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Research and restoration technology of video motion target detection based on kernel method

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ABSTRACT

In recent years, due to the video surveillance applications more and more widely, people are not satisfied with the goal of monitoring, and the video monitoring technology of intelligent video moving object detection and tracking technology has received extensive attention. The research work in this paper is in the field, the moving target detection spatiotemporal correlation and difference contour tracking algorithm based on a fixed background. The algorithm in the background under the condition of fixed to pay a smaller time complexity, the target detection and tracking has a good effect, so it has higher application value. In this paper, the prospect of caused motion detection of occlusion background foreground correlation problem, put forward the video moving object detection method based on kernel independent component analysis, canonical correlation to minimize the component in the high dimensional feature space in order to separate the foreground nuclear background. Independent component analysis assumes that the foreground and background independent, avoid the correlation problem. The two objective functions based on Kernel Independent Component Analysis: analysis of kernel independent component analysis based on kernel canonical component (KCCA) and kernel independent component analysis (KGV) based on the generalized variance. KCCA is the application of canonical correlation analysis in the kernel method, discuss is the first canonical correlation separation component of high dimensional map, and KGV are typical correlation between the components in the high dimensional space of the whole spectrum. Both KCCA and KGV improved the accuracy of motion detection.

KEYWORDS

Moving object; Kernel method; Active; Pattern recognition; Image features.

INTRODUCTION

With the development of technology and society, information has become more and more diversified and complicated, artificial intelligence and human-computer communication application demand is gradually increasing[1]. The main purpose of the artificial intelligence research is a complex work so that the machine can do some human intelligence needed to complete[2]. Computer vision is a kind of can let the computer simulation of human vision mechanism to obtain the ability of information processing technology, further said, refers to the use of cameras and computer to replace human eyes detection, recognition, tracking the target, such as fingerprint recognition, face recognition, retina recognition, palm-print recognition, and further image processing[3].

The detection and tracking of video moving object is a key topic in the field of computer vision, the underlying technology is the key of intelligent video surveillance system[4]. Video moving object detection and tracking is the video image signal by using visible light image sensor or infrared heat, low light level imaging sensor intake of moving target, the corresponding digital image processing, detection, extraction of moving objects in video target tracking, and then based on the technology of image feature of targets[5]. Detection and tracking of moving object in the two processes are closely related, the detection is the basis of tracking, and the tracking is to obtain the target motion parameters, such as position, velocity and trajectory, thus for the following motion analysis, understand the behavior of moving objects and provide reliable data sources to complete the higher level mission, and provide help for moving target detection[6-8].

Video motion detection and pattern recognition is the basic content in the research of computer vision technology in. Video moving target detection is the separation of relative video background moving foreground objects from image sequences[9]. The moving target is detected will directly affect the computer vision target tracking and target identification analysis processing to achieve the effect, so the detection precision and robustness is crucial. In practical application, natural light, artificial light slow change, due to rapid changes in light intensity, the shadow of foreground and background color similar to the foreground object occlusion and background related issues will be on the moving target detection have a big impact, and these are must face detection method the challenge[10]. Introduction and analysis of the optical flow motion estimation method and block matching motion estimation for image motion parameters, and matching the search strategy based on the design of a new search strategy. This strategy is commonly used in the block motion estimation based on the center biased characteristic of motion vector distribution, and makes use of the characteristics of the idea of parallel processing and visual fovea, can effectively improve the matching speed, and at the same time to ensure the accuracy and reliability of matching results.

According to the number of input low resolution image, super resolution restoration method of video image can be divided into two categories: super resolution image reconstruction and single frame image blind restoration. If between a plurality of video image of the same target exist reciprocal motion (such as translation and rotation), then the image sequence contains similar but not exactly the same information. The image super-resolution reconstruction method can use these different but complementary information and prior information, restore the single high-resolution image from a series of low resolution images. The advantages of this method are in addition to using prior information and image object information, but also make full use of the complementary information of different images. But can not satisfy the multi frame image sequence super resolution processing requirements, single image blind restoration has become an effective means. This kind of method of fuzzy function in the image is difficult to determine the circumstances, to extract information from the image degradation, according to degradation of information to select the appropriate image restoration method, and then recover the high resolution image of the ideal[11].

