Engineering Applications of Artificial Intelligence 28 (2014) 210–217

Contents lists available at ScienceDirect

Engineering Applications of Artificial Intelligence

journal homepage: www.elsevier.com/locate/engappai

OFGM-SMED: An Efficient and Robust Foreground Object Detection in Compressed Video Sequences

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ARTICLE INFO

Article history:
Received 9 May 2013
Received in revised form
12 July 2013
Accepted 2 September 2013
Available online 9 November 2013

Keywords:
Optical Flow
Gaussian Mixture Models
SMED
Segmentation
Background subtraction

ABSTRACT

Segmenting Foreground objects from a video sequence is a key processing and critical step in video analysis such as object detection and tracking. Several Foreground detection techniques and edge detectors have been developed till now but the problem is that it is very difficult to obtain an optimal foreground due to the interference from the factors like weather, light, shadow and clutter. Background subtraction is used in many of the applications, where the background noise appears at fixed places and also, when it is used for long image sequence, there may be more accumulated error in the foreground. Optical flow is the velocity field which warps one image into another (usually very similar) image where the background noise appears randomly. It covers long distance and the background noise due to brightness change is less which results in less accumulate error percentage. However, it cannot get rid of light influences which result in background noises. This paper proposes a new foreground detection approach to overcome these issues by combining the background subtraction algorithm and optical flow along with SMED (Separable Morphological Edge Detector) to reduce the background noises. SMED has robustness to light changing and capable of detecting even slight movement in the video sequence. The proposed work is highly accurate in detecting the moving objects in various scenarios such as fast moving objects, slow moving objects and even moving objects in dynamic scenes, where both the foreground and background changes.

1. Introduction

A video surveillance system (Lucas and Kanade 1981) must be capable of continuous operation under various weather and illumination conditions. It should be capable of dealing with movement through cluttered areas, objects overlapping in the visual field, shadows, lighting changes, and effects of moving elements of the scene (e.g. swaying trees), slow-moving objects, and objects being introduced or removed from the scene. Traditional approaches based on backgrounding methods typically fail in these general situations.

Background subtraction is a very important part of surveillance applications for successful segmentation of objects of interest in a scene for applications such as surveillance. The purpose of Background Subtraction algorithm is to distinguish moving objects (hereafter referred to as the foreground) from static or moving parts of the scene (called Background). Simple motion detection algorithm (Barnich and Van Droogenbroeck 2011) compares a static background frame with a current frame of a video scene, pixel by pixel. This is the basic principle of background subtraction where each video frame is compared against a background model, and the pixels which significantly deviate from the model are considered to be the foreground. These "foreground" pixels are further post-processed for object localization and tracking. The general framework of BackGround Subtraction (BGS) (Cong et al., 2011) usually comprises of four steps: preprocessing, background modeling, foreground detection, and post processing. The preprocessing step collects training samples and removes imaging noises; the background modeling step builds a background model which is in general robust to certain background changes; the foreground detection step generates foreground candidates through calculating the deviation of a pixel from the background model; finally, the post processing step thresholds those candidates to form foreground masks.

Among these four steps, the third step namely foreground detection is the important process that should detect foreground object exactly. i.e., the resultant video sequence or image thus so obtained should not contain background noise. Our goal is to create a robust, adaptive tracking system for foreground detection of video objects under the compressed domain that is flexible enough to handle variations in lighting, moving scene clutter, multiple moving objects and other arbitrary changes to the observed scene.

1.1. Previous work and current Shortcomings

The existing foreground detection algorithms can be divided into three categories: frame difference, optical flow and background subtract.

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0952-1976/$ - see front matter © 2013 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.engappai.2013.09.007

Frame difference (Gupta and Kulkarni 2007) calculates pixel gray scale difference between adjacent two frames in a continuous image sequence and determines foreground by setting threshold. Frame difference method can be used in dynamic environment, but it cannot completely extract all the foreground area, the central part of the target will be lost, which results in bad target recognition. In addition, this method is difficult to accurately detect fast moving objects as well as multiple objects.

Optical flow (Horn and Schunck 1981) is the distribution of apparent velocities of movement of brightness patterns in an image. Optical flow can arise from relative motion of objects and can give important information about the spatial arrangement of the objects viewed and the rate of change of this arrangement. Discontinuities in Optical flow can help in segmenting images into regions that correspond to different objects. Since it is very difficult to calculate the true velocity field using image sequence, the optical flow field which is obtained from the information of moving objects can be used to replace the velocity field. But, the optical flow field alone cannot be used because it cannot get rid of background noises (Stauffer and Grimson 1999) which occur due to the influence of ambient light.

