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A Multiple Target Detection Algorithm Based on Imperialist Competitive Algorithm

Mohammad Rismanbor and Karim Faez, Member, IEEE

***Abstract*— in this paper in order to introduce multiple target detection method. We combination histogram feature and Imperialist Competitive Algorithm (ICA). We use histogram feature because it is robust to the target rotation and scales. To overcome the computation problem of pixel by pixel searching, ICA is employed. Another advantage of ICA is that if several targets in the image or frame exist, we will be able to detect simultaneously all targets in the frame. Then we apply a threshold in order to remove weak empires which belong to objects which have similarity to targets. Then clustering empires based on the distance and selecting most powerful empire of each cluster as one of the targets contained in frame, therefore we can detect all targets existing in the frame. Finally we compare ICA method with PSO (Particle Swarm Optimization) method and show that ICA is faster and more accurate than PSO in the field of target detection.**

I. Introduction

The researches for segmenting, estimating, and tracking semantic objects in videos have received great attention for the last few years, which have many important applications including, video surveillance, human motion analysis, human-machine interaction, and object based video encoding (e.g., MPEG4), [1] These broad applications have different constraints and requirements in terms of tracking accuracy, processing speed, allowed user interaction, and available prior information about the object and the background.

Multiple target tracking [3] is an important element of surveillance. Target detection and tracking represent two fundamental steps in automatic video-based surveillance systems where the goal is to provide intelligent recognition capabilities by analyzing target behavior. And an object detection mechanism is required for every object tracking method either in every frame or in the first frame in a video when the object first appears.

A large number of detection and tracking algorithms have been developed in the past decades. The interested reader can refer to [2] for a recent comprehensive survey of the field. In detection alone schemes, various detection algorithms have been employed based on point detectors [4], such as background subtraction [5], segmentation [6], supervised learning methods [7-9], frame differencing [10], optical flow [11], etc. About the detection of moving object, most of techniques are based on the features of color, texture, shape, edge, motion, and shape. Generally, the color feature is frequently used [12], since the human perception is sensitive to the color. In fact, color is one of the most widely used features to represent the object appearance for detection and tracking. Most of object detection and tracking methods used pre-specified models for object representation.

It is very important to select a general feature for object representation of the unconstrained videos. We noticed that histogram is the statistical feature of a region and not a point or a specific shape. And also it is a general character to represent object. Therefore the histogram is selected as the object representation in this paper, and the results of experiment showed that it is promising.

On the other hand, the computational complexity is another challenge for real-time applications. In this paper, we use a method called Imperialist Competitive Algorithm to search for the position in video frame (or static image) of which the histogram is proximate to that of the target. Imperialist Competitive Algorithm (ICA) is a new algorithm which has been proposed by Atashpaz Gargari and Lucas [13], in 2007 that has inspired from a socio-human phenomenon. ICA has been applied successfully in different domains namely designing controllers [14-15], recommender systems, characterization of elasto-plastic properties of materials [16] and many other optimization problems [17].

Although some object detection methods use the temporal information computed from a sequence of frames, it is a common approach for object detection to use information in a single frame. Therefore in this paper we propose a target Procedure for Paper Submission detection algorithm, which combines the histogram feature of target object and Imperialist Competitive Algorithm.

The rest of the paper is organized as follows. Section II gives a description of histogram feature. The robust of the histogram feature for object representation is analyzed. The Imperialist Competitive Algorithm is presented in section III. In section IV, the proposed method is shown, in section V we have experimental results, and followed with the conclusion and discuss in section VI.

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Mohammad Rismanbor Department of Electrical, computer & IT, Qazvin Islamic Azad University, Qazvin, Iran (phone: 00989144144418; fax: 00984113330240; e-mail: Mohammad_rismanbor@yahoo.com).

Karim Faez, Electrical Engineering Dept.., Amirkabir University of Technology, Tehran, Iran, 15914 (e-mail: kfaez@aut.ac.ir).

II. ANALYSIS OF HISTOGRAM FEATURE

A color histogram is a representation of the distribution of colors in an image. For digital images, a color histogram represents the number of pixels which have colors in each of a fixed list of color ranges that span the image's color space, the set of all possible colors. Histogram is a statistical representation of features. Histogram has some advantages such as simplicity, robustness and efficiency. Histogram only produces the information on global intensity or color distribution. Therefore, the targets in image can still possess high similarity in their corresponding histograms when the targets have some small changes, such as translations, rotations, or distortions. Many works of image retrieval or target tracking have been reported based on histogram feature which could provide useful clues for measuring the similarity between image patterns [18-20].