Nuclear methods can be the original sample data are mapped to a high dimensional feature space and is infinite dimensional, such as radial basis kernel function is the inner product of infinite

dimensional linear mapping[12]. Dimension but need characteristic matrix processing in the operation process is just the number of training samples. That is to say, the kernel method will transform the original data into a high dimensional feature space, but does not need to solve directly in the high dimension space problem, the solution space is only one dimension of the number of training samples. This is the key to the kernel method is a nonlinear method can solve the dimension disaster proble[13]. This paper mainly studies the fundamental theories and key technologies of extraction of video moving object detection and pattern recognition system characteristics, this paper proposes a video moving object detection algorithm based on kernel independent component analysis, the paper kernel independent component analysis and canonical correlation analysis in the feature space, and discusses two kinds of objective function, experiment simulation and moving target detection method for other comparisons, it proves that the algorithm has the advantages of better, the moving target detection algorithm based on independent component analysis.

VIDEO MOVING OBJECT DETECTION BASED ON KERNEL INDEPENDENT COMPONENT ANALYSIS

Kernel function and kernel method

At present the study on the kernel method is most main is the kernel parameter optimization. Types and corresponding kernel function parameter will have a direct impact on the kernel method in the practical application effect, blindly setting type and parameter can not get ideal effect. In practical application, with either type of kernel function, different parameter values are achieved in the kernel method will result in the different experimental results[14-15]. Therefore, many researches on the method selection of kernel function parameter or algorithms have been proposed, aimed at optimal performance of kernel methods. These methods and algorithms from different point of view the parameters selection, and the parameter selection using the objective function of each not same as the criterion in the process[16].

Let x, y∈X, X belong to the original space R, nonlinear mapping function input space mapping X to a high dimensional feature space F. x ∈R → Φ(x) ∈ F, F which belongs to R, n < < M. The kernel function can be expressed as X, nonlinear mapping of Y inner product form[17]:

$$k(x,y)=\left\langle \Phi(x),\Phi(y)\right\rangle \quad \textbf{(1)}$$

HS is a complete inner product space, the kernel Φ mapping to generate the input space of X space F can be expressed as:

$$F=span\{\Phi(x)\mid x\in X\} \quad \textbf{(2)}$$

The functional f ∈H, linear combination of arbitrary functional f can be expressed as basis functions to construct the H space:

$$f(\square)=\sum_{i=1}^{p}\alpha_i\Phi(x_i) \quad \textbf{(3)}$$

Assume that the input samples X={x1, x2, …, xn}, kernel function K corresponding to the Gram matrix one meet one of positive semi definite, then the kernel function for semi positive definite kernel. Meet the core function of positive semi definite Mercer for a nuclear.

$$K(x,x_i)=\left\langle x,x_i\right\rangle \quad \textbf{(4)}$$

$$K(x, x_i) = \left[\langle x, x_i \rangle + 1\right]^d \quad \textbf{(5)}$$

$$K(x, x_i) = \exp\{-\frac{|x - x_i|^2}{\sigma^2}\} \quad \textbf{(6)}$$

$$K(x, x_i) = \tanh[v\langle x, x_i \rangle + a] \quad \textbf{(7)}$$

Independent component analysis

Independent component analysis (ICA) is a statistical analysis method (Figure 1) based on the signal characteristics of higher-order, structure relationship among data[18], observed signal is decomposed into independent components. ICA to decompose the observed signal as a linear combination of a set of non Gauss signal independent of each other, the basic model can be expressed as:

