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Object Recognition Using Template Based Matching Method

D. A. Simonyan, R. A. Simonyan

***Abstract*— The best-so-far ABC (BSF-ABC) is the modified algorithm of artificial bee colony (ABC) which is implemented to solve optimization problems. This algorithm is one of the swarm intelligence algorithms which has recently been introduced in the literature and the results of which show that the BSF-ABC can lead to higher quality solutions with quicker interaction than ordinary ABC or the algorithm based on the currently implemented modern ABC. In this work our goal is to implement the approach based on the BSF-ABC for detecting objects. The aforementioned approach is built on template-based matching using the difference of histograms of RGB level. The latter matches to the target object and template object as an objective function. The results come to prove that the suggested method has successfully been implemented both in object detection and in optimization of time spent on problem solving.**

***Index Terms*— Object recognition, template matching based on RGB level histograms,ABC, recognition speed increase, video surveillance, configurable applications.**

I. Introduction

Template matching is a method of computer vision, which is used to find a sub image of the target image matching to the template image. The method is widely used in the spheres of object detection such as surveillance [1, 2, 3], watching of transport means, robotics, medical imaging and production. In general the approaches of template matching can be grouped into two categories. The first one is based on level histogram, the second-on feature extraction. Here the priority is given to the first group, as the corresponding methods of level histogram are simple in the usage and quantitative analysis has been implemented to check/on its accuracy and the marks of errors. However, this method also requires complex calculations as the matching process includes the movement of template image in all the possible directions in the larger target image and the calculation of numeric index which shows to what extent the template matches to the image in that position. Thus, the problem is conceived as an optimization problem. The algorithms based on swarm intelligence, which have been recently used in works, have been viewed as a means to alleviate the long-term development defaults/drawbacks in this problem [4-8].

Swarm intelligence [9-14] is metaheuristic method in the sphere of artificial intelligence which is used to solve the problems of optimization. It is based on the collective behavior of some insects, birds flock and fish school. The aforementioned animals can solve complex problems without having centralized controller. The famous algorithms of swarm intelligence, which have been introduced recently, include Ant colony optimization-ACO based on the ants' behavior of searching for food, Particle swarm optimization based on birds flock and fish school behavior and the colony of artificial bees based on the behavior of bees searching for food.

The ACO characteristics, which can be useful in finding global optimums and in normalized product correlation-Nprod, are accepted as similarity measure, have been developed to assess the matching point of template image and the etalon image of the same point. A new approach, based on improved ACO algorithm, has been suggested for matching the adaptive template. The method uses the coarse-fine searching method to make the matching results more accurate and precise. ACO algorithm has been used in robotics to solve the problem of object recognition. Normalized cross correlation has been used as an objection function in the optimization process. Afterwards, a hybrid algorithm of ACO and Differential Evolution has been developed to improve the local/place search capability in the scale of matching grayscale. This was followed by the suggestion of model matching algorithm based on the grayscale of images which will ensure the vision guided autonomous underwater vehicle's attachment process.

The model has used Quanta-PSO to find the best matching point and it has used the degree of grayscale absolute correlation of target image and template image as a matching function. For preventing any kind of error which may occur when the environment under surveillance becomes extremely varied. The ACO based approach has been introduced to watch/follow a variety of objects using histogram matching [7, 15] and ultimately ABC has been used for the recognition of objects in digital images. The absolute amount of the intensity difference between the pixels of the target image and the template image is viewed as a non similarity function, instead of using similarity means. An ABC algorithm with edge potential function has been introduced with the aim to provide a solution to the problem for planes to recognize the target object. This hybrid method had the advantages of EPF accuracy and stability in recognizing the shape of the target, and ABC algorithm was accepted for optimization of the parameters of the matching.

In this article it is suggested using the BSF-ABC approach for object detection. The aforementioned approach is based on template matching by using the difference of histogram image and template image matching to the RGB level target object. The research aims at improving the quality of the solution, which is measured by the accuracy of the object detection and the time span of the optimization needed for solving the problem.

D. A. Simonyan, Institute for Informatics and Automation Problems of NASRA

R. A. Simonyan, Institute for Informatics and Automation Problems of NASRA

A method has been developed which allows the user of the system to configure the templates. That is to say, the user will have the opportunity to arrange the templates according to the characteristics of the environment, according to their preference. For instance in urban areas for surveillance of streets the preference will first be given to cars, motorcycles, humans and after this to other possible objects. If we have 10 templates and if the target is a car the system will compare with the template of the utmost importance, i.e. with cars, will recognize the target and will finish the work not comparing with other templates. In this way we will avoid wasting the time.

Firstly, let's speak about the method (function) of template matching, how the BSF-ABC can be implemented for object detection.

II. Template Matching Method (function)

In this work the difference of RGB level histogram and template object is presented as matching measure function.The number of pixels for each tonal value was compared with the plot of each independent channel of the triplet RGB level values. This resulted in the calculation of histograms of both the target and template images.

We will mark HI_i^x as target object histogram, HJ_i^x –as template object histogram, wherei can take a value from 0-255. The latter is the value of each level of the direction of RGBand x=(R,G,B).

Thus,

$$HI_i^x = \sum_{m=r}^{M} \sum_{n=c}^{N} g_{m,n},$$

where

$$g_{m,n} = \begin{cases} 1 \text{ ifvalue at } (m,n) \text{ in channel } x \text{ equal to } i \\ \quad 0 \text{ otherwise,} \end{cases}$$

(1)

$$HJ_i^x = \sum_{m=0}^{M} \sum_{n=0}^{N} g_{m,n},$$

where

$$g_{m,n} = \begin{cases} 1 \text{ ifvalue at } (m,n) \text{ in channel } x \text{ equal to } i \\ \quad 0 \text{ otherwise,} \end{cases}$$

where (r, c) show the coordinates of the flat of M x N dimension of the upper left corner angle of the template image in correlation to the target object. If the target object has A x B dimension, then $0 \le r \le A - M$ և $0 \le c \le B - N$.

To be more exact, figure 1 shows how the histogram of the image can be received from the template of the target, which has the size of 8x6 pixels and the template with the size of the pixels. Figure 1 depicts the value of each pixel in each image.

