Available online at www.sciencedirect.com

ScienceDirect

Procedia Computer Science 183 (2021) 533–544

Procedia Computer Science

www.elsevier.com/locate/procedia

10th International Conference of Information and Communication Technology (ICICT-2020)

The key frame extraction algorithm based on the indigenous disturbance variation difference video

Xiao-Gen PEI[a,b,]*

[a]Anhui Wenda University of Information Engineering, Hefei 231201
[b]School of Information Science and Engineering, Shandong University, Jinan 250100

Abstract

In view of the traditional support vector machine (SVM) learning algorithm for widespread learning parameters is not easy determined in the process of video key frame extraction, the problem of low accuracy, an independent perturbation variable difference SVM algorithm used for video key frame extraction. First of all, the study of the biological mechanism of differential evolution algorithm, put forward an improved way of autonomic disturbance variation. Secondly, combined with improved forms of independent disturbance differential evolution algorithm for SVM parameters optimization, designed the key frame extraction algorithm of the video based on the improved differential of SVM algorithm. Through the standard test functions and video test database experiments show that the improvement of autonomic disturbance variation difference video key frame extraction algorithm can more effectively optimize parameters of support vector machine, so as to contribute to the improvement of the recall of video retrieval rate of (quasi) two algorithms performance evaluation standard.

© 2021 The Authors. Published by Elsevier B.V.
This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/)
Peer-review under responsibility of the scientific committee of the 10th International Conference of Information and Communication Technology.

Keywords: Autonomic disturbance variation; differential evolution; video; key frames; extract

1. Introduction

For Video the extraction of information mainly has two kinds of methods: one is based on the extraction of shot content; the second is based on the extraction of text description. The current commercial video key frame extraction method is based on the second text description, text description extraction algorithm is relatively simple,

* Corresponding author. Tel.: +86-18155219856
E-mail address:peixiaogeng1@sina.com

1877-0509 © 2021 The Authors. Published by Elsevier B.V.
This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/)
Peer-review under responsibility of the scientific committee of the 10th International Conference of Information and Communication Technology.
10.1016/j.procs.2021.02.094

using text retrieval to replace the video retrieval, simplified calculation and complexity, such as BIDU, Google, etc. The method of the corresponding deficiency is: simplified text description, often cannot accurately reflect the content of the video, comprehensively and label text is different from person to person, also is unable to use the existing image template or key frames characteristics such as advanced retrieval methods. Under the background, the relevant researchers studied the shot content based on the video key frame extraction method (CBVR) [1].

To simplify the data processing, data frame processing mode to the video that is converted to video retrieval into the video key frame extraction.

Three mainstream research direction: one is the research of video feature extraction based on bottom, such as the literature [2] put forward a kind of color histogram key frame feature processing method, by the removal of the color almost reduced interference factors; The second is based on the research of matching based video sample, such as the literature [3] based on Markov chain with dynamic characteristics put forward a kind of graph template based video key frame extraction system framework. These two kinds of video key frame extraction method has been very mature and is used by commercial; the third direction is based on the semantic video key frame extraction, such as the literature [4] on the movement of video semantic content modeling in this paper, a detection model of video semantic, this is this article mainly uses the way of design. Non-semantic of the bottom characteristics and the template matching method contrast high-level semantic concepts in human thinking difference is very big, bad understand affecting the usability of video key frame extraction system, the method of key frame extraction based on semantic and non-semantic the fundamental differences in the former uses the sample training this machine learning method, often used main pattern recognition methods, learning algorithm such as MRF, SVM, etc.

Support Vector Machine (SVM) at the beginning of the design is mainly aimed at solving nonlinear problems such as small sample, as the SVM theory gradually improve the learning method has been the concern focus of intelligent technology areas. The literature [5] designed gradient descent way the SVM parameters selection, the gradient is function value to increase or decrease the fastest direction, thus to improve the algorithm using gradient approach has a lot of, but the gradient is essentially a method of linear search is dependent on the initial value selection of SVM parameters, with the improvement of the performance of the algorithm of limitations. Literature [6] using the PSO of the nonlinear search features combined with k-fold error algorithm for SVM parameters selection effect is very good.

Intelligent optimization algorithm which applied to the SVM parameters selection is a major innovation, the author put forward an improved independent perturbation difference variation SVM parameters design scheme (Improved self perturbation mutation differential evolution based SVM algorithm, referred to as“ISPMDE-SVM”) based on intelligent optimization, and use the algorithm to the video key frame extraction of applications for laboratory studies.