X=A*S **(8)**

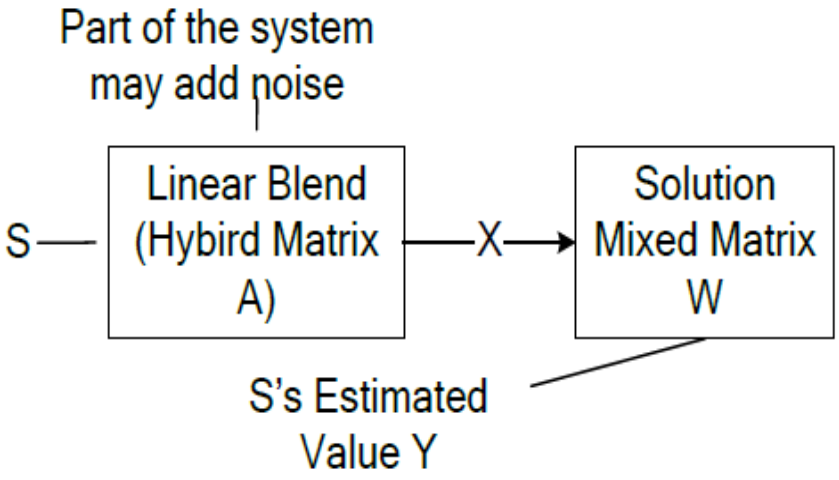

Figure 1: Independent component analysis (ICA) is a statistical analysis method

The X = [x1, x2, …, xn] ^{T} said N mixed signals observed, A is mixed moments of unknown source signals, is the need to solve. Mixed matrix A and source S can not be directly through the known mixed signal X obtained[19-21]. The goal of ICA is to find a separating mixed matrix W solutions statistically independent signals from X, Y is the estimation of the source signal S, expressed as:

Y = W*X =WAS **(9)**

TSS algorithm is the three step search algorithm, use Figure 2 to explain the three step search, the search window is set to the size of 9x9.'0'tag matching points, the same position, it is located in the reference frame of the first step, select the pixel labeled 0 and marked as nine point 1 is calculated and compared with the criterion function, the second step, to the best matching point in the first stage (represented by a circle a circle of 1) as the center, a choice of 8 labeled as 2 point to calculate the criterion function, and then in the next step, the new center to search point half the distance, in order to obtain better resolution, after three step calculation, get the final motion estimate.

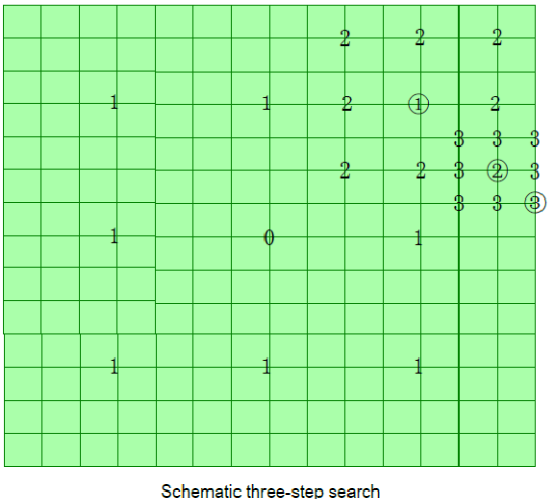

Figure 2: Schematic three-step search

Cross search (CS) algorithm is a more commonly used search methods, there are four search position at each step, they are (x) shape or (+) cross point shape, Figure 3 depicts the (+) figure ten cross search process, the numbers in the figure represent the corresponding search process in the search.

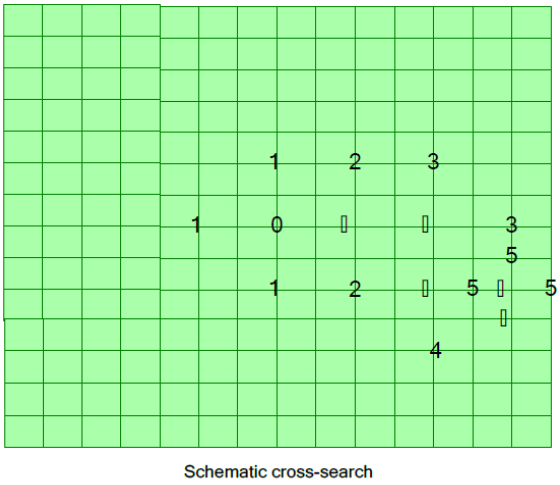

Figure 3: Schematic cross-search

Correlation analysis based on kernel canonical (KCCA)

The selection of kernel function, three kinds of methods commonly was used. One is the use of a priori knowledge of predefined kernel function; one is to use cross validation method, using different kernel function, summed up the minimum error is the best kernel function; another is the use of mixed kernel function method. In the kernel function used in the Gauss kernel function, wide application, it was decided to have good learning ability, both low dimensional, high dimension, small sample and large sample, Gauss kernel function can meet the classification basis functions, is an ideal.

