Tracking, Feature Points.

Introduction

Object detection is a method to locate or identify object of interest in the consecutive frames of a video files, while object tracking is a process to situate moving attracted object or multiple objects in a video file or camera with respect to time [1]. Technically, in object tracking aim is to approximate or identify the pathway of the moving object plane around the image plane. With the advancement in computational power of technology, good quality and low cost video camera are easily available. Moreover, the need of automated video system results in the increasing interest of humans in object tracking algorithm. Three major steps for video analysis are:

- Detection of interested object from moving objects,
- Tracking of that interested objects in consecutive frames, and
- Analysis of object trajectory to understand the behaviour of interested object.

Correct detection of objects is a challenging task, as the objects need to be identified can have complicated structures and may change in shape, size, location and orientation over subsequent video frames. Numerous algorithms and schemes have been developed in the past decades to detect and track objects in a particular video sequence. However, each algorithm is identified by its own advantages and disadvantages. Identification is more difficult if the background appeared is quite similar to interested object or another object, which are present in the scene. This problem is termed as clutter. Another major challenge is the difficulty to detect interested object by the appearance of the object itself in the frame plane. Following are some of the factors that may influence the object detection and tracking:

- Object poses in the video frame: In a video file, since the object is moving so the appearance of an interested object may vary its projection on a video frame plane.
- Ambient illumination: In a video, it is possible to change in intensity, direction and color of ambient light in appearance of interested objects in a video frame plane.
- Noise: In the acquisitions process of video, it may possible to introduce a certain amount of noise in the image or video signal. The amount of noise depends upon sensor qualities that are used in acquitting the video.
- Occlusions: In a video file, moving object may fall behind some other objects, which are present in the current scene. In that case, tracker may not observe the interested object. This is known as occlusion.

Discriminating forefront objects from the stationary backdrop is one of the most noteworthy and complicated research problems. In all the optical surveillance systems, initial step is the detection of available objects in foreground. As we have to only dealt with the foreground object pixels, so these foreground pixels can be considered as the base for the various processes like behaviour understanding, classification and tracking which overall reduces the computation time. It is somewhat difficult to detect objects fast and reliable, as it truly entails the long and short term dynamic changes in scene like sudden illumination variations, camera noise, shadows, light reflectance and repetitive motions (e.g. waiving tree leaves). So, there is the need to have special attention for the object detection to be fast visual, robust and reliable in surveillance system.

In this research paper, work of different authors for the object detection in smart TV is presented. Further, section 2 presents the object detection approach for the smart TV, section 3 presents the existing concepts of object detection from video. Section 4 concludes the paper with future directions.

2. Object Detection for Smart TVs

With the aid of TV with PC technology and internet connection, user can directly interact with smart TVs. Even consumers are able to stream channels as per their wish with the help of the internet connection. This latest advancements have not made only the live streaming easy but users also detect the objects showing their TV screen. Consumers can directly interact with live TV and purchase the required objects by directly selecting from the online streaming. The object detection task can be addressed by considering the video as an unrelated sequence of frames and perform static object detection [2]. On the other hand, it can be tackled by utilizing the additional information offered by the progression of the video sequence [3] [4]. For example, consider a fashion show in which models uses the appeals, handbags, shoes, bracelets, other gadgets, and many more. These things attract the consumer well in such a manner that they become ready to purchase these fashion gadgets. So, in these smart TV systems, consumers can detect the object and make them save for future purchase. This is also shown in TV notifications. In future, whenever a consumer wishes to purchase these products, he can directly stream those products and purchase from internet available online stores. For still images, most approaches employ additional information from co-occurrence and/or spatial relationships between object labels [5] [6], but these do not incorporate the temporal information embedded in video sequences. Very few approaches do address the temporal information as an additional cue [7] [8]. Most of the previous approaches fail to detect complex and multiple objects like watches, apparels, shoes, etc. on screen. But, there are still available methods to work on complex methods to detect multiple objects from moving item.

3. Object Detection Methods

In this section, the work of different authors in the field of Multiple Object Tracking Features, Single Object Tracking and Object Detection is presented. Different authors have used the different approaches for the tracking of moving objects. The work of different authors is presented here. Table 1 also presents the overall brief of these concepts.

