The Application of Characteristic Point about Moving Object Detection and Tracking Method Based on OpenCV

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Abstract. Moving target detection is one of the research hotpots of intelligent technology, is widely used in the field of video processing, through the detection of moving object in video sequences, we can find a convenient person or thing of human concern, positioning and tracking target. This paper mainly researches on moving target detection and tracking method, analyses the three kinds of traditional methods about detection of moving object, including the based on background-difference method, the inter-frame difference method, and the optical flow method, using FAST algorithm based on OpenCV development platform to realize the feature point detection of image, and according the position relationship of feature point and initial frame to realize the tracking of these feature points, and realize the tracking of moving target; finally, the results of simulation experimental show that the FAST algorithm can realize detection and tracking of moving targets, and have advantage of fast speed and good effect.

Introduction
In criminal case investigation, the first task is criminal scene investigation, and the investigation of surveillance video around the scene is a important part of it. Surveillance video can record the process of a case. Even if the process is not exposed to surveillance video, you can find some clues to suspect vehicle or person by searching the contents of surveillance video around the criminal scene. The moving objects in the surveillance video are often key points that investigators focus on. Moving object is composed of sequential image frames. By detecting and tracking the moving object, the police can search information about suspects conveniently and swiftly, and achieve the investigation. Therefore, the research of detecting and tracking the moving object in video sequence can help us obtain visual information that we need, and it has becoming one of the hotpots of video processing research field.

This paper make use of the theory knowledge of moving object detection, draw support from Visual Studio 2012 software development platform, and apply moving object detecting algorithm called FAST to detect moving object. We detecting a video of characteristic points, and achieve the goal of tracking the object fast.

Moving Object Detecting
Moving object detecting is to identify moving person or things automatically from a continuous video sequence. The key of moving object detecting is detecting and classifying the moving object in the image or video sequence, and continuous tracking the object. By using this method, we can find the trajectory of the object, recognize the behavior of moving object, and comprehend as well as describe the hole image or the video scene. There are three methods to achieve moving object detecting: Background Subtraction, Temporal Subtraction, Optical Flow.

Background Subtraction
Background subtraction is using background parameter model to approximate the pixel value of the background. Compared the pixel value of the current image to the pixel value of the background image, if the difference value between the current and the background image is large, that is pixel area, that also indicate that there is movement of the object in this area. Else, we believe that the
object does not move. In that way you can achieve detecting the moving object of a video. The process of detecting moving object is shown in Figure 1.

![Figure 1. Moving object detecting.](image)

**Temporal Subtraction**

Temporal subtraction is doing subtraction between adjacent two frames of image or several frames of image. We can get the foreground image of the moving object. This method is simple to operate, but for slow motion or not violent moving object, the detecting results are easily distorted. The specific flowchart is shown in Figure 2.

![Figure 2. Temporal Subtraction.](image)

**Optical Flow**

The method to detect moving object by optical flow is to analyze variation of pixel from image sequence in terms of time, find the correlation between the current frame of image and the adjacent frame of image. On the basis of the correlation between them we can find the differences between the two frames of image. In that way, we can calculate the motion information of people or objects in the frames of image.

Using Optical Flow to detecting moving object, first we need to build a vector field in original image, and give all the frames in the image a kinematic vector. Then, calculate according to the projection relationship, so that the points on the image and the points on the objects can achieve one-one-correspondence at a specific moment. Finally, according to the velocity vector characteristic of each pixel point, we can make dynamic analysis of the image. In the process of dynamic analysis, if the object in the image is not moving, then the optical flow vector is continuously variable in the whole image region, and we consider that the people or objects in the video do not move. When the people and objects in the video are moving, there are movement between the current frame and the background frame, and there must be differences between the velocity vector of current frame and the motion vector of background image. We can figure out the position of the object by calculating the difference of motion vector. Anyway, we cannot achieve real-time moving object detection because of the complicate and large calculated amount of the method of Optical Flow.
Feature Point Detecting and Tracking Method

Feature Point Detection

Feature point detection, also known as the point of interest detection or corner and vertex detection, refers to detect specific definition feature point or feature point that can be detected. Detecting these points, extracting basic information of the image, sifting characteristic of the image, and achieve image processing. In terms of image processing, the feature mainly refers to the extreme point of image, the terminal point of the line segment, a point with maximum curvilinear curvature, the extreme points of horizontal direction and vertical direction. These points are highlighted in the image and can generally represent the meaning of the image. These feature points implicit significant characteristic of image. It is important for people to comprehend image, analyze image, and process image. In terms of processing image, we can use feature point instead of the whole image. In that way, we can reduce the data size, and increase the efficiency of image processing. Meanwhile, we can keep the feature information of the image. It’s convenient to matching the image, and achieving real-time image processing.

At present, the main methods of feature point detection are: Corner and vertex detection based on grey level image, Corner and vertex detection based on profile gram, Corner and vertex detection based on binary image. In these ways, we can recognize the image, do image rectification, reconstruct 3D effect, and realize the detection and tracking of the moving object.

Feature Point Detection Based on OpenCV

Open Source Computer Vision Library OpenCV consists of a large number of C functions and C++ classes, including many common algorithms in image processing, computer vision and HighGUI user interaction. OpenCV provides a wealth of visual processing algorithms. By programming in C language, as long as the process is not wrong, we can realize compiled interlinkage and generate executive program without adding new external support. As a result, OpenCV can realize algorithm transplant. It makes it popular in many applications such as Human machine interaction, object recognition, image segmentation, face recognition, motion recognition, motion tracking, etc.