In the feature space transform axis optimal minimum mean square error sense of ui (i=1,2,…, m) one of M is a linear combination of all the input samples in the feature space, that is to say, ui can be expressed as linear open of $\Phi(x1)$, $\Phi(x2)$, $\cdots$, $\Phi(xn)$:

$$\sum = \frac{1}{l}\sum_{i=1}^{l}\Phi(x_i)\Phi(x_i)^T \tag{10}$$

The unit transform axis representation for

$$u_i = \sum_{j=1}^{l} \beta_j^i \Phi(x_j) \tag{11}$$

From a practical point of view, the kernel method has the following defects: on the one hand because the feature vector space as a linear combination of all the training samples in high dimensional feature mapping, kernel method for feature extraction of a sample, compute kernel function between the sample and all training samples, so as the training set increases, may result in the decrease of feature extraction efficiency. On the other hand, kernel method relies on the use of large training sets to improve the generalization ability. There are some pattern recognition system, will the new samples are added to training set time increased, so there will be a huge training set, kernel method is not suitable for this kind of system. In addition, some of the calculation efficiency of online system is also very difficult to accept the computing kernel method efficiency is relatively low, especially the data dimension is high and the training set is very large case, kernel methods do not have the practical value.

$$u^i = \frac{1}{\sqrt{\lambda_i}} \sum_{j=1}^{l} \beta_j^i \Phi(x_j) \tag{12}$$

After the feature points on the image of DT constitute the DT grid, grid vertices of the triangle became the feature points of the image, motion estimation based on. Because of the location of the feature points in the image are usually irregular distribution, change, and change with time and thus, only by feature point itself unable to motion estimation, must use the triangular or polygon feature points to connect, motion estimation. Degradation of DT connection was shown in Figure 4.

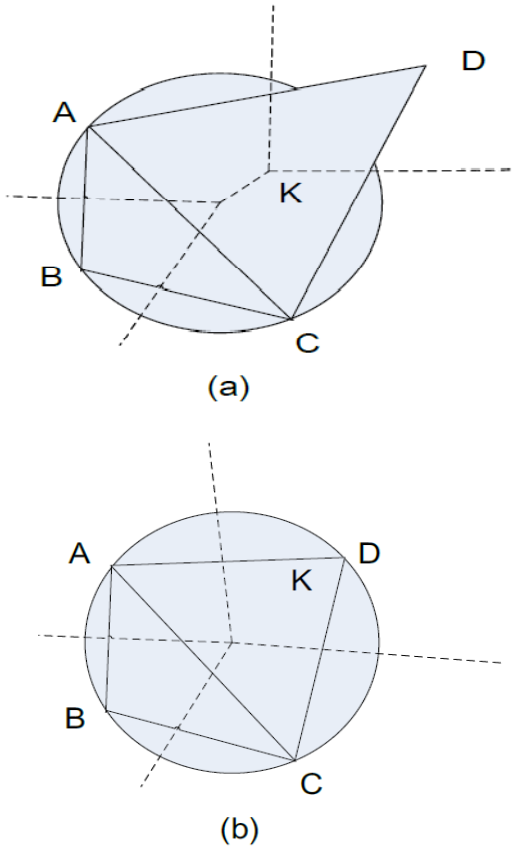

Figure 4: Degradation of DT connection

The update unmixing matrix

(a) The implementation of KICA

To sum up, the basic KCIA process is as follows:

(1) The input observation image data and kernel function, the input image X = AS, A is said the mixed matrix, S is the source signal and whitened data center;

(2) Minimizing the objective function C W: one of first calculates the center of observation images. The smallest features are then calculated value

(3) The output estimated moving object with the actual background of Y WX, W is the solution matrix.

