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A Rapid Target Tracking Algorithm Based on Template Match for Monitoring Image in Coal Mine

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Abstract: In order to improve the tracking speed and the precision of the moving target of the monitoring image in the coal mine, a fast template matching target tracking method has been proposed. According to the relationship of the time and space constraints in the target tracking process, the Kalman filter has been used to predict so as to obtain the initial search point frame, the searching strategy of adaptive step length and forecast has been used, it adjust the scope and the step size of the searching area which use the update mechanism in the template to guarantee the real-time of the information, it could reduce the amount of calculation for the template matching process. Experimental results show that the tracking velocity and the tracking precision of the moving object in video undergrounded has been improved in the coal mine complex condition.

Key words: Target tracking, template matching, kalam smoothing, adaptive step length

INTRODUCTION

It is very important to monitor and track the moving targets in intelligent monitoring information systems. By using the known target template matching in the area of the image to search arithmetic, template matching method could find the target position in the image region, so this method is easy to implement and with high precision (Huang *et al*., 2006; Gao *et al*., 2008).

In the actual detection and tracking, this method is full of attention. Normalized Cross-correlation (NCC) has high precision in tracking, good anti-interference and robustness. NCC is suitable for the objects' detection and tracking of whose background is relatively complex and average gray level have take place great changes. The template matching similarity metric function is improved, so it could get a fast correlation matching criteria (Chen and Chen, 2011); Chen propose a matching method based on gray level statistics and enhance the matching speed greatly (Chen and Ma, 2009; Zhang and Song, 2006) used the template matching in high-speed target tracking and designed a cross template in order to improve the matching speed (Chen and Ma, 2009); it used the template matching algorithm based on correlation matching and updated template in target tracking (Huang *et al*., 2007; Ji and Zhang, 2008).

In tunnel of coal mine, the video monitoring information are not clear because the tunnel video is locate in complicated background and more interference scene, the uneven illumination distribution would affect the target detection and tracking correctly. So it puts forward higher requirements about the reliability and real-time performance of the moving target detection and tracking. The traditional method could not suit for the requirements of coal mine.

As a result of down hole video quality is poorer, uneven distribution of light and background is complex, this paper puts forward an improved NCC template matching algorithm, according to the relationship between time and space constraints in the process of target tracking, we reduce the amount of calculation in the process of template matching and enhance the accuracy and stability of the tracking process by using the search strategy of adaptive step length and forecasting by using the template update mechanism.

TEMPLATE MATCHING PRINCIPLE

Template matching is a process that can search the most similar area with the target template in the image which will be matched and the target template is a known small image. The traditional template matching algorithm is translation the target template Point by point, it traverses every position and measures algorithm according to the similarity and calculate the correlation coefficient of the sub-band image and the template image

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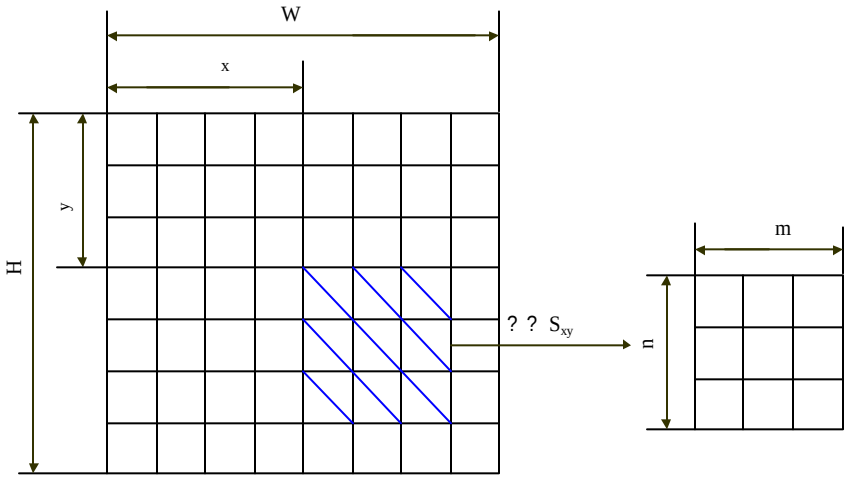

Fig. 1: The image and template T

of the location point and determine the target location in accordance with the size of the correlation coefficient. The template matching principle is shown in Fig. 1.

The template matching algorithm is globally search on the whole image, it tracking a high accuracy, but as increase the image number, calculate the amount of increase, tracking speed becomes slower, it cannot satisfy the requirement of real-time (Tang and Li, 2010). The researchers try to reduce a certain accuracy within the acceptable range and looking for other methods to improve the matching speed.

