Target Detection Algorithm Based on Region Segmentation in Moving Background

Shanqiu Zhang [a], Jianhua Yang [b] and Wei Lu [c]

School of Dalian University of Technology, Dalian 10141, China

[a]zhangshanqiu@163.com, [b]jianhuay@dlut.edu.cn, [c]luwei@dlut.edu.cn

Abstract. A new method of target detection based on region segmentation was proposed for the problem of reciprocating pumps and other disturbances for segmenting moving foreground. In this method, the background region is segmented by means of mean and variance, and divided into static background area and dynamic background area, and the target detection algorithm is used to identify the two different target detection algorithms. Three frame difference algorithm is used for target detection in the static background area, and the interference of the reciprocating motion of the pump is eliminated. In the dynamic background region, an improved codebook algorithm based on gray level image was used to target recognition. The simulation results show that the method has very good practicability, which greatly reduces the false detection rate, and the algorithm meets the requirement of accurate target identification in the mining field of coalbed gas in real-time, accuracy etc.

Keywords: Coal Bed Methane extraction; Regular reciprocating motion; Region segmentation; CodeBook; Update background.

1. Introduction

Moving object detection is one of the research topics in computer vision, mainly refers to the extraction of target of interest from the video sequences, the target for identification, separation and tracing of processing, so as to achieve the separation of foreground and background, accurate identification of target motion. With the development of intelligent video surveillance system in recent years, moving target detection algorithm as the core part of intelligent video surveillance system has been widely studied.

The target detection algorithm studied in this paper is mainly aimed at the anomaly monitoring of the coal bed gas [1] acquisition field. The ability to accurately and quickly identify the moving object from the video sequence is the key and basic of a typical monitoring system. The traditional segmentation foreground and background mainly has inter frame difference method [2], background subtraction method [3] and non-parametric kernel density algorithm [4]. And as the traditional algorithm of moving object detection, background subtraction is widely used and developed in recent years. The background difference method includes: the establishment of the background model, the recognition of the moving foreground and the updating of the background model. And the accurate establishment of the background model is the guarantee of the accuracy of moving object recognition. At present, the main background modeling methods include: background statistical model [5], codebook background model [6], single Gauss background model [7], mixed Gauss background model [8], etc. Different background modeling methods have different effects on different application scenarios. For certain scenarios, it is particularly important to choose a suitable background modeling method. Single Gauss background modeling is firstly proposed by Wren [7], which usually has good effect on the single mode condition of static background. It assumes that each background image in the background image corresponds to a Gauss distribution, to create a single Gauss model for each pixel according to this. Due to the complexity of the field environment and the presence of noise, the method is not applicable to the complex scene of the scene. Therefore, Stauffer [8] proposed a hybrid Gauss model modeling method, which generally requires the definition of 3 ~ 5 the Gauss function with weight to represent the pixel value of each pixel. Therefore the method compared with single Gaussian background modeling method has better ability to adapt to the environment, more suitable for multi-modal scene, but the initial stage of the method needs to assume the parameters, the calculation is relatively large, the processing speed relatively slow, so it does not meet the

requirements of the actual field application of higher real-time. The codebook algorithm is proposed by Kim [6], which uses the standard of quantization clustering, and carries on the background modeling to each corresponding pixel point of a series of image sequence frames. Codebook algorithm establishes a CodeBook (CB) structure for the current image of each pixel, each CodeBook structure is composed of a number of CodeWord (CW). The form of CB and CW is as follows:

$$CB = \{CW1, CW2, \ldots, CWn, t\}$$

$$CW = \{FHigh, FLow, Max, Min, t_{last}, stale\} \quad (1)$$

Where n is the number of CW contained in a CB, when n is too small, it will degenerate into a simple background, when n is larger, the complex background can be modeled: t is the number of CB updates. CW is a 6 tuple, in which FHigh and FLow are used as the upper and lower bounds of the update on learning and the maximum and minimum values of the current pixel are recorded by Max and Min. The last update of the time t_last and old time stale (record how long the CW did not be accessed) is rarely used to remove the use of CodeWord. CodeBook algorithm to detect the moving target of the process as follows:

(1) Select a frame to multi frame using the update algorithm to establish the CodeBook background model;

(2) According to the method mentioned above, the foreground (moving target) is detected;

(3) Update the CodeBook model with the update algorithm regular intervals, and time filtering for CodeBook;

(4) If the test continues, turn (2), or the end.

CodeBook algorithm is applied to the multi-modal background, the original algorithm uses the RGB space image, the image information is more, and the amount of computation is relatively large.