The basic KCIA process was shown in Figure 5.

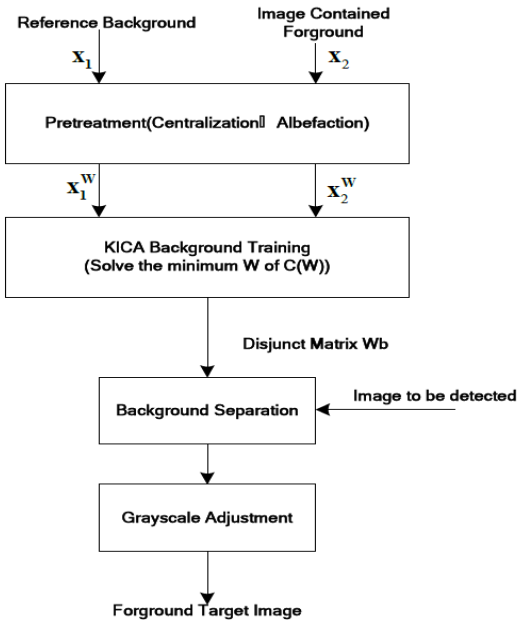

Figure 5: The basic KCIA process

(b) Background capture and estimation

KICA separation in the matrix W is in conformity with the stiefel flow shape, the objective function (V=On) can be regarded as a smooth function defined on stiefel manifolds. So the KICA algorithm in this paper on the stiefel manifold based on minimizing the objective function. In the stiefel manifold, can use some of the most commonly used optimization algorithms, such as gradient descent method, the method of steepest descent, conjugate gradient method, to update the separation matrix W.

In the stiefel manifold, natural gradient defined objective function C(W) is one of:

$$\nabla C = \frac{\partial C}{\partial W} - W\left(\frac{\partial C}{\partial W}\right)^T W \tag{13}$$

Tangent space Stiefel manifold is composed of all the H matrix space, H meet that is antisymmetric matrix. Starting from the W ground measured along the direction defined for H:

$$G_{W,H}(t) = W\exp(tW^T H) \tag{14}$$

Geodesic in mathematics was defined as the space between two points on the curved surface the shortest distance path. According to the definition of antisymmetric matrix, $(A-A^T)/2$ antisymmetric matrix, so the formula:

$$\nabla C\square W = \frac{\frac{\partial C}{\partial W}W^T - \left(\frac{\partial C}{\partial W}W^T\right)^T}{2} = W^T H \tag{15}$$

The update algorithm can be expressed as:

$$W_n = W_{n-1}\exp(tW_{n-1}^T H) = W_{n-1}\exp(t\nabla C\square W) \tag{16}$$

The value of t was determined by local search to gold. The value of Wn for every update, the value of t must identify a. Gold local search algorithm is a local optimal solution algorithm, here is to search for the optimal W_{N-1} determined values.

In gold by local search, need to assume values C1(W), C2(W) and C3(W), calculate the corresponding value. In Figure 6, assume that the C1(W)>C2(W)> C3(W), so that the minimum at [t1, t3]. If one C2(W) not for the minimum value of gold, local search along the one C3(W) search for small values of C1(W),

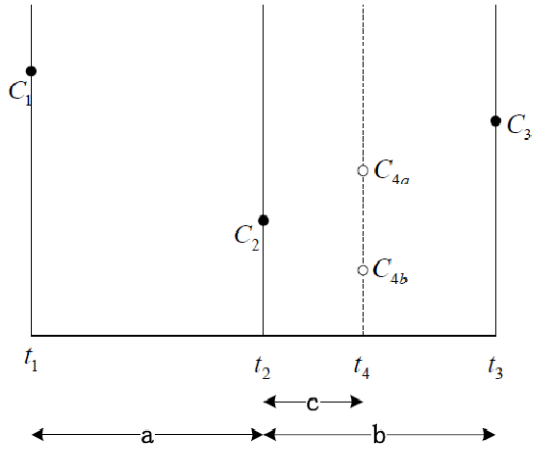

Figure 6: The gold local search

(c) Moving target feature extraction and search algorithm

Through the KICA learning has been the separation matrix, and can carry out the prospect of moving object image separation with other image sequences.

$$Y_t = W[x_b, x_t]^T \tag{17}$$

Future use of images obtained after the separation matrix is normalized data, in order to view the separation results, the need for grayscale adjustment:

$$I_t = y_t\square c\sigma_b + \mu_b \tag{18}$$

Which σ_b is the standard reference background, η is the gray value of reference. C is converting a constant adjustment range of gray, here let C = 5.