2. Video feature extraction and processing

2.1. Motion feature extraction

The literature [7] presents a motion feature extraction algorithm of video key frames (as shown in figure 1), N_1 , N_2 , C_1 , C_2 as constant value factors, main effect is the size of the calibration video key frames feature area. The left of the figure as a global motion feature extraction area, the right of the figure for local motion feature extraction area.

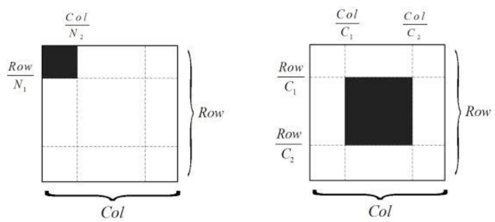


Fig. 1. Motion feature extraction area

A global motion feature extraction: using Lucas & KANADE optical flow algorithm, the global motion characteristics of the k frame of the video as:

$$Gd(k)=\frac{\sum_{i=0}^{N_1}\sum_{j=0}^{N_2} gd(i,j)}{N_1\times N_2} \tag{1}$$

In the formula, $gd(i,j)$ shows pixel (i,j) of the optical flow size. The global motion characteristics of the distance between the k , $k+1$ frame as follows:

$$GD(k,k+1)=\left|Gd(k)-Gd(k+1)\right| \tag{2}$$

Partial motion feature extraction: color histogram method is simple and more in line with the human visual characteristic, this article uses the space model calculating the local characteristics. Assumes that the selected H 8, S 3, V 3 divisions, the shot key frames can be converted into 72 d data array, and related algorithm used for the joining together of vector [8 ~ 10]:

$$l=9H+3S+V \tag{3}$$

Vector $l[k,0]\sim l[k,71]$ is the HSV figure of images, that is, the frame of local motion characteristic **[9].** The local movement distance between the k frames and the $k+1$ frames can be defined as:

$$PD(k,k+1)=\frac{\sum_{i=0}^{71}\left(l[k,i]-l[k+1,i]\right)^2}{\left(\frac{Col}{C_2}-\frac{Col}{C_1}\right)+\left(\frac{Row}{C_2}-\frac{Row}{C_1}\right)} \tag{4}$$

2.2. Feature vector structure and preprocessing

After get local and global motion characteristics, can construct characteristic vector for:

$$x[i]=\left(R_1,R_2,S_1,S_2,F\right) \tag{5}$$

$F=n-m$ shows the shot interval number, m,n shows the position between adjacent two frames; R_1 shows two frames distance average value; R_2 shows the extent of change as a local motion between two frames; S_1 shows the global movement feature in the distance average value between two key frames; S_2 shows two key frames global movement volatility situation. Define [9]:

$$\begin{cases} R_1 = \dfrac{\sum_{i=0}^{n-m-1} PD(m+i,m+i+1)}{n-m} \\ R_2 = \dfrac{\sum_{i=0}^{n-m-1} \left|R_1 - PD(m+i,m+i+1)\right|}{n-m} \\ S_1 = \dfrac{\sum_{i=0}^{n-m-1} GD(m+i,m+i+1)}{n-m} \\ S_2 = \dfrac{\sum_{i=0}^{n-m-1} \left|S_1 - GD(m+i,m+i+1)\right|}{n-m} \end{cases} \tag{6}$$

To obtain the video feature vector for normalization processing, and construct the fitness function f_i are as follows:

$$f_i = \beta_1\left(\alpha_1 \frac{R_{1xi}}{R_{1A}} + \alpha_2 \frac{R_{2xi}}{R_{2A}}\right) + \beta_2\left(\alpha_1 \frac{S_{1xi}}{S_{1A}} + \alpha_2 \frac{S_{2xi}}{S_{2A}}\right) \tag{7}$$

In the formula, R_{1xi} shows the vector $x[i]$ component values R_1, the rest is similar; α, β shows the weight value, $\alpha_1+\alpha_2=1$, $\beta_1+\beta_2=1$. If R_{1xi}/R_{1A} 's four ratio value greater than 1, then take its countdown.