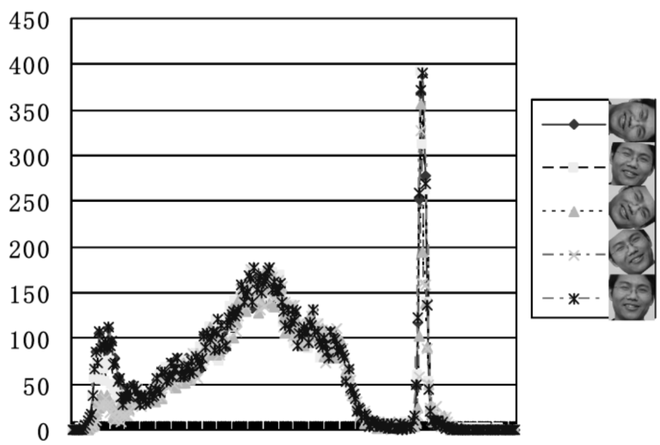

Figure 1. The histogram examples in case of target rotation

In figure 1 and figure 2 are shown that histogram feature is robustness against of rotation and scale. From figure1 and figure 2 [21], we could see that the histogram changes little in case of the target rotation or the scale changes.

On the other hand, the histograms of different targets may have little similarity even under the same rotation and scale as showed in figure 3. [21]

We can use an appropriate threshold value to solve this problem. Therefore we choose the histogram as the feature for target detection.

To solve the global optimum problem, one of the solutions is to search the image pixel by pixel, which has high computation. So here we would employ the Imperialist Competitive Algorithm (ICA) to cover the computation problem.

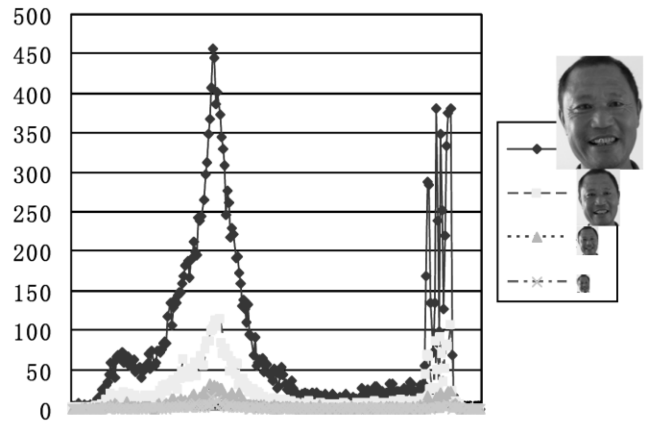

Figure 2. The histogram examples in case of target scale changes

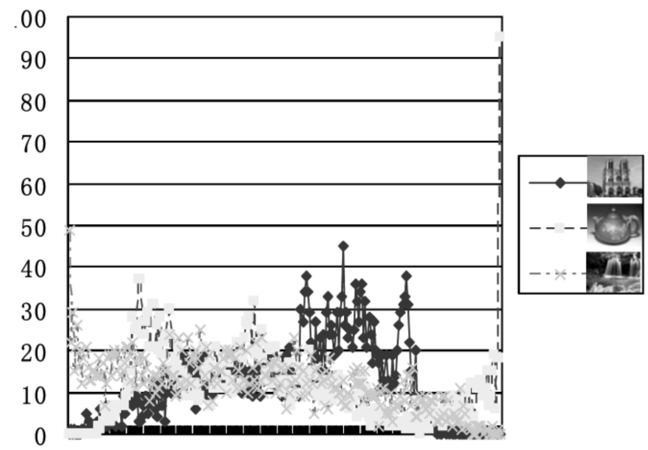

Figure 3. The histogram examples of different targets

III. IMPERIALIST COMPETITIVE ALGORITHM

Imperialism is the policy of extending the power and rule of a government beyond its own boundaries. ICA is a novel global search strategy which uses imperialism and imperialistic competition process as a source of inspiration. The algorithm starts with an initial random population called countries. Some of the best countries in the population are selected to be the imperialists and the rest form the colonies of these imperialists. In an N dimensional optimization problem, a country is a 1×N array. This array is defined as below

$$Country=[p_1,p_2,p_3,...,p_{Nvar}] \quad (1)$$

The cost of a country is found by evaluating the cost function F at the variables $(p_1,p_2,p_3,...,p_{Nvar})$.