The fore ground image It solution obtained by two valued processing can get the foreground object region, the two threshold value can be used as adaptive form:

$$thes = \mu_l + l\sigma_l \quad (19)$$

In this paper, the use of the algorithm was tested on two types of indoor and outdoor environment of video data. The two group video data, the dual effect of indoor environment by natural light and indoor lighting, outdoor environment has a part in the intense sunlight, part in the shadow, so whether the moving target detection algorithm has good effect will be very good expression.

EXTRACTION OF IMAGE FEATURES BASED ON VIDEO MOTION NUCLEAR METHOD

The spatial correlation of the block differential detection

The experimental data for the image size is shooting 240 320, frame rate of 10 frames per second of the indoor environment of video. There is a window in the video, the dual influence of indoor lighting conditions will be affected by the outdoor natural light changes and indoor lighting changes. Outdoor natural light in different time of illumination changes gradually, and the indoor illumination affected by light, can switch different numbers of light to change the illumination condition, create a light changing scene, the ability to test the algorithm under different lighting conditions in the indoor environment of the foreground object detection.

The outdoor scene video sequence experimental data for the image size is 550*661 pixels. In the video, is composed of two parts, one part is in shadow, part of it is in natural light irradiation, the ability to detect moving target detection algorithm in outdoor scene changes in natural light intensity. The training phase in Figure 7, (a) as the reference background, (b) image includes the foreground object is known, (c) background image for the KICA isolated, (d) KICA isolated from the prospect of two value of the image obtained after the prospect target.

(a)

(b)

(c)

(d)

Figure 7: Outdoor training phase image

The differential motion target tracking

For noisy image, the spectral information includes the image contains noise information, only one line was fitted through the origin, must be due to the presence of noise and the influence of the fitting effect, should try to avoid the influence of noise "spectrum information center in the center, near the is the low frequency information, record the main details, and away from the center of the high frequency information, on behalf of the edge contour and feature point information.

As can be seen, the discrete curve in local transition near the origin is relatively smooth, while in the local jitter from the origin far more severe, the jitter is mainly caused by noise. Therefore one of the improvement is proposed in this paper is to limit the range of frequency domain data, a spectrum data is also near the origin is smooth fitting, so as to reduce the influence of noise. The quantitative criteria of L^1, L^2, H^m evaluation of the quality of the images, L^1, L^2, H^m standards are defined as follows:

$$L^1 = \frac{\left\| N^{-2} \sum_{x,y=1}^{N} |f(x,y)| - f_e \right\|}{\| f_e \|} \quad \textbf{(20)}$$

$$L^2 = \frac{\left\| \{N^{-2} \sum_{x,y=1}^{N} |f(x,y)|^2\}^{1/2} - f_e \right\|}{\| f_e \|} \quad \textbf{(21)}$$

$$H^m = \frac{\left\| \{N^{-2} \sum_{\varepsilon,\eta=1}^{N} (1+\varepsilon^2+\eta^2)^m \left| \hat{f}(\varepsilon,\eta) \right|^2 \}^{1/2} - f_e \right\|}{\left\| f_e \right\|} \quad (22)$$

EXPERIMENTAL RESULTS

Overview of experimental model algorithm

KCCA is a compression method the optimal dimension features in the minimum mean square error. In the compression dimension under the same conditions, the use of KCCA means square error. The basic idea of PCA is, the covariance matrix of all the training samples are calculated, and then calculate the former several features of the covariance matrix, the eigenvectors corresponding to form a transformation matrix, the data dimension reduction operation by using the transform matrix.

$$\Sigma \frac{1}{L} = \sum_{i=1}^{L} \phi(x_i) \phi(x_i)^T \quad (23)$$

Note that, independent component analysis for standard, need to meet the following three conditions, the problem is solvable:

(1) Source signals Si are statistically independent.

