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Target detection method based on KCF algorithm and object motion state

Qing Zhou *, Gongquan Tan

School of Sichuan University of Light Chemical Technology University, Sichuan 510000, China.

* Corresponding Author

Abstract

In recent years, machine vision technology has been widely used in various fields. This paper designs and implements a target tracking method based on motion detection and KCF algorithm. Compared with the traditional single motion detection algorithm and target tracking algorithm, this method has a lot of moving target tracking. Advantage. The single motion detection algorithm cannot detect well after the target stops moving, and the single target tracking algorithm needs to specify the tracking target in the early stage. The method designed in this paper uses motion detection as the trigger condition. Correlation filters are trained through a multilayer network.Once a moving target is detected, the target tracker is turned on to track the target, so the moving target can be tracked in real time, efficiently and stably. This method has great application potential for smart security and video surveillance technology.

Keywords

Motion detection, KCF algorithm,target tracking; machine vision.

1. Introduction

Research on difficult issues such as feature expression and ID conversion in target detection and tracking algorithms, more and more videos are rapidly detecting moving targets. As long as it is detected that mobile surveillance is integrated into our lives and is our personal and property safety mark, it will immediately lock the mobile target and automatically track the target. Provide reliable protection. However, traditional surveillance systems can only provide video. Currently, there are many classic target tracking algorithms, such as TLD, recording, storage, and playback, which can no longer satisfy our objects such as Struck, CT, and KCF. However, many target tracking algorithms are required for quality life. There are also some video surveillance that can realize the performance of KCF on the move in all aspects. In the detection of average accurate targets, the accuracy of KCF is as high as 73.2% in the general requirement of tracking the Japanese standard in the machine vision algorithm, and the essential operator of Struck manually specifies the tracking target, so the current motion detection accuracy is 65.6 %, the accuracy of TLD is 60.8%, and there are very few video surveillance systems that combine the accuracy of CT with target tracking. The series are 64, 28, and 20. The working mode of the video surveillance system with high real-time requirements is: when there is no moving object in the monitoring area, the monitoring, choosing KCF as the target tracking algorithm can make the system higher control system not work, so it can save a lot of system resource. One effect can better meet people's needs. Object detection has applications in many areas of computer vision, including image retrieval and video surveillance.

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2. Moving target detection

According to the relationship between the target and the camera, the algorithm of moving target detection can be divided into motion detection in a static background and target detection in a moving background. Target detection under a static background is to distinguish the actual changing area from the background from the sequence image. There are many methods to detect moving objects under the premise of static background, and these methods focus on the elimination of small noises from background disturbances. Typical algorithms include background difference method, inter-frame difference method, optical flow method, and Gaussian Mixture Model (GMM). Target detection under a moving background, compared with a static background, the idea of the algorithm is different. Generally, it focuses more on matching and requires global motion estimation and compensation of the image. Because when the target and the background are moving at the same time, it is impossible to simply judge based on the movement. There are also many moving target detection algorithms in the moving background, such as block matching and optical flow estimation

2.1. Target detection in static background

2.1.1. Background difference method

The background difference method is a general method for motion segmentation of still scenes. It performs a difference operation between the currently acquired image frame and the background image to obtain the gray image of the target motion area, and threshold the gray image to extract the motion area. And in order to avoid the influence of environmental lighting changes, the background image is updated according to the currently acquired image frame. According to foreground detection, background maintenance and post-processing methods, there are several different background difference methods

2.1.2. Inter-frame difference method

If the number of subtracted two frames of images is the kth frame and the (k+1)th frame respectively, the frame images are the inter-frame difference method, which is two images that are two adjacent frames or a few frames apart in the video stream. The pixel value is subtracted, and the subtracted image is thresholded to extract the motion area in the image. If the number of subtracted two frames of images is the kth frame and the (k+1)th frame, the frame images are respectively:

$$f_k(x,y),\ f_{k+1}(x,y) \tag{2.1}$$

The difference image binarization threshold is T, and the difference image is represented by D(x, y), and the formula of the inter-frame difference method is as follows:

$$D(x,y)=\begin{cases}1, |\ f_k(x,y),\ f_{k+1}(x,y)\ | > T \\ 0, others\end{cases} \tag{2.2}$$

2.2. Target detection in dynamic background Optical flow estimation

The optical flow field method is a detection and segmentation method based on the estimation of optical flow. The optical flow includes not only the motion information of the observed object, but also related structural information. The discontinuity of the optical flow field can be used to segment the image into regions corresponding to different moving objects. However, the calculation of most optical flow methods is complicated and time-consuming, and it is difficult to meet the needs of real-time monitoring.