$$Cost_i= F(Country_i) = F(p_{i1},p_{i2},p_{i3},...,p_{iNvar}) \quad (2)$$

Then the algorithm starts with N initial countries and the N_{imp} best of them (countries with minimum cost) are chosen as the imperialists. The remaining countries are colonies that each belong to an empire. The initial colonies belong to imperialists in convenience with their powers. To distribute the colonies among imperialists proportionally, the normalized cost of an imperialist is defined as follow

$$C_n = \max_i\{c_i\} - c_n \quad (3)$$

Where, c_n is the cost of nth imperialist and C_n is its normalized cost. Each imperialist which has more cost value, will have less normalized cost value. Having the normalized cost, the power of each imperialist is calculated as below and based on that the colonies are distributed among the imperialist countries.

$$P_n = \left| \frac{Cn}{\sum_{i=1}^{Nimp} ci} \right| \quad (4)$$

On the other hand, the normalized power of an imperialist is assessed by its colonies. Then, the initial number of colonies of an empire will be

$$N.C._n = round\{(P_n.(N_{col})\} \quad (5)$$

Where, NC_n is the initial number of colonies of nth empire and N_{col} is the number of all colonies. To distribute the colonies among imperialist, NC_n of the colonies is selected randomly and assigned to their imperialist. The imperialist countries absorb the colonies towards themselves using the absorption policy. The absorption policy shown in Fig.4 makes the main core of this algorithm and causes the countries move towards to their minimum optima. The imperialists absorb these colonies towards themselves with respect to their power described in (6). The total power of each imperialist is determined by the power of its both parts, the empire power plus percents of its average colonies power.

$$T.C_n = Cost(Imperialist_n) + \xi mean\{Cost(colonies\ of\ empire_n)\} \quad (6)$$

Where TC_n is the total cost of the nth empire and ξ is a positive number which is considered to be less than one.

$$x \backsim U(0, \beta \times d) \quad (7)$$

In the absorption policy, the colony moves towards the imperialist by x unit. The direction of movement is the vector from colony to imperialist, as shown in Fig.4. In this figure, the distance between the imperialist and colony shown by d and x is a random variable with uniform distribution. Where β is greater than 1 and is near to 2. So, a proper choice can be β =2. In our implementation γ is $\pi/4$ (Rad) respectively.

$$\theta \sim \cup (\gamma, \gamma) \quad (8)$$

In ICA algorithm, to search different points around the imperialist, a random amount of deviation is added to the direction of colony movement towards the imperialist. In Fig. 4, this deflection angle is shown as θ, which is chosen randomly and with a uniform distribution. While moving toward the imperialist countries, a colony may reach to a better position, so the colony position changes according to position of the imperialist.

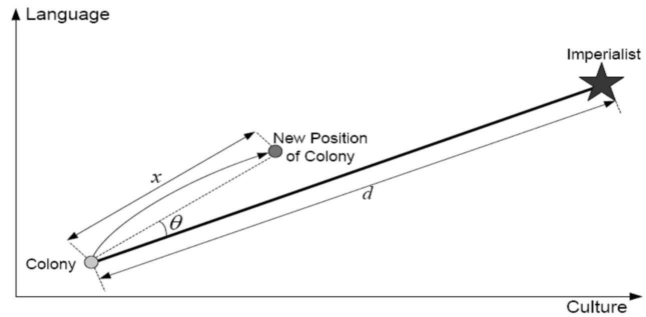

Figure 4. Moving colonies toward their imperialist

In this algorithm, the imperialistic competition has an important role. During the imperialistic competition, the weak empires will lose their power and their colonies. To model this competition, firstly we calculate the probability of possessing all the colonies by each empire considering the total cost of empire.

$$NTC_n = \max_i\{TC_i\} - TC_n \quad (9)$$

Where, TC_n is the total cost of nth empire and NTC_n is the normalized total cost of nth empire. Having the normalized total cost, the possession probability of each empire is calculated as below

$$p_{pn} = \left| \frac{NTC\, n}{\sum_{i=1}^{N_{imp}} NTci} \right| \quad (10)$$

After a while all the empires except the most powerful one will collapse and all the colonies will be under the control of this unique empire.