2. Target detection algorithm based on region segmentation

2.1 Background model based on region segmentation

In this paper, the main difficulty of the motion detection algorithm is to eliminate the influence of the periodic reciprocating motion of the pumping unit under the fixed scenes. In other words, the reciprocating motion of the pumping unit can easily be detected as a motion foreground, which can cause false alarm, send out the alarm information, and affect the accuracy of the system. At the same time, the algorithm of this paper will be applied to the wireless monitoring field of coal bed gas collection, so the accuracy of motion detection is relatively strict. In order to solve this problem, this paper puts forward an algorithm based on the background model in the field of the field. The main steps of region segmentation are:

(1) Quantify the acquisition of the first N frame video image sequence , where each frame of image interval St image, and count the pixels of each pixel on the time axis of the information;

(2) The mean and variance of each pixel in the time axis are calculated;

(3) The variance of each pixel is compared with the threshold, and the static background and dynamic background are extracted;

(4) Separate the static background and dynamic background and the static background and dynamic background are obtained.

Figure.1 segmentation and recognition of background region

The image above is the result of region segmentation, and accurately identify the dynamic background region including the regular movement of pumping unit. Then the dynamic background region is separated from the static background region, which provides the guarantee for the accurate identification of the next target detection.

2.2 Motion foreground recognition in static region

Different background models are established according to the dynamic background region and the static background region.

Static background area is relatively simple, there is no complex motion disturbance, so this paper uses three frame difference method to detect moving foreground. The main steps are as follows:

(1) For the collection of 3 consecutive frames of video image sequence to quantify, where each frame of image interval St Frame image;

(2) Motion detection using the following formula:

$$\begin{cases} d(x,y,t) = |F(x,y,t) - F(x,y,t-1)| \\ d(x,t,t+1) = |F(x,y,t+1) - F(x,y,t)| \end{cases} \quad (2)$$

Where F (x, y, t) represents the pixel value of the pixel (x, y) of the pixel value of the gray image in the t moments, d (x, y, t) represents the difference between the pixel value of the gray level image of the two adjacent frames.

$$\mathrm{D(x,y,t)} = \begin{cases} 255 & d(x,y,t) \geq Tt \\ 0 & d(x,y,t) < Tt \end{cases} \quad (3)$$

Tt is the threshold value of the image in t time. For threshold selection, the paper adopts an adaptive threshold, due to the actual scene, the brightness of the scene is gradual. Therefore, this paper uses the mode that average gray value of image is calculated every 5 minutes, and according to the field measurement, the average gray value weighted as threshold at this time:

$$\mathrm{Tt} = \mathrm{w} * \mathrm{ad(t)} \quad (4)$$

Where w is a weighted value, and the ad (t) is the average gray value of the image in the t time. Then the two binary images and by phase:

$$\begin{cases} b(x,y,t) = D(x,y,t) \,\&\, D(x,y,t-1) \\ b(x,y,t+1) = D(x,y,t+1) \,\&\, D(x,y,t) \end{cases} \quad (5)$$

2.3 Motion foreground recognition in static region.

Dynamic background region is relatively complex, mainly contains the motion of pumping unit, so this paper uses the improved simplified codebook algorithm to establish the background model of the region. Different from the traditional codebook, the improved codebook algorithm used in this paper is based on the gray space, the gray image processing, relatively simple, the amount of computation is smaller, and the main steps are as follows:

(1) Quantify the acquisition of the first N frame video image sequence , where each frame of image interval St image, and count the pixels of each pixel on the time axis of the information ;

(2) Record the different values of each pixel in the time axis;

(3) According to the change of the value of each pixel in the time axis, the background database is set up, that is, the algorithm establishes a BGL structure for each pixel of the current image:

$$BGL = \{bg1, bg2, bg3, \ldots, bgn\} \quad (6)$$

(4) Make the difference calculation between the current pixel and the pixels of background database, as long as there is a difference is less than the threshold value that is determined as the background point, then turn to 5, it is the foreground point if all the difference is greater than the threshold;

(5) Background update. Update background with the adaptive background update strategy. When a pixel is judged as the background, the following formula [6] is updated:

$$p(x,y,0) = \alpha * p(x,y,0) + (1-\alpha) * p(x,y,t) \quad (7)$$

Where $\mathrm{p(x,y,t)}$ is the value of current pixel and $\mathrm{p(x,y,0)}$ is the pixel of the background database which their values are closest. The α is the learning rate.