3. Target Tracking

Target tracking is an important issue in the field of computer vision. It is currently widely used in sports event broadcasting, security monitoring, drones, unmanned vehicles, robots and other fields. Simply put, target tracking is to establish the position relationship of the object to be tracked in a continuous video sequence to obtain a complete trajectory of the object.

3.1. KCF target tracking algorithm

KCF is a discriminative tracking method. This type of method generally trains a target detector during the tracking process, uses the target detector to detect whether the predicted position of the next frame is the target, and then uses the new detection results to update the training set Then update the target detector. When training the target detector, the target area is generally selected as a positive sample, and the surrounding area of the target is a negative sample. Of course, the area closer to the target is more likely to be a positive sample.

3.2. KCF's main contribution

(1) Use the circulant matrix in the area around the target to collect positive and negative samples, use ridge regression to train the target detector, and successfully use the diagonalization property of the circulant matrix in Fourier space to convert the operation of the matrix into the Hadamad product of the vector , That is, the dot product of the elements, greatly reduces the amount of calculation, increases the calculation speed, and enables the algorithm to meet the real-time requirements. A tracking method based on the fusion measurement method of depth feature and scale adaptive KCF.

(2) The ridge regression of the linear space is mapped to the nonlinear space through the kernel function, and a dual problem and some common constraints are solved in the nonlinear space. Similarly, the diagonalization of the circulant matrix Fourier space can be used to simplify the calculation.

(3) A way to integrate multi-channel data into the algorithm is given.

3.3. KCF target tracking algorithm principle

3.3.1. One-dimensional ridge regression

Set the training sample set($x_{i,}y_i$), Then its linear regression function $f(x_i)=w^T x_i$, w Is the column vector representing the weight coefficient. Can be solved by least squares method:

$$\min_w \sum_i (f(x_k(x,y),_i)-y_i)^2+\lambda \| w\|^2 \tag{3.1}$$

Among them, λ is used to control the structural complexity of the system, that is, the VC dimension to ensure the generalization performance of the classifier. Tracking algorithms are generally more complicated in order to ensure accuracy.

Where X =$[x_1, x_2, \cdots\ x_n]^T$ each row represents a vector, y is a column vector, and each element corresponds to the label of a sample, so the derivative is 0, which can be obtained:

$w=(x^T x+\lambda \mathrm{I})^{-1} x^T \mathrm{y}$.

All the training samples in KCF are obtained by cyclic displacement of the target sample, and the cycle of the vector can be obtained by permutation matrix, such as:

$$w=(x^T x+\lambda I)^{-1} x^T y \tag{3.2}$$

$$x=\begin{bmatrix} x_1, & x_2, & \dots & x_n \end{bmatrix}^T \tag{3.3}$$

$$p=\begin{bmatrix} 0 & 0 & \dots & 0 & 1 \\ 1 & 0 & \dots & 0 & 0 \\ 0 & 1 & \dots & 0 & 0 \\ & & \vdots & & \\ 0 & 0 & \dots & 1 & 0 \end{bmatrix} \tag{3.4}$$

$$P_x=\left[x_n, \quad x_1, \quad x_2 \quad \cdots \quad x_{n-1}\right]^T \tag{3.5}$$