OpenCV main functions of following aspects:(1)Image enhancement: image histogram equalization, image histogram normalization, average filtering, etc; (2)Image transform: Fourier transform, DCT(discrete cosine transform), etc; (3)Mathematical calculation: addition, subtraction, multiplication, and division of matrix, transposition, logic operation, SVD decomposition, etc; (4) Image processing: geometric transformation, morphological operation, color space transformation, feature matching, etc; (5) Structural analysis: Contour processing, geometric shape calculation, plane division, etc.(6) Motion analysis: object tracing, camera calibration, three-dimensional reconstruction, object detection, classifier design, etc.

In the complex image processing process, only the detection of the feature points can lay a good foundation for the next image processing. There are various algorithms to realize feature points detection in OpenCV. Among these methods, FAST(features from accelerated segment test) is a efficient detection method, it can obtain the feature point only by using the comparative information of the surrounding pixels.

The idea of FAST feature point detection algorithm is based on the grey value of the image around the feature point. The specific detection method is: first, select a candidate feature point in the frame of image, and then do a full range of detection to the pixel around the feature point. When the difference between the pixel grey value of the detected pixeland that of the pixel grey value of the feature point is large enough, and the number of pixels in this category is enough, the candidate feature point is considered to be an effective feature point, otherwise it is not a effective feature point.

\[
N = \sum_{x \in \text{circle}(p)} |I(x) - I(p)| \varepsilon_d
\]
Setting $I(x)$ is the grey value of any point on a circle, $I(p)$ is the grey value of its center, $\varepsilon_d$ is threshold value of the difference of the grey value. If the the following $N$ is greater than the given threshold, we think the point is a feature point, and the formula is as follows:

$$
N = \sum_{i=-1}^{1} |I(x_i) - I(p)| - \varepsilon_d
$$

In order to get a faster detection effect, you can use the following method to accelerate: To detect the pixel points in the four perpendicular orientations around the candidate feature point, when there are at least three pixel points in the grey value and the candidate feature point grey value of the difference is large enough, that candidate point is considered as a feature point, and we do not need to detect other pixel points any more.

When we are using FAST feature point detection of OpenCV, we first look for a set of feature points in the image, then call detect function to check these feature points. Finally, we plot the detected feature points on the sample picture. Figure 3 shows an example image after image feature point detection by OpenCV. The threshold value of detection is 40.

![Figure 3. Detection of feature point.](image)

**Feature Point Tracking.**

When doing moving object detection to video sequences, the main task is to detect the feature points of each image in the video sequences. In order to trace the feature points, we need detect the feature points in the current image, then we need to locate these feature points in the following frames of image. According to the location of feature points and the position of initial frame image, we can trace these feature points successfully. In dealing with video sequences, objects with feature points may have moved. In order to solve this problem, we need to search the position of feature points in initial frame of image, and we can find the position of feature points in the next frame of image. We can use `cv::calcOpticalFlowPyrLK` function of OpenCV to realize feature points searching, use `cv::calcOpticalFlowPyrLK` of OpenCV to realize feature points tracing. In order to realize tracing the whole video sequence, we input two adjacent frames of image and the number of feature point groups for the first frame of image, the function will return a new set of feature points’ locations. On account the new returned position, the detected feature points will lost. The decrease in the number of tracked feature points may have an impact on the detection of moving objects. In order to get better detection effect, we detect the following frames of image at regular time, and we can realize feature point tracing.

**Simulation Experiment and Result Analysis**

**Simulation Experiment**

The development platform of this article is built mainly through Visual Studio 2012 and OpenCV2.4.9 versions. Using the theoretical knowledge of FAST moving object detection algorithm, and combined with feature point detection and tracing method, we can do simulation experiment on OpenCV development platform. First we set up parameters of environment and attribute registration, then we write the program function code of moving object detection, finally we debug the results. Figure 4- Figure 6 are results of feature points detection and tracing experiment.
Result Analysis

Through the analysis of simulation experiment results, we can find that the advantages of FAST algorithm are mainly as follows:

1. The method can accurately detect the motion objects appearing in the video sequence, whether they are people or moving objects, as long as there are motions between adjacent frames of image, we can detect moving objects accurately.

2. By tracing feature points, continuous can be showed in the video.

3. This method is influenced little by the environment and other factors. If the trajectory of the object in the video is blocked by trees and other objects during a certain period of time, the tracking of the feature points of the moving object will not be stagnant, but follow the movement of the object. When leaving the shelter, it can form continuous feature point tracking.

4. This method has high detection efficiency. Compared with other traditional detection methods, FAST moving object detection has advantages of short time, nice detection effect, etc. It can meet the general demand for video applications.

The disadvantages of the simulation experiment of the moving object detection: on the one hand, all the moving objects in the video sequence can be detected but cannot detect the specific person or object; on the other hand, there are a mass of moving objects in video, when we are detecting and tracing feature points, the continuous detection and tracing of feature points cannot be achieved.

Conclusion

With the development of high-definition surveillance video technology as well as the popularity of intelligent, the moving object detection search in the future will not be limited to simple image and video sequences detection, and moving object detection is not only detect all the moving things in video sequences. It will detect and trace specific person and object. It can also be combined with face recognition, motion trajectory studying and other related technologies. We can quickly find out moving objects that people care about in real-time and stored surveillance videos. We not only can detect the moving objects, but also can automatically identify and filter out the interference items that appear in the video sequence. We will lock the object that people care and detect the identity and related information of the moving object. Moving object detection and tracing will serve video analytics applications better.

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References