3. Improve the independent perturbation mutation differential evolution algorithm

3.1. Autonomic disturbance variation way

The variation design way of the original differential evolution algorithm:

$$x_m = x_{s3}^s + F * \left(x_{s1}^s - x_{s2}^s\right) \tag{8}$$

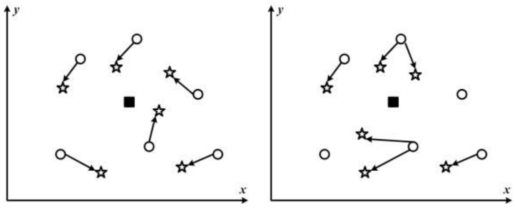
$$x_m = x_b^s + F\left[\left(x_{s1}^s - x_{s2}^s\right) + \left(x_{s3}^s - x_{s4}^s\right)\right] \tag{9}$$

Formulas (8) mutation method is called DE/rand/1/bin, formulas (9) mutation method is called DE/best/2/bin. In the two formulas, $x_{s1}^s, x_{s2}^s, x_{s3}^s, x_{s4}^s$ shows the different random particles; x_{b}^s shows this generation of population individuals best position; $F \in [0,2]$ is the difference variable scaling factor [4]. Relative to the formula (9), formula (8) using three random variation ways of individuals $x_{s1}^s, x_{s2}^s, x_{s3}^s$, the selection method can maintain the diversity of population is suitable for global search, but the convergence speed is slow. The formula (9) fitness of the best individual in current population x_{b}^s as basic variables, and use the four different individual random $x_{s1}^s, x_{s2}^s, x_{s3}^s, x_{s4}^s$ direction quantity to increase as the variation of randomness, but the mutation found in the simulation method, although in the early stages of the algorithm convergence speed quickly, but easily fall into local extreme value points, relatively suitable for local search.

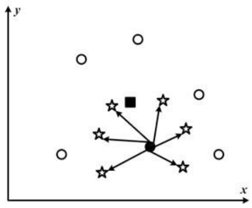
In conclusion, if a new mutation methods able to comprehensive formulas (8) and (9) mutation methods of the characteristics, the performance of the algorithm will be greatly improved. To this, literature [7] presented a double group pseudo parallel differential evolution algorithm, the algorithm adopts two populations parallel evolutionary, one population used formula (1) variation method, another population used formula (2) variation method, and under certain conditions, two populations were mutual exchange of information. But need to note is that the algorithm turn double populations algorithm complexity into two times, with the algorithm complexity in exchange for the improvement of the performance. Formula (9) in the form of variation method, with four different random individual $x_{s1}^{s},x_{s2}^{s},x_{s3}^{s},x_{s4}^{s}$ as the direction of quantity, can increase the mutated individual randomness, is helpful for maintaining the differences between individuals, which can maintain the diversity of population, so this article in the form of formula (9) to improve:

$$x_{i}^{s+1}=x_{i}^{s}+F\left(x_{r1}^{s}-x_{i}^{s}+x_{r2}^{s}-x_{r3}^{s}\right) \tag{10}$$

In the formula (10), $x_{s1}^{s},x_{s2}^{s},x_{s3}^{s}$ shows random individual which each other is not the same. Compared with the formula (8) and (9) mutation methods, formula (10) in x_{i}^{s} as the base variable and as a parameter of the direction of quantity, that is to say, individual every time variation is based on their own change, can maximum degree keep the diversity of population.



(a) ISPM mutation methods (b) Formulas (8) variation methods



(c) Formulas (9) variation methods

Fig. 2. Three variation methods of individual distribution

In the figure 2,"○"shows the s generation of the individual,"☆"shows the s+1 generation of the individual,"■"shows the local optimal value,"*" shows the global optimal value. Figure 2 shows the independent disturbance (SPM) variation method has better ability to keep population diversity, covered with its offspring solution of the search area is the largest. DE/rand/1/bin way due to the base vector is the expression of the random variation effect on the entire population near some individuals have more offspring individuals, but not for some individuals around individuals, and thus its ability to keep individual diversity inferior to SPM way. Due to the DE/best/2/bin way for each individual with x_{b}^{s} as the base vectors, which individuals will all around near x_{b}^{s}, if x_{b}^{s} is a global optimal value, the algorithm can fast convergence, if x_{b}^{s} is local minima value, the algorithm will be premature convergence.