(2) The source signal may have at most one obeys Gauss distribution.

(3) Need to be bigger than the number is equal to the number of source signals observed signals, N1>N2.

If the source signal is two or more than two Gauss signal, then only can estimate all other non Gauss signal, but not isolated Gauss signal, because Gauss separated signals may be those of Gauss signal component of the linear combination.

Considering the actual imaging process in addition to existing global motion caused by camera motion, and in a real scenario, due to the natural environment can not be completely static (such as: different moments of illumination changes, brightness and shadows of branches and leaves hair caused by shaking) caused by the slow change. Therefore, must be caused by global motion and the natural environment changes eliminated first video scene camera motion caused by the slow changes, then the motion region detection algorithm. It can be a moving target adaptive video image detection and segmentation system (Figure 8) is as follows:

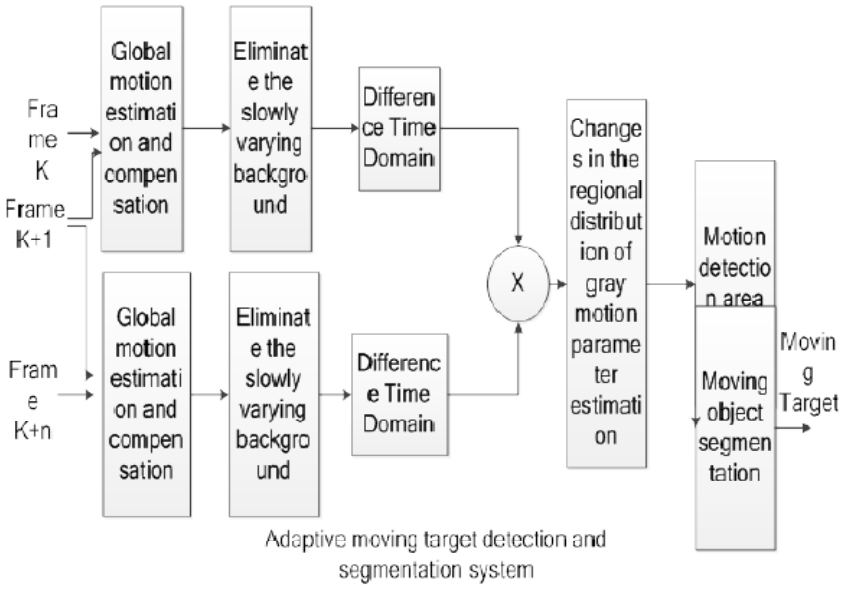

Figure 8: Moving target adaptive video image detection and segmentation system

In the video object shown in Figure 8 of the automatic generation system, the most important step is to detect automatically the change region, and the innovation of this chapter is to propose a method to estimate the double difference contains noise gray level distribution parameter algorithm results in the image and characteristic parameters according to remove the residual noise thus, to adaptively detect the change region.

Simulation results and analysis

For any one through the origin line can reflect the information characteristics of frequency domain, see Figure 9, although local jitter badly, but the overall trend is still with the increasing of. Another improvement idea is put forward in this paper likely to appear deviation, if make full use of the fitting error through the origin line balance of information, that can improve the precision of parameters.