A FAST TEMPLATE MATCHING ALGORITHM

The template matching similarity calculation method adopted in this text is the Normalized Cross-correlation method (NCC), the calculated to the sub-graph areas and the similarity of the template of figure1is shown:

$$R(x,y)=\frac{\sum_{i=1}^{m}\sum_{j=1}^{n} f(x+i,y+j)T(i,j)}{\sqrt{\sum_{i=1}^{m}\sum_{j=1}^{n} f^2(x+i,y+j)\sum_{i=1}^{m}\sum_{j=1}^{n} T^2(i,j)}} \quad (1)$$

T is the template image, F is the target real-time image.

In order to speed up the matching, we select the initial search point by means of prediction method, we use the search strategies that are adaptive adjustment of the search step length and set the search direction and speed up the search. In order to ensure the accuracy of the tracking, we join the template update mechanism. In this paper, the overall flow chart of the algorithm is shown in Fig. 2.

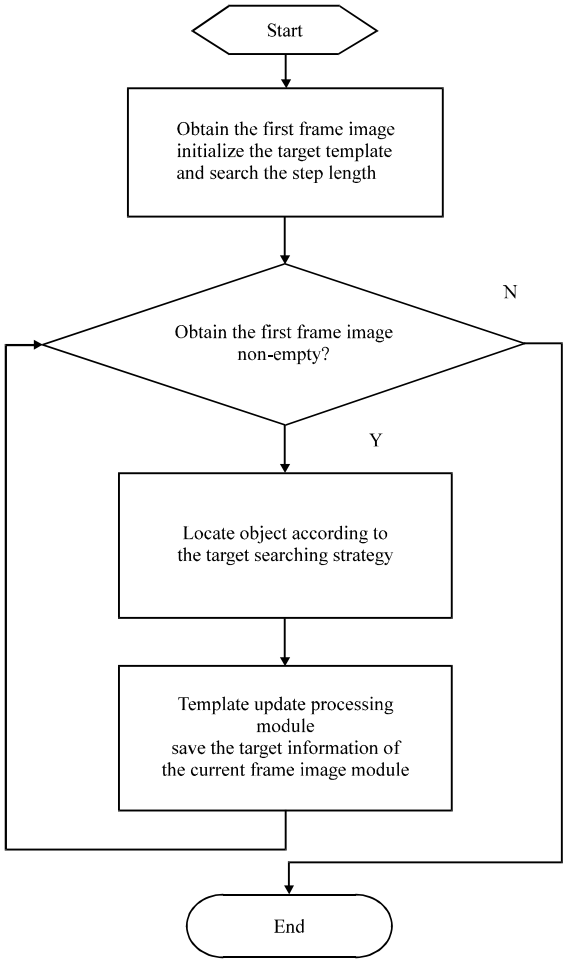

Fig. 2: The process of the fast template matching algorithm

The choice of initial search point: The target information is changed between each frame, but the continuous frames move slowly and the shape changes rarely, we can use the front frame of target information for the next frame to provide a reasonable initial search point information based on this assumption and prepare the way for the further target. In addition, the target may disappear in the field of view due to a temporary block in a movement, hence we must make a prediction to the target location to ensure the continuous tracking.

The adjustment of the hunting zone and the step length: On account of the sampling time of video is short (Such as 29 frames/sec), therefore the target position between adjacent frames should change within the scope of a certain range, in order to reduce the amount of calculation, we shrink the scope of the search area, search target at the initial point of the local area, rather than having to search in the whole image. In the process of searching target, we need to adjust step length by self-adapting. If the match degree is superior, we shrink the step to find a best match point; or else we increase the step to ensure to find the target quickly. We will represent the determination of the search direction in the next section.

Sets the initial size of local area is F_0 and the upper limit of range of the area is the whole image, set the initial value of step is S_0, the upper limit value of step is S_1; the lower limit value of similarity is T_0, the adjustment strategy of search area and step length is as follows:

- It search the target in a S_0 searching step length within an F_0 initial searching point area, if the similarity between the result and the template is $T>T_0$, then we considered it contain the target in this area without adjusting the size of the local area. In this case, narrowing the step length for half of their original cost and continue to search when the current target is the centre and the step length is two times to seek better goals
- If $T<T_0$, we don not think the target is in the area. Now we keep on searching the target and calculating the similarity in a larger range until meet $T>T_0$, then we restore the range F of local area and the step length S to the initial value, repeat the operation in (1)
- If in $T<T_0$ case, it still cannot meet the condition for $T>T_0$ goal after enlarging the local area image increases to the whole image and searching in the initial step and calculating the similarity T, then we should consider that it exist occlusion or the target condition disappear, on which condition we could use the predicted value as the aim of the current frame image, keep on target tracking to the next frame of image

The setting for the direction of motion. There is a process that monitor a goal is move repeated on a certain track in the mine coal monitoring video, therefore we could determine the search direction through fitting trajectory from the information which has been tracking in the tracking procedure, in combined with adjustment of searching step above consequently speed up the searching process.