3.2. Improve the way of independent disturbance variation

Although SPM mutation methods has better ability to keep population diversity, but should noticed its excessive emphasis on the population diversity and ignored the population convergence speed. In order to balance this problem, for the selection of $x_{r1}^{s},x_{r2}^{s},x_{r3}^{s}$ improvement ways are put forward. From the perspective of vector operation, there is a problem of the vector direction. Generally the better the fitness of the individual direction searched, will be more easy and fast to find the global optimal solution [7]. The SPM variation pattern will take sort ways:

$$\begin{aligned} &x_i^{s+1} = x_i^s + F\left(x_{rb}^s - x_i^s + x_{rm}^s - x_{rw}^s\right) \\ &x_{rb}^s = best\left(x_{r1}^s, x_{r2}^s, x_{r3}^s\right) \\ &x_{rm}^s = mid\left(x_{r1}^s, x_{r2}^s, x_{r3}^s\right) \\ &x_{rm}^s = mid\left(x_{r1}^s, x_{r2}^s, x_{r3}^s\right) \end{aligned} \tag{11}$$

From vector angle consideration, $\left(x_{rb}^s - x_i^s + x_{rm}^s - x_{rw}^s\right)$ includes x_i^s item, x_{rb}^s as $x_{r1}^s, x_{r2}^s, x_{r3}^s$ of the best individual, the adaptive value should be better than or equal to x_i^s, namely the selection $x_{r1}^s, x_{r2}^s, x_{r3}^s$, first of all to ensure one of the fitness value is better than that of x_i^s **.** Improve the direction of the mutation operation is more sure, balance the disadvantages factors too random. Because more individual participation variation, and the certainty is a kind of random certainty, can guarantee the global search performance of the algorithm is an efficient of mutation way.

3.3. ISPMDE algorithm steps

Step 1: Set population number *NP,* scaling factor *F,* such as algorithm parameters, the initial search space $\left[l^0, u^0\right]$, $s = 1$;

Step 2: Initial population and judge the individual adaptation degree;

Step 3: If meet the requirements of the terminating or precision grade, then the termination of the algorithm;

Step 4: In the population randomly selected one by one individual x_{r1}^s, satisfy the adaptive value $f\left(x_{r1}^s\right) \le f\left(x_i^s\right)$, again randomly selected x_{r2}^s, x_{r3}^s, meet $x_{r1}^s \ne x_i^s \ne x_{r2}^s \ne x_{r3}^s$;

Step 5: In sorting for x_{r1}^s, x_{r2}^s and x_{r3}^s, determining the value of the x_{rb}^s, x_{rm}^s and x_{rw}^s, and using the formula (4) ISPMDE variation way for population variation;

Step 6: Taking the crossover and selecting operation;

Step 7: Calculation the aim function value of the new species individual, make $s = s + 1$, turn to Step3.

As you can see from the above steps, for the improvement of the standard differential evolution algorithm is just two steps in the Step4 and the Step5, while the standard differential evolution algorithm's time complexity are mainly concentrated in the Step6 crossover operation part, so the effect of ISPMDE algorithm for time complexity is small relatively.

4. ISPMDE-SVM key frame extraction process

The extraction algorithm based on the ISPMDE-SVM video key frame process as shown in figure 3, assuming that the original sample video after the key frame extraction and the bottom feature extraction operation (see chapter 2), getting basic training data sets for:

$$U = \left\{(x_1, y_1), (x_2, y_2), \cdots, (x_n, y_n)\right\} \tag{12}$$

Using the formula (12) of the video training set's data U combining with ISPMDE algorithm training the SVM model, and then using the SVM model to detect new video streaming, according to the output value of the SVM model (fitness value) sorting and deposited in the video database for the user query. The process has three input parts: one is the video sample input, used as training data to ISPMDE-SVM parameter optimization; the second is video streaming input, used for SVM parameters detection and correction the SVM parameters optimization value; the third is the user query input, according to the user in

the client input information for video database based on semantic query. In conclusion, the core part of the algorithm framework is the SVM parameters optimization. [11~12]

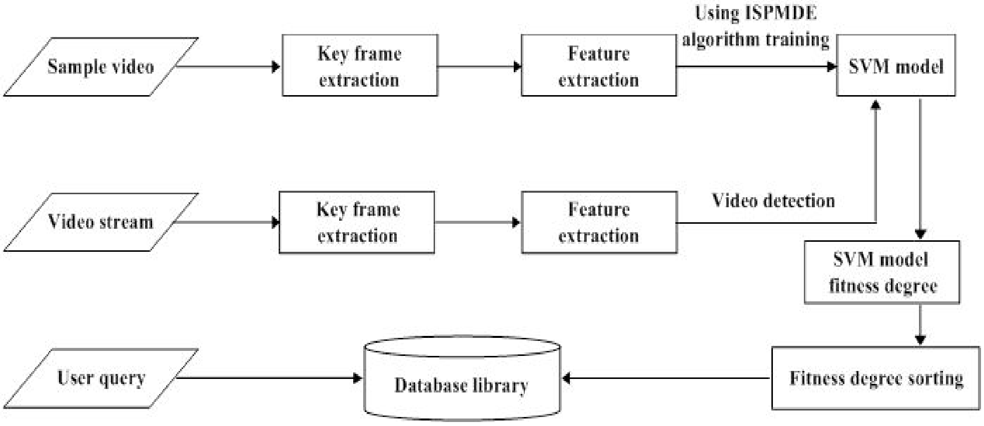


Fig. 3. ISPMDE-SVM key frame extraction

Reference literature [6] algorithm using k-fold as target value of parameter choice, ISPMDE-SVM steps:

Step 1: Reading the video sample data S , and random initialization $\{C,\phi\}$ as the initial values of differential evolution individuals;

Step 2: The sample S is divided into k each other no contain of subset $S_1,\cdots,S_k$;

Step 3: Taking the above subset as training data set, using ISPMDE algorithm optimized the SVM algorithm parameter $\{C,\phi\}$, calculating the k-fold cross-validation error as species adapt value f ;

Step 4: Taking the operation steps related to difference, and using the ISPM mode for individual variation which is given in this paper;

Step 5: Return to Step2, until it reaches the terminating number or meet the precision requirement.

5. The experimental results and analysis

Experiment 1: (ISPMDE algorithm performance test) adopts the common practice to choose three commonly used basic test functions as the test object:

(1) $f1=\sum_{i=1}^{30}x_i^2,\quad |x_i|\le 100,\ \min(f1)=0$

(2) $f2=\frac{1}{4000}\sum_{i=1}^{30}x_i^2-\prod_{i=1}^{30}\cos\left(x_i/\sqrt{i}\right)+1,$

$|x_i|\le 100,\ \min(f2)=0$

(3) $f3=\sum_{i=1}^{29}\left|100\left(x_{i+1}-x_i^2\right)^2+\left(x_i-1\right)^2\right|,$

$|x_i|\le 5.12,\ \min(f3)=0$

With reference to relevant literature and common standards, set up the simulation parameters are as follows: the dimension $D=30$, population generally take set dimension of 5~10 times [4], the simulation of algorithm take population $NP=200$. Parameters in ref. [4] $F\in[0.4,0.8]$, $CR\in[0.3,0.9]$. Set up the parameter [8] ASMDE and SACPMDE, DERL parameters [4],the standard DE algorithm $F=0.6$, $CR=0.8$, the simulation accuracy $VTR=10^{-6}$. Simulation results such as table 1, as shown in figure 4~6, in order to compare results show more clearly, in figure 4~6 convergence curve value of logarithmic mapping, taking the function $f4$ convergence curve value opposite logarithmic mapping were compared.

Simulation experiment data of listing 1 and figure 4~6 convergence curve comparison chart shows:

1. Test functions $f1$. ISPMDE and ASMDE algorithm performance is close to, DERL algorithm convergence value relatively optimal but also appear premature convergence and other comparison algorithm premature convergence, the optimization effect is not ideal.

2. Test functions $f2$. ISPMDE algorithm performance advantage is obvious, convergence speed is obviously better than the contrast of algorithm, in addition to DERL algorithm, other algorithm premature convergence, although DERL has a tendency to continue to optimize but the speed slower.

3. Test functions $f3$. ISPMDE, ASMDE and SACPMDE algorithm performance is close to, SACPMDE performance even slightly better than the other two algorithms, though comparison algorithm has a tendency to continue to optimize but slower.

Specific experimental data see Table 1, adopted comparison algorithm in different types of test function on the performance is not stable, show that algorithm design is flawed or a specific too much，algorithm is suitable for the positioning of the type function optimization, and although ISPMDE algorithm on individual test function performance slightly lose (basic), but the best overall performance and stability, and verified its effectiveness and universality.