Background subtract (Stauffer and Grimson 1999) is a common method used in foreground detection shown in Fig. 1. It calculates the difference between the current image and background image and detects foreground by setting threshold. Basically there are two methods to obtain background image, viz., 1. Defining background image manually, and 2. Obtaining a background model by a training algorithm as like used in Gaussian Mixture Model (GMM). Compared to the former, the latter is more accurate and the result of foreground detection is much better. Background subtract method has robustness to light changing and slight movement, but when using this method to deal with long image sequence there may be much accumulate error in the foreground. Moreover, GMM produces good results of detecting Foreground in uncompressed domain of Video sequence. But for compressed domain of video it produces very poor results with high background noise. Optical flow covers long distance and the background noise due to brightness change is less which results in less accumulate error percentage.

In digital image processing (Gonzalez et al., 2002), the edge detection is an important technique. Edge detection is the process of finding meaningful transitions in an image. Various edge detection (Rajesh, R. 2008) algorithms have been proposed based on either gradient operator or statistical approaches. Mostly the gradient operators are easily affected by background noise, and the filtering operators are used to reduce the background noise rate. In edge detection, morphological edge detectors (Fathy and Siyal 1995) are also available which are more effective than the gradient operators. Some kinds of morphological detectors are also available and those are not efficient while comparing to separable morphological edge detector. But the edges at different angles are not covered and thin edges are missed by this mathematical morphological detector. Hence separable morphological edge detector detects thin edges and the edges at different angles with less background noise (Siyal and Solangi 2006).

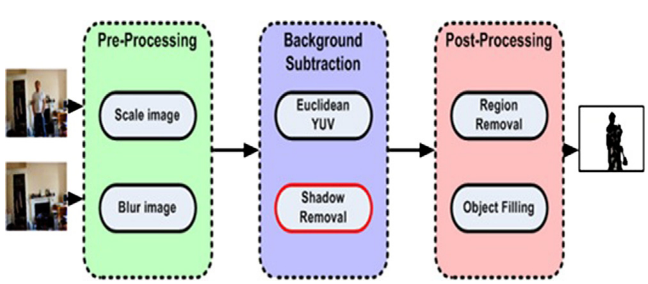

Fig. 1. Background Subtraction.

Various methods have been proposed to video image processing until now. But these existing methods have some difficulties with congestion, shadows, background noise and various lighting conditions. This literature report describes various techniques involved, their constraints like memory, computing tie, complexity.

The Video surveillance method proposed by Baumann.A et al. Baumann et al., (2008), aims at robustness with low volume of false positive and false negative rate simultaneously. But the requirement is to have zero false negative rates and also it should cope with varying illumination condition, occlusion situations and low contrast. Real time video surveillance proposed by Nan Lu et al. Lu et al., (2008) deals with real time detection of moving objects. This deals with problems like storage space and time consumption to record the video. To avoid the above problems this uses motion detection algorithm but this covers only the video that has important information. In real time visual surveillance W4S (Rourke and Bell 1988) method (What, When, Where and Who) is the low cost PC based real time visual surveillance system for detecting and tracking people and monitoring their activities in an outdoor environment. It has been implemented to track people and their parts of the body. It has the problems like sudden illumination changes, shadow and occlusion. W4S is an integrated real time stereo method which has addressed the limitation that W4S has met. It deals with tracking of people in outdoor environment. But this makes tracking much harder in intensity images. End-to-End method has been proposed which is used for removing moving targets from a stream of real time videos. It sorts them according to image based properties. But this involves in forceful tracking of moving targets. Smart video surveillance systems support the human operators with identification of significant events in video. It can do object detection in outdoor and indoor environments under varying illumination conditions. But this is based on the shape of detected objects. Automatic video surveillance using background subtraction (Schmoldt et al., 1997) has different problems. Pixel based multi color background model is a successful solution to this problem. However this method suffers from slow learning at the beginning and it could not differentiate between moving objects and moving shadows. Multimedia surveillance (Rajesh, R. 2008) utilizes assorted number of related media streams, each of which has a different assurance level to attain numerous surveillance tasks. It is difficult to insert a new stream in the system with no knowledge of prior history.

Edge detection has been a challenging problem in image processing. Due to lack of edge information the output image is not visually pleasing. Various types of edge detectors are discussed here, Robert edge detector (Fathy and Siyal 1995) detects edges which run along vertical axis of 45 and 135 degree. The only drawback is that it takes long time to compute. Gaussian edge detector reduces background noise by smoothing images and gives better results in a noisy environment. The difficulty is that it is very time consuming and very complex for computation. Zero crossing detectors use second derivative of the input image and it includes the laplacian operator. It is having fixed characteristics in all directions. But it is sensitive to background noise. In Canny edge detector approach, if the set threshold is low, it produces false edges and conversely, if the set threshold is high it leaves out important edges. The main disadvantage of canny edge detector is that it is not susceptible to background noise (Rajesh, R. 2008).

To overcome the aforesaid problems involved in the existing techniques we propose a newly adapted approach. This is very effective and could overcome all the above mentioned problems like congestion, shadow & lighting transitions, robustness to light changing and even slight movement. This proposed approach will be very effective and the best choice for both static and dynamic