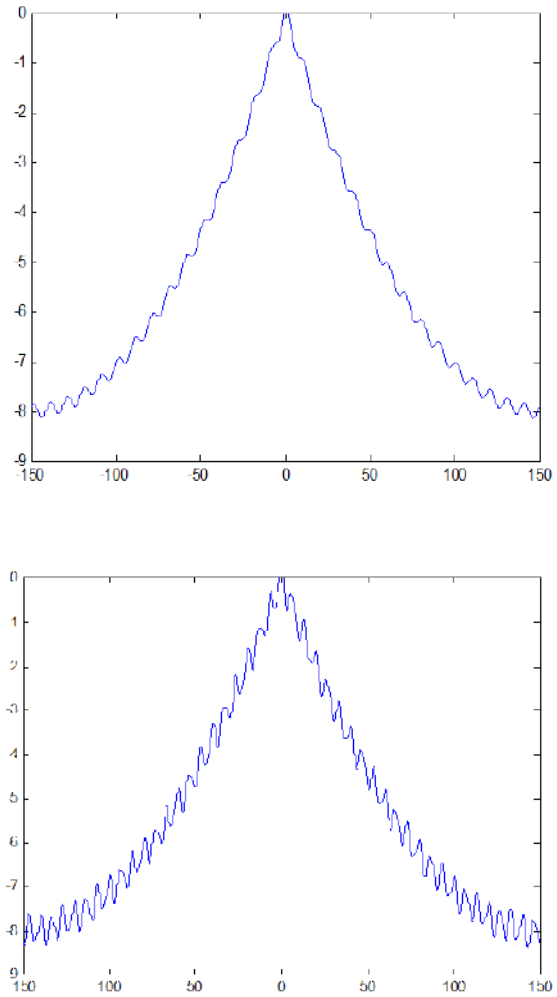

Figure 9: The information characteristics of frequency domain

Moving object segmentation algorithm is proposed in this paper and the simple difference, Geo-pixel, Shading etc. comparing several classical algorithm, Figure 10 is a graph segmentation results compared to get the simulation experiment of X axis, the noise in the image, Y axis for the change of regional accounts for the proportion to increase the image, Figure 11 shows this algorithm in noise, better able to eliminate the influence of noise, while maintaining the sensitivity to the changes caused by the target movement, can effectively detect the change region and extract the moving target, has strong robustness.

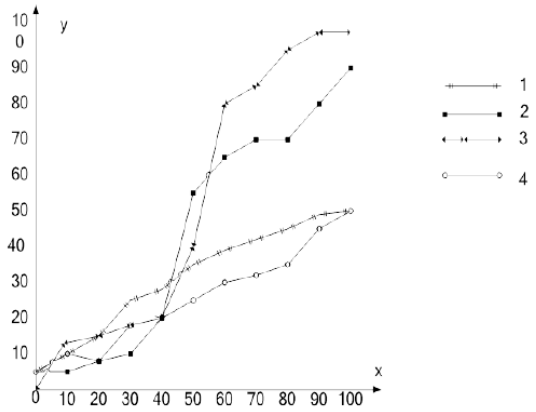

Figure 10: Graph segmentation results compared to get the simulation experiment of X axis

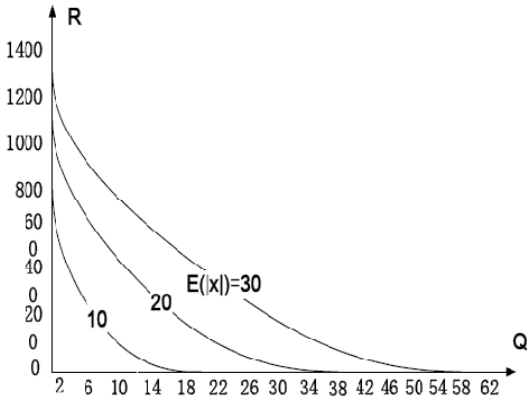

Figure 11: The algorithm in noise

CONCLUSIONS

Video moving target detection and feature extraction is an important research content in computer vision, relates to the video image processing and pattern recognition technology, it plays an important role in artificial intelligence, the man-machine communication applications. So the research on video moving target detection and feature extraction is of great theoretical significance and application value. Through the study of their respective scope of application and limitations; in view of the existing problems in the design of block matching method, a fast search strategy, through the combination of parallel search and linear search is to reduce the computational complexity "experiments show that, this method can effectively reduce the number of search points in time, ensure the movement parameter search precision. In the video moving object detection algorithm, the KICA algorithm is described in this paper while considering the correlation between foreground and background, but follows the ICA model, using linear model to approximate the nonlinear problem, itself has a certain limitation. The follow-up can be improved based on the model.

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