And the particular way is: As the initial searching of the video is searching along the x direction and y direction at the same time and it use the least square method to fit the target trajectory by making use of the target location information. If the fitting changes little between the consecutive frames, then we search target along the fitting movement direction, or else we should continue search along the x and y.

Template update: This text updates the template according to the level of similarity between the template image and the clip box. When the similarity of the target and the template greater than the setting threshold value, we update the template with the current target and the original template, or we do not update the template. We always do experiment to gain the threshold value.

Set the threshold of the template update similarity for T_1, the update strategy as follows: When the similarity between the real-time target and the template greater than the threshold, $T>T_1$, we consider that tracking is normal and the target information is better and can be used to update the template. The update formula is:

$$Mt = (1-)M_{t-1}+O_t \quad (2)$$

From Eq. 2, Mt is the updated template, M_{t-1} is the template before update; On the matching sub-graph of current frame; α is the weighting coefficient which can be confirm in accordance with the change scope of the similarity. If the similarity is lower than the threshold, $T \leq T_1$,the current tracking target information is likely to be sheltered, it cannot be use to update the template information.

This kind of adjusting method to template can overcome the influence of the gradual changes of target image and sudden changes on the tracking process and make sure the continuous tracking.

ALGORITHM STEPS

According to the above theoretical analysis, this algorithm can improve the speed of target tracking, the specific algorithm steps are as follows:

- **Step 1:** Initialization the template M_0, target position (x_c, y_c), the step length S_0, local search area of the initial scope F_0, similarity of lower limit T_0, the size of the image for Q
- **Step 2:** For video image sequence and assign a target in the current frame position potential (x_0, y_0), set the goal of the current frame position (x_t, y_t), according to the (2) to calculate the similarity coefficient of T (x_0, y_0)
- **Step 3:** Along the search direction in the area of the search point position (x, y), T (x, y)
- **Step 4:** If T (x, y)>T (x_0, y_0), the (x_0, y_0) please (x, y), turn to step 3
- **Step 5:** If T (x_0, y_0)<T_0, if increase the search range of F<Q, step length S =, turn to step 3; If F>Q, the target disappear (x_t, y_t) please (x_0, y_0)
- **Step 6:** If T (x_0, y_0)>T_0, if S = S_0, then the search area for 2 times S rectangular area, half step to step 3. If S indicates S_0, (x_t, y_t) please (x_0, y_0), if T (x_1, y_1)>T_1, according to the type (1) update the template, S = S_0.
- **Step 7:** (x_c, y_c) and have access to (x_t, y_t) trajectory fitting, if two adjacent frames fitting trajectory are basically the same, is to set the search direction to the direction of the movement Step 2

PERFORMANCE SIMULATIONS

Use VS2008 experiment platform, selection of underground scene surveillance video, kumite anchor repetitive motion detection and tracking. Evaluation index by the frame of the image tracking speed and tracking precision, tracking speed of tracking the time required for each frame and deal with the average time of the whole video, tracking precision is through the results of all the frame image tag targets after judgment.

Figure 3 is to use the target tracking method is proposed to deal with video after the search, the black rectangular box used to tag matching target anchor, figure (a), (b), (c) and (d) are respectively the 0, 900th, 1400th and 4400th frames tracking matching figure.

Table 1 and 2 shows the track of video information processing speed and tracking accuracy. The experimental results show that even in the case of target from outside interference, such as light intensity changes, the method of variable template could be used to effectively solve the problem of traditional template matching target change. This method is simple in process, tracking speed has increased significantly, but also can complete with a small amount of movement target tracking

Fig. 3(a-d): Play anchor underground video images and tracking results (a) The 0 frame (b) The 900th frame (c) The 1400th frame and (d) The 4400th frame

Table 1:Video image tracking time (s)

Tracking method	The 0 frame	The 900th frame	The 1400th frame	The 4400th frame
Improved method	0.063	0.031	0.078	1.016
Traditional method	0.078	0.878	0.194	1.414

Table 2:Video image tracking performance

Tracking method	Average tracking time per frame (s)	Tracking accuracy (%)	The counting accuracy (%)
Improved method	0.2392	95.40	96.07
Traditional method	0.7685	94.49	95.62

under shade, to a certain extent to ensure the stability of the tracking system.

CONCLUSION

Improved template matching target tracking algorithm is a method of fast track the target. Through to the goal of initial search point prediction, the adjustment of the scope of the search area, the application of adaptive step and update mechanism of the template Settings, accelerated the speed of the target tracking and can guarantee the tracking accuracy. The simulation results show that this algorithm under the premise of the tracking accuracy is not affected, greatly improve the tracking speed. In the field of target size, shape, will have corresponding change, in the process of identifying the size of the template and the change of the Angle to make real-time correction, image sequences to complete the continuous identification and continuous tracking of moving targets, so fast template matching target tracking method is scientific and feasible, meet in the coal mine safety production monitoring of intelligent information processing requirements.

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