IV. THE PROPOSED METHOD

In order to targets detection in the frame or image, countries are distributed uniformly in image space. And a number of these countries which are more powerful are elected as empire. Each imperialist randomly picks N of the colonies. After creating the initial empires, colonies start moving toward their relevant imperialist state. If this movement causes to find a colony with better position (lower cost) than that of imperialist, the colony moves to the position of the imperialist. But according to real world complex situations (changing lighting, the distance …) obviously, the power of targets will be different from each other. According to this point if we continue the algorithm to satisfy stop condition, the most powerful empire belongs to target which has been given as input to the algorithm. And the rest empires belong to other targets and objects similar target which have been removed due to competition with the most powerful empire. Then we apply a threshold to remove weak empires which belong to objects which have similarity to targets. Then rests of the empires are clustered based on distance. Therefore, the number of clusters is equal to number of targets in the frame. If the most powerful empire is chosen from each cluster, all targets are detected in the frame. According to this point the numbers of targets in various frames are different. Empires (targets in the frame) are clustering automatically. Therefore we don't need to have any basic information about the number of targets in the each frame.

V. EXPERIMENTAL RESULTS

In order to represent the power of proposed method, we have shown some of the experimental results in Fig.5 and Fig.6. In Fig.5 targets are people's faces that are different in terms of appearance and color, and all of the faces were detected correctly.

And Fig.6 includes the lotus flower, that despite obvious differences in shape and size of them, ICA method detected all of them properly.

In order to evaluate the performance of ICA method in the field of target detection, we compare ICA method and PSO method with each other.

Figure 5. Face target detection example

Figure 6. Lotus flower target detection example

ICA method is faster than PSO method because in ICA to detect all targets existing in each frame, we need to run the algorithm one time but in PSO we must run the algorithm as number as targets existing in each frame. As shown in Fig.7, we have compared the runtime of both algorithms in same situation. Each of the algorithms was run on every picture five times .Therefore we use average time in graph.

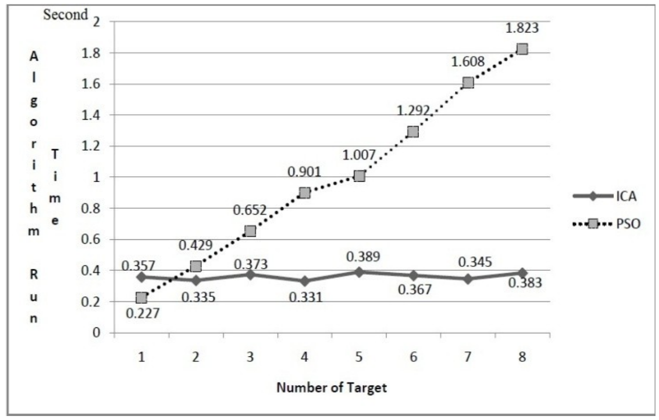

Figure 7. Compare ICA and PSO runtimes

We use 350 various pictures, in order to compare the performance of both algorithm. According to table 1 we found that ICA performance is also better than PSO in field of target detection.

TABLE I. COMPARE PERFORMANCE OF ICA AND PSO

Algorithm	ICA	PSO[21]
Performance(True Detect)	%92.6	%90.2
Miss Target	%2.33	%3.47
False Positive	%5.07	%6.33

VI. CONCLUSIONS

Histogram is the statistical feature of a region and not a point or a specific shape. It possesses the merits of simplicity, robustness and efficiency. In this paper, we choose the histogram as the feature for target detection.

On the other hand, to overcome the computation problem, ICA is introduced, which is a new and powerful search technique. ICA method not only increases the success rate of the search but also expedites the search process, and we are able to detect multiple targets in the frame or image.

In this paper, in order to evaluate the performance of ICA method, we compare it with PSO method. Based on experiments results, we found, that the ability of ICA method is higher than PSO method in the field of target detection. However, this phenomenon is partly justified. Because in PSO, each particle move randomly toward the local (the best position that particle has visited) and global (the best position is determined by any particles in the swarm) best positions. But in ICA algorithm countries are moving toward several imperialist (the best solutions obtained so far). Local and global optimal evolve simultaneously. Therefore expected, ICA method has better result than PSO method in field of target detection.

By the combination of histogram and ICA, a multiple target detection method robust to rotation and scales is presented which also have a good performance in real time. The research of how to construct significant target detection and object tracking system is still ongoing.

REFERENCES

[1] C.E. Erdem, F. Ernst, A. Redert, E. Hendriks, "Temporal, stabilization of video object segmentation for 3D-TV applications," Signal Processing:Image Communication, Volume 20, Issue 2, pp.151-167, February 2005.