Table 1. All the algorithm run averaging 20 times

		Optimal performance	The average performance	Iterations number	Variance	Time/s
$f1$	ISPMDE	5.24×10^{-6}	6.54×10^{-6}	331	2.69×10^{-18}	9.8
	SACPMDE	5.37×10^{-6}	7.85×10^{-6}	297	8.77×10^{-18}	7.6
	ASMDE	5.28×10^{-6}	7.76×10^{-6}	1087	8.21×10^{-18}	8.3
	DERL	6.54×10^{-6}	7.97×10^{-6}	314	3.89×10^{-13}	2.6
	DE/rand/1/bin	6.67×10^{-6}	7.98×10^{-6}	2178	4.14×10^{-13}	21.0
	DE/best/2/bin	6.42×10^{-6}	8.02×10^{-6}	2363	3.80×10^{-13}	23.5
$f2$	ISPMDE	4.57×10^{-6}	5.93×10^{-6}	306	3.52×10^{-14}	8.7
	SACPMDE	5.98×10^{-6}	7.00×10^{-6}	301	5.16×10^{-13}	7.3
	ASMDE	5.57×10^{-6}	7.04×10^{-6}	1159	6.19×10^{-13}	16.8
	DERL	6.50×10^{-6}	1.29×10^{-2}	5813	2.07×10^{-4}	75.3
	DE/rand/1/bin	6.64×10^{-6}	2.78×10^{-4}	2170	2.73×10^{-6}	25.1
	DE/best/2/bin	6.86×10^{-6}	5.28×10^{-3}	5110	6.05×10^{-5}	67.3
$f3$	ISPMDE	5.78×10^{-6}	6.18×10^{-6}	1219	5.63×10^{-13}	35.3
	SACPMDE	6.62×10^{-6}	1.35	4413	1.81×10^{1}	46.1
	ASMDE	2.67×10^{-3}	6.31×10^{-3}	8000	8.51×10^{-6}	82.3
	DERL	7.62×10^{-6}	1.41×10^{2}	6457	2.42×10^{5}	75.9
	DE/rand/1/bin	7.57×10^{-6}	7.92×10^{-6}	6170	1.19×10^{-12}	63.9
	DE/best/2/bin	6.58×10^{-6}	1.99×10^{-1}	5970	6.95×10^{-1}	42.3

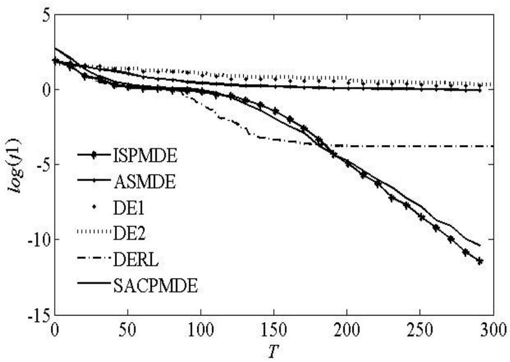


Fig. 4. Convergence curves of the objective function $f1$.

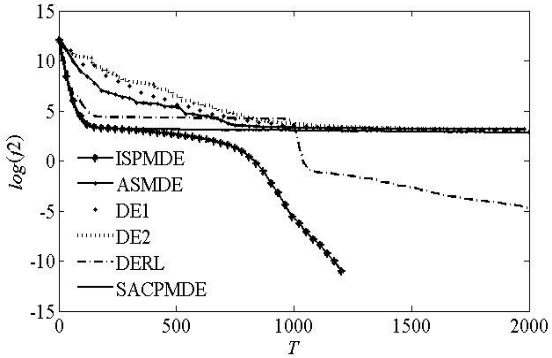


Fig. 5. Convergence curves of the objective function $f2$.

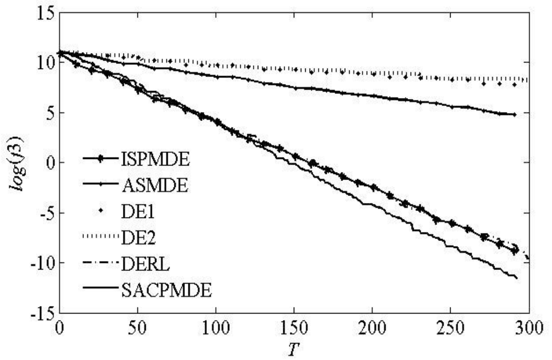


Fig. 6. Convergence curves of the objective function $f3$.

Experiment 2: (ISPMDE-SVM video key frame extraction) video key frame extraction of evaluation index main has two indicators: check precision rate and check whole rate. Using standard test video database is TREC2009 video library, the following to compare different algorithms check precision rate and check whole rate are testified by the simulation and proper analysis, the results are shown in Figure 7~8.

Check precision rate and check whole rate are complement each other of the two evaluation indexes, the high check precision rate algorithm is the error video key frames can be effective to identify, relatively low check precision rate does not mean that the video key frame extraction comprehensive is also low, can also be caused by low threshold value algorithm to extract relative increase caused by the number of error frame. Similarly, the index of the simple check whole rate does not mean that algorithm extracting accuracy is high based on the video key frames. Only the check precision rate and the check whole rate of equilibrium can reflect the performance advantage of video extraction algorithm. Figure 7~8 algorithm respectively in TREC2009 video library of the check precision rate and check whole rate performance behave:

1. Check precision rate aspects. Three algorithms for grassland, alpine and building relative single obvious key frame extraction effect is good, overall results is ISPMDE-SVM algorithm is superior to DE- SVM algorithm, the SVM algorithm of key frame extraction precision result is the worst.