Jadhavet et al. [9] have presented the moving object detection and tracking using reference subtraction. In this method, they use static camera for video, first frame of video consider as a background frame, and this frame is subtracted from the current frame to detect moving object. Then they set the Threshold T value. If the pixel difference is greater than the set value T, then it determines the pixel from moving object otherwise as background object pixel. It is suitable for complex environment due to lightning changes. This algorithm is very fast

and uncomplicated, able to detect moving object better and it has a broad applicability. This method is very reliable and mostly used in video surveillance applications.

del-Blanco et al. [10] have presented an efficient multiple object detection and tracking framework for automatic counting and video surveillance applications. In this paper, automatic visual object detection and tracking framework is proposed for video surveillance and counting-based applications in the consumer electronics environment. It is based on off-the shelf equipment, such as IP, web cameras, and PCs, and does not need special installation and configuration requirements. The detection stage is based on a parametric background subtraction technique that detects the moving regions in the input video flow. The tracking stage uses a Bayesian model to simulate the object trajectories. This moving object detector has also the ability to detect and remove shadows. The proposed algorithm has been compared with another approach, also oriented to consumer electronics, proving its superior performance.

Kushwaha et al. [11] have described the method for multiple moving object detection and tracking using haar feature haar with smart video surveillance system. Authors have proposed a method for moving human detection and tracking system with a static camera has been developed to estimate velocity, distance parameters. The use of Haar classifiers has boosted to the upgrade of the system that is fast and more accurate. These methods allow segmenting each image into a set of regions representing the moving humans by using a background-differencing algorithm.

Tiwari and Kumar [12] have used Haar classifier, like in today's world of technology; there are multiple ways of detecting moving humans and objects. Different approaches are followed for more accurate results without any false detection. This proposed approach is based o Haar classifiers which divides the image into few segments where each segments represents moving humans by using background algorithm. In this method template matching technique is used to implement human tracking system. This method also used for validating the image and finding the velocity of objects in video.

Sharma and Nevetia [13] have proposed efficient detector adaptation method. This proposed is computationally very efficient as this can be used for multiple online test videos in very less time. It also provides accuracy inspite of any pose variation. This approach works with any online sample video collected in unsupervised manner. Efficient result can be obtained using this approach by dividing the samples of videos in different categories. This method concludes a very generalized as it work with any baseline classifier.

Khraief et al. [14] discussed a region-based method and conventional method which uses background modeling for object detection and tracking. This approach works well even with the week boundary areas and even with the objects also with week boundary. It produces efficient results with the lesser computational time. The main limitation of this method is that it doesn't give accurate result with frequent illumination changes and object movement.

Shantaiya et al. [15] used Kalman filter and optical flow for multiple object tracking. Kalman filter helps to estimate the state of target object. It's being used in various areas like navigation, tracking of object etc. It is a region based object filter technique which tracks the region of object in next frame. The center of object is first find and after detecting the centre of object, the Kalman filter is used to find the adjacent regions in the next frame. It consist of two steps prediction and correction. Optical flow is an estimation of different motions of objects between observer and the scene. Through detecting and analyzing the flow between video frames, it helps to define the velocity of objects in the video. By this, it helps to detect the closer objects more clearly than the object at far distance. Optical flow cannot use for handle occlusion. So, its improved version i.e Improved Optical flow is used to handle occlusion. Hence, this paper concludes that Improved Optical flow is better and more accurate technique for better optimization in less computation time.

Kumar [16] proposed a framework for handling big videos. The proposed framework use GPUs for challenge imposed by big videos. Different algorithms are described in this paper are GMM, morphological operations, and CCL. All the algorithms are compare with the GPUs and from this it concludes that it is efficient than any other in computational time and memory used for handling high resolution videos for detecting and tracking object in it.

Muthuswamy and Rajan [17] have proposed HVS(Human Visual System) for object detecting by

separating foreground and background even if the scene are formed only once. In this approach various salient regions are detected from video. This approach detects saliency at pixel-level with any complex computation. The proposed system can be used to detect multiple objects by segmenting the video based on salient values. Two main approaches: Top-down and Bottom-up are used for salient region detection. This paper concludes that spatio-temporal saliency maps and color features are used for quick, clear detections and avoid false detections.

Huang et al. [18] presented the method to detect moving and static objects in a video. This paper proposed an approach for object detection by a novel model-based tracking. In this first the video is divided into small clips and then find the similar object in the video and then locate the target object in the video clips. By this proposed approach Hough-voting framework is combined for verifying the proposed method by detecting the human action. This paper concludes that the approach is effective is computation time and accuracy. This approach can also be used with more complicated videos also without affecting its effectiveness.