3.3.2. Ridge Return of Nuclear Space

We hope to find a non-linear mapping function column vector to make the mapped sample linearly separable in the new space, then ridge regression can be used to find a classifier in the new space $f(x_i)=w^T\phi(x_i)$,so the weight coefficient obtained at this time is:

$$\min_{w}\sum_{i}(f(x_i)\text{-}y_i)\frac{x\text{-}\mu}{\sigma}w+\lambda\|w\|^2 \tag{3.6}$$

$$\alpha=\min_{\alpha}\|f(X)f(X)^T\alpha\text{-}y\|^2+\lambda\|f(X)^T\alpha\|^2 \tag{3.7}$$

$$\alpha^*=(K+\lambda I)^{-1}y \tag{3.8}$$

$$f(z)=w^Tf(z)=\alpha^Tf(x)f(z) \tag{3.9}$$

w Is $\phi(X)=[\phi(x_1), \quad \phi(x_2), \quad \cdots, \quad \phi(x_n)]^T$ a vector in the space formed by the row vector, so we can make $w=\sum_i \alpha_i\phi(x_i)$ becomes $\alpha=\min_{\alpha}\|\phi(X)\phi(X)^T\alpha-y\|^2+\lambda\|\phi(X)^T\alpha\|^2$.

For the kernel method, we generally do not know the specific form of the nonlinear mapping function $\phi(x)$, but only the kernel matrix in the kernel space $\phi(x)\phi(x)^T$. Then we let denote the kernel matrix in the kernel space, which is obtained by the kernel function, then $\phi(x)\phi(x)^T$,get:

$$\alpha^*=(K+\lambda I)^{-1}y \tag{3.10}$$

3.3.3. Quick check

First, the detector is trained by training samples and labels. The training set is composed of the target area and several samples obtained from its displacement. The corresponding labels are assigned according to the criterion that the closer the distance, the greater the probability of the positive sample. Then you can getα. The sample set to be classified, that is, the sample set to be detected, is the sample set obtained from the prediction area and its shift $z_i=p^jz$. Then you can choose $f(z_i)=\alpha^T\phi(X)\phi(z_j)$. The largest sample is used as the new target area detected, and the position of z_i the target is judged. Then the sampling window will generate mn sample by shifting, whether it is a training sample or a test sample, so K^z must be a square matrix. So get the response of each test sample:

$$f(z)=(\alpha^T\phi(X)\phi(z)^T)^T=(K^z)^T\alpha=F^{-1}(f) \tag{3.11}$$

$$f(z)=Fdiag(K^{xz})F^H\alpha \tag{3.12}$$

$$f=(K^{xz})^*\alpha \tag{3.13}$$

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4. KCF algorithm overall control flow

4.1. Nuclear correlation filter tracking algorithm

Flow chart of the nuclear correlation filter tracking algorithm Acknowledgements Natural Science Foundation:

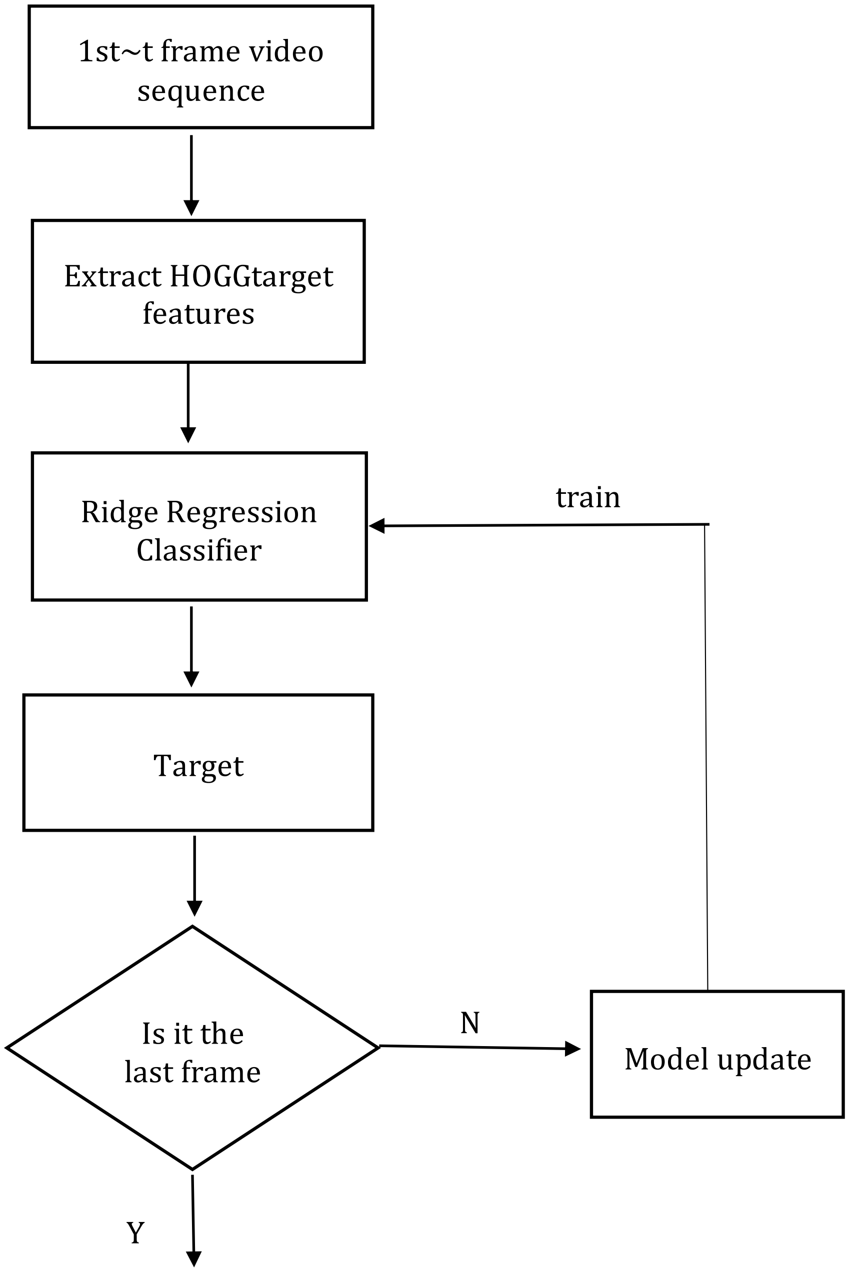

Figure 1 Nuclear correlation filter tracking algorithm flowchart

4.2. KCF tracking algorithm overall process

The algorithm will make a preliminary judgment on the content of the collected video, whether there are moving objects in the video. If it is judged that there is a moving object, the system will detect and lock the moving target. After the lock is successful, the system will track the target. If the preliminary judgment is that there is no moving target, the system will not work..

After the moving target appears in the video image, the morphological expansion and erosion are performed first to extract the foreground:

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Figure 2 Foreground extraction dynamic target detection

It can be seen from Figure 4 that after a dynamic target appears in front of the camera, the algorithm extracts the center position of the dynamic daily mark shape.

According to the center coordinates of the dynamic target, draw a frame, start the KCF target tracking algorithm, and enter the target detection and tracking link.

Figure 3 KCF target detection and tracking

5. Concluding remarks

This paper designs and implements a moving object tracking algorithm that combines moving target detection and KCF target detection and tracking. The algorithm uses moving target detection as a tenne rigger condition to trigger the back-end KCF target tracking algorithm to track moving objects, Target detection and tracking are extremely important in the field of computer vision, compared to traditional motion Target detection camera algorithm, this algorithm has great advantages in target tracking, and the target tracking algorithm in machine vision needs to specify the tracking target in the early stage. The algorithm uses moving object detection as the trigger condition to make the tracker directly track the moving object. For security monitoring and other industries, this algorithm has great application potential.

Various interferences will appear in the process of the target, which will affect the tracking accuracy. To improve tracking accuracy, it is necessary to choose a suitable target detection and tracking algorithm. The detection method, feature extraction method and tracking algorithm proposed in this paper have all been improved to a certain extent, which can achieve the ideal tracking effect. However, the distributed multi-camera shooting method proposed in this article in moving target tracking is costly, and the stability of the algorithm needs to be improved, and further research is needed.

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