2. Check whole rate aspects. Three algorithms in the grass, table tennis match and vehicles three video data types of the check whole rate is highest, overall ISPMDE-SVM algorithm is superior to DE-SVM algorithm, the SVM algorithm of video key frame extraction check whole rate the result is the worst.

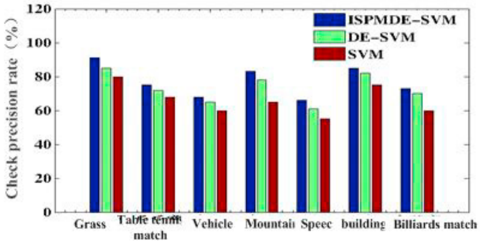


Fig. 7. Check precision rate

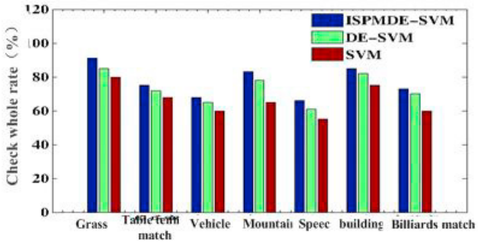
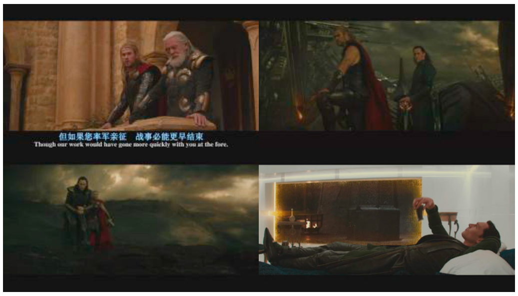
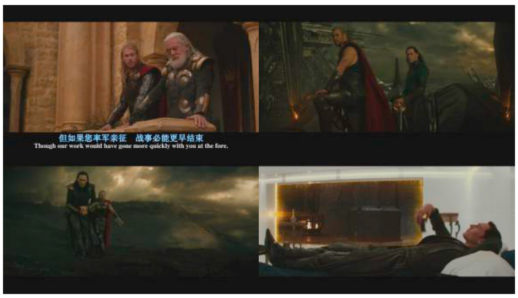


Fig. 8. Check whole rate

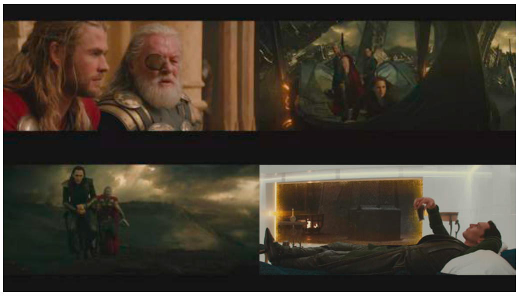
Below to film <Thor II: The Dark World> for material to establish a synthetic video clips of algorithm key frame extraction of the accuracy of the simulation test, the section with a total of four lens 256 frames. Its characteristics from the shot on the vision background color darker and more complex, bigger interference on the front key information, and higher similarity of the middle two lenses (including background), the first shot of the main information is similar degree higher than the middle of the two lenses, and the video shot background difference is bigger, the fourth video shot and the front three video shots are obviously different on the vision, the background is large difference.



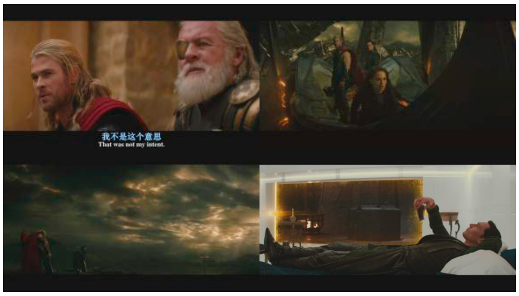
(a) The first frame of the original shots