3. Experimental results and analysis

Figure.2 The original image

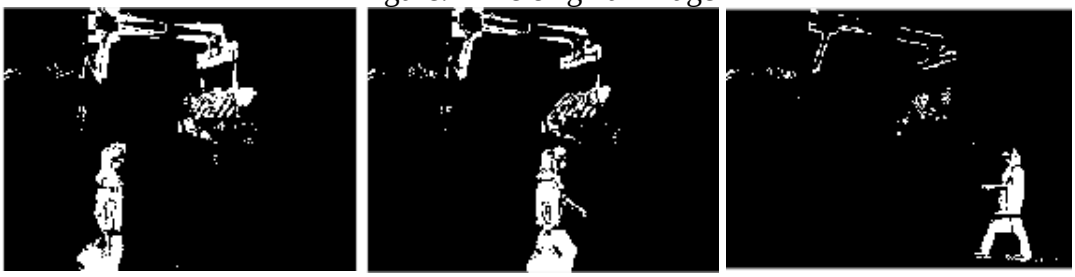

Figure.3 Motion detection of single Gauss algorithm

Figure.4 Motion detection results of mixed Gauss algorithm

Figure.5 The preliminary motion detection results of the algorithm

Figure.6 Further processing results of the algorithm presented in this paper

Figure 2 is the original image. Figure 3 is single Gaussian background modeling method in dealing with image, Figure 4 is Gaussian mixture modeling method in dealing with image , Figure 5 is the algorithm after the initial processing of image, Figure 6 is the image showed in Figure 5 after open operation.

Table 1 Comparison of the results of different algorithms

Algorithm	Resolution	Training time/s	Identifying time/s
GM algorithm	320×240	6.26	1.29
GMM algorithm	320×240	13.25	4.24
Algorithm in paper	320×240	8.64	0.86

Because the research goal of this algorithm is related to the speed of reciprocating motion of pump, therefore, the time used in above table is corresponded to this training sample. The specific application needs to adjust the training sample size according to the reciprocating speed of the pumping unit under different scenarios. In this paper, the time used by the algorithm to detect including used for static region detection and dynamic area detection, in the absence of moving objects, the static region detection is about 60ms per frame. In the case of a moving target, the time consuming will increase, and the average time per frame is about 110ms.

4. Summary

In this paper, we propose a target detection algorithm based on region segmentation, the algorithm firstly uses the mean and variance method to divide the background of the periodic reciprocating motion of the pump into the background of the dynamic background area and the static background area. Then the algorithm is divided into three frame difference method and improved simplified codebook algorithm according to the different regions. Through the background segmentation, effectively eliminate the interference of the pump periodic reciprocating motion of moving object extraction, improves the accuracy of target detection. The algorithm which is proposed in this paper is suitable for moving target detection with regular moving background. Moreover, the algorithm has a short operation time, meets the requirements of real-time monitoring, and has good practicability, which lays the foundation for further video surveillance.

Acknowledgements

This work was financially supported by Major National Science and Technology Programs of China in the "Twelfth Five-Year" Plan period (2011ZX05039).

References

[1]. CUI L, SUN J, HU Z, et al. Coal bed methane extraction significance and theory analysis, J. Science and Technology Innovation Herald. 22(2009) 120-120.

[2]. Lipton A J, Fujiyoshi H, Patil R S. Moving target classification and tracking from real-time video, C. IEEE Workshop on Applications of Computer Vision. 1998: 129-136.

[3]. ARSENEAU S, COOPERSTOCK J R. Real-time image segmentation for action recognition, C. IEEE Pacific Rim Conference on Communications, Computers and Signal Processing. 1999: 86-89.

[4]. Elgammal A, Duraiswami R, Hanvood D, et al. Non-parametric model for background subtraction, M. Computer Vision-ECCV, 2000, 1843: 751-767.

[5]. Horprasert T, Harwood D, Davis L S. A statistical approach for real-time robust background subtraction and shadow detection, C. IEEE International Conference on Computer Vision Frame-Rate Workshop, 1999: 1-19.

[6]. K. Kim, T. H. Chalidabhongse, D. Harwood and L. Davis, Real-time foreground–background segmentation using codebook model, C. Real-time Imaging, 2005, 11(3): 172-185.

[7]. Wren C, Azarbayejani A, Darrell T, et al. Pfinder: real-time tracking of the human body, C. IEEE Transactions on Pattern Analysis and Machine Intelligence, 1996,19(7): 780—785.

[8]. STAUFFER C, GRIMSON W E L. Adaptive background mixture models for real-time tracking, C. Proceedings of the 1999 IEEE Computer Society Conference on Computer Vision and Pattern Recognition. 2007, 2:2246.