Rout et al. [19] proposed the approach for handling various illumination conditions. In previous approaches object recognition and tracking fails due to failure of the algorithms. The proposed approach is used to find the correlation function for inter-plane correlation between consecutive planes that are R, G and B. In this correlation matrix is used for estimating the rough idea of object. And further segmentation is done of correlation plane by using threshold. This method concludes that correlation method gives better results.

Zhang et al. [20] have proposed a Stormbased real-time framework. With emerging big data technologies like Hadoop processing of larger videos or data have become more efficient then earlier techniques. In this approach data at very larger scale can be processed very easily and various CRUD operations can be performed efficiently. This paper concludes that this approach can be efficiently used for big data processing as compare to the traditional method.

Table 1: Comparative Analysis of Multiple Object Detection Methods

Authors	Technique	Key Features
Jadhavet et al. [9]	Reference Subtraction method	• This method is very reliable and mostly used in video surveillance applications. • This approach uses a static camera for video, first frame of video consider as a background frame, and this frame is subtracted from the current frame to detect moving object. • This algorithm is very fast and uncomplicated, able to detect moving object better and it has a broad applicability.
del-Blanco et al. [10]	Automatic visual object detection method and Bayesian model	• Automatic visual object detection and tracking framework is proposed for video surveillance and counting-based applications in the consumer electronics environment. • The tracking stage uses a Bayesian model to simulate the object trajectories. • The proposed algorithm has been compared with another approach, also oriented to consumer electronics, proving its superior performance.
Kushwaha et al. [11]	Haar feature	• Authors have proposed a method for moving human detection and tracking system with a static camera has been developed to estimate velocity, distance parameters. • The use of Haar classifiers has boosted to the upgrade of the system that is fast and more accurate.
Tiwari and Kumar [12]	Haar classifier	• In this method template matching technique is used to implement human tracking system. • This method also used for validating the image and finding the velocity of objects in video.
Sharma and Nevetia [13]	Efficient detector adaptation method.	• This approach works with any online sample video collected in unsupervised manner. • This method concludes a very generalized as it work with any baseline classifier.

Khraief et al. [14]	Region-based method and Conventional method	• This approach works well even with the week boundary areas and even with the objects also with week boundary. • The main limitation of this method is that it doesn't give accurate result with frequent illumination changes and object movement.
Shantaiya et al. [15]	Kalman filter and Optical flow	• This paper concludes that Improved Optical flow is better and more accurate technique for better optimization in less computation time.
Kumar [16]	GPUs	• All the algorithms are compare with the GPUs and from this it concludes that it is efficient than any other in computational time and memory used for handling high resolution videos for detecting and tracking object in it.
Muthuswamy and Rajan [17]	HVS(Human Visual System)	• This approach detects saliency at pixel-level with any complex computation. The proposed system can be used to detect multiple objects by segmenting the video based on salient values. • Two main approaches: Top-down and Bottom-up are used for salient region detection. • This paper concludes that spatio-temporal saliency maps and color features are used for quick, clear detections and avoid false detections.
Huang et al. [18]	Model-based tracking	• By this proposed approach Hough-voting framework is combined for verifying the proposed method by detecting the human action. • This paper concludes that the approach is effective is computation time and accuracy. This approach can also be used with more complicated videos also without affecting its effectiveness.
Rout et al. [19]	Inter-frame correlation Approach	• The proposed approach is used to find the correlation function for inter-plane correlation between consecutive planes that are R, G and B. In this correlation matrix is used for estimating the rough idea of object.
Zhang et al. [20]	Storm based real-time framework	• In this approach data at very larger scale can be processed very easily and various CRUD operations can be performed efficiently. • This paper concludes that this approach can be efficiently used for big data processing as compare to the traditional method.

4. Conclusion

Understanding activities of objects moving in a scene by the use of video is both a challenging scientific problem and a very rich domain with many promising applications. Thus, it draws attentions of several researchers, institutions, and commercial companies. In the existing approaches, there are well explained techniques for the detection of video objects. But in case of multiple objects, existing approaches for object detection shows availability of negative frames even more than the positive objects. Also, most of the cases are considered for the fixed background and still camera based object detection. So, there is need of some appropriate approach that can detect the multiple moving objects with moving camera instead of fixed location. From the existing methods, it can be observed that there is need to focus more on moving objects in video frames instead of fixe camera and background. In future, we can recommend the use of multiple features extraction approach along with the use of some meta-heuristic concepts. Meta-heuristic concepts have problem solution optimization features that can enhance the performance of the algorithm.

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