[2] Alper Yilmaz, Omar Javed, and Mubarak Shah, "Object Tracking: A Sruvey". ACM Computing Surveys, Volume.38, Issue 4, Article 13,December 2006.

[3] Mark R. Morelande, Christopher M. Kreucher, and Keith Kastella "A bayesian approach to multiple target detection and tracking" IEEE Transactions on Signal Processing, Volume. 55, Issue 5, May 2007

[4] Mikolajczyk K. and Schimd, C. "A performance evaluation of local descriptors". In IEEE Conference on Computer Vision and Pattern Recognition (CVPR) Wisconsin, Volume 2, pp.II-257–II-263, 2003.

[5] Haritaoglu I., Harwood D., and Davis L. "W4: real-time surveillance of people and their activities," IEEE Transactions on Pattern Analysis and Machine Intelligence, Volume 22,Issue 8, pp.809–830. August.2000

[6] Jianbo Shi Malik, J. "Normalized cuts and image segmentation," IEEE Transactions on Pattern Analysis and Machine Intelligence, Volume22, Issue 8, pp.888-905, August. 2000

[7] Henry A. Rowley, Shumeet Baluja, Takeo Kanade. "Neural Network-based face detection," IEEE Transactions On Pattern Analysis and Machine intelligence, Volume 20, Issue 1, pp23-38, January.1998

[8] Viola, P., Jones, M., and Snow, D. "Detecting pedestrians using patterns of motion and appearance". IEEE International Conference on Computer Vision (ICCV), Nice, pp. 734–741,October. 2003

[9] Jinhao Deng, Juan Zhu, "Research on pedestrian detection algorithms based on video". IEEE International Conference On Computer Design And Applications (ICCDA), Qinhuangdao,Volume 5,pp.474-478,June.2010

[10] Beren, J.R. et al. "A three frame algorithm for estimating two component image motion" IEEE Transactions on Pattern Anal. Mach.Intell. Volum14, Issue 9, pp.886–896 .September 1992

[11] L.Wixson, "Detecting salient motion by accumulating directionary-consistent flow," Transactions on Pattern Anal. Machine Intell., volume. 22, Issue 8, pp.774–780, August. 2000.

[12] Hieu T. Nguyen, Arnold W.M. Smeulders, "Fast occluded object tracking by a robust appearance filter," IEEE Transaction on Pattern Analysis and Machine Intelligence, Volume26, Issue 8 ,pp1099–1104, August .2004

[13] E. Atashpaz-Gargari and C. Lucas, "Imperialist competitive algorithm: an algorithm for optimization inspired by imperialistic competition", IEEE Congress on Evolutionary Computation, Singapore, pp.4661-4667, September.2007

[14] E. Atashpaz-Gargari, F. Hashemzadeh and C. Lucas, "Evolutionary design of PID controller for a MIMO distillation column using colonial competitive algorithm", international journal of intelligent computing and cybernetics, volume1.issue3, pp.337-355, 2008.

[15] A.Khhabbazi, E.atashpaz, caro lucas, "Imperialist comp ivealgorithm for minimum bit error rate beamforming", international journal of Bio-Inspired computation, volume 1, pp.125-133, 2009

[16] Biabangard-Oskouyi , E. Atashpaz-Gargari, N. Soltani and C. Lucas. "Application of imperialist competitive algorithm for materials property characterization from sharp indentation test", International Journal of Engineering Simulation, 2008

[17] Rajabioun, R., Atashpaz-Gargari, E., Lucas, C., "Colonial competitive slgorithm as a tool for nash equilibrium point achievement", Lecture notes in computer science, Springer Berlin, volume 5073, pp.680 695, 2008.

[18] Stricker, M., Swain, M., "The capacity of color histogram indexing". IEEE Conference on Computer vision and pattern recognition, pp.704-708, June.1994

[19] Ennesser, F., Medioni, G., "Finding Waldo, or focus of attention using local color information," IEEE Transactions on Pattern Analysis and Machine Intelligence, Volume17, Issue 8, pp.805-809, August. 1995

[20] Pass, G., Zabih, R., Miller, J., "Comparing images using color coherence vectors". Procedings of ACM Multimedia, pp.65-73, 1996

[21] Wei-feng LIU, Yan-jiang WANG, "A target detection algorithm based on histogram feature and particle swarm optimization" IEEE Fifth International Conference on Natural Computation (ICNC), Tianjin ,Volume.3, pp.206-209, August. 2009