(b) ISPMDE-SVM algorithm to extract the first frame



(c) DE-SVM algorithm to extract the first frame



(d) SVM algorithm to extract the first frame

Fig. 9. Movie clips of key frame extraction

The main design thoughts have two aspects: 1, the front three video test shots used to test the algorithm of key frames best discrimination ability; 2, the fourth test shots used to test the minimum discrimination performance of three algorithms. To facilitate comparison, we are using the video footage of the first frame as the target of retrieval, which use real first frame for the standard of the original video shot, as shown in figure 9. Can intuitive see, in the front three shots, which based on ISPMDE-SVM algorithm to extract the first frame is more close to the original video of the first frame, and three kinds of algorithms for the fourth shot extract key frames of the first frame are consistent with original shots of the first frame. Conclusion: three algorithms for the simple contrast of high accuracy of the extraction of video shot is very good, but when the shots similarity degree is higher (main information and background information) ISPMDE-SVM video key frame extraction algorithm performance is more stable, the accuracy of extraction is best, show the feasibility of the algorithm in the practical application.

6. Conclusion

Because the video key frame extraction algorithm needed for the great amount of data, so the algorithm of simple and efficient for its actual application value has the important influence, the article from the perspective of minimize the impact on the computing complexity, from the angle of mechanism analysis improved the way of mutation based on differential evolution algorithm, this way of improvement is one of the most basic and efficient way of improvement, has barely increases time complexity after the algorithm improved, implements the algorithm improvement and efficiency pay equal attention to effect. By means of the test function the simulation show that ISPMDE algorithm has higher convergence speed and accuracy. Finally through SVM for intermediate algorithm, designed the video key frame extraction algorithm based on ISPMDE algorithm, the video testing database library and self-built testing library of the simulation results show that the algorithm has higher check precision rate and check whole rate, to self-built the first key frames of video library for extract more accurate, the conclusion shows that ISPMDE-SVM video key frame extraction algorithm is feasible and effective.

Acknowledgement

Fund Project: Anhui University Natural Science Research Project in 2019 [KJ2019A0907]; Major Teaching and Research Project of Anhui Quality Engineering (2017 JYXM 0877); Anhui Wenda Institute of Information Engineering Key Natural Science Foundation Project [XZR2018A02]; 2018 National Undergraduate Innovation and Entrepreneurship Training Program [201812810021].

References

[1] KAELO P, ALI M M. A numerical study of some modified differential evolution algorithms [J]. European Journal of Operational Research, 2006, 169: 1176-1184.
[2] FENG S, MANMATHA R. A Discrete Direct Retrieval Model for Image and Video Retrieval[C] //*CIVR'08*, Niagara Falls, Ontario, Canada: ACM, 2008: 427-435.
[3] GRANA C, VEZZANI R, CUCCHIARA R. Enhancing HSV Histograms with Achromatic Points Detection for Video Retrieval[C] //*CIVR'07*, Amsterdam, The Netherlands: ACM, 2007: 302-308.
[4] PAPADOPOUIOS G T, MEZARIS V, KOMPATSIARIS I. Accumulated Motion Energy Fields Estimation and Representation for Semantic Event Detection[C] //*CIVR'08*, Niagara Falls, Ontario, Canada: ACM, 2008: 221-230.
[5] Wright A H. Genetic Algorithms for Real Parameter Optimization. Foundations of Genetic Algorithms[M]. Rawlins GJEEDSCA: Morgan Kaufmann, 1991: 205-218.
[6] SHAO X G, YANG H Z, CHEN G. Parameters selection and application of support vector machines based on Partiele swarm optimization algorithm [J]. Control Theory & Applications, 2006, 23(5): 740-748.
[7] YONG S P, JEREMIAH D D, MARTIN K P. Wildlife video key-frame extraction based on novelty detection in semantic context[J]. *Multimedia tools and applications*, 2013, 62(2): 359-376.
[8] WU L H, WANG Y N, ZHOU S W. Research and application of pseudo parallel differential evolution algorithm with dual subpopulations [J]. Control Theory & Applications, 2007, 24(3): 453 – 458.
[9] Barhoumi W, Zagrouba E. On-the-fly Extraction of Key Frames for Efficient Video Summarization [J]. *AASRI Procedia*, 2013, 4: 78-84.
[10] LIU X M, HAO A M, ZHAO D. Optimization-based key frame extraction for motion capture animation [J]. *The Visual Computer* , 2013, 29(1): 85-95.
[11] Sanjay K, Panda K R, Ananda S. Chowdhury Video key frame extraction through dynamic Delaunay clustering with a structural constraint [J]. *Journal of Visual Communication and Image Representation*, 2013, 24(7): 1212-1227.
[12] Guan G L. Keypoint-Based Keyframe Selection [J]. *IEEE Circuits and Systems Society*, 2013, 23(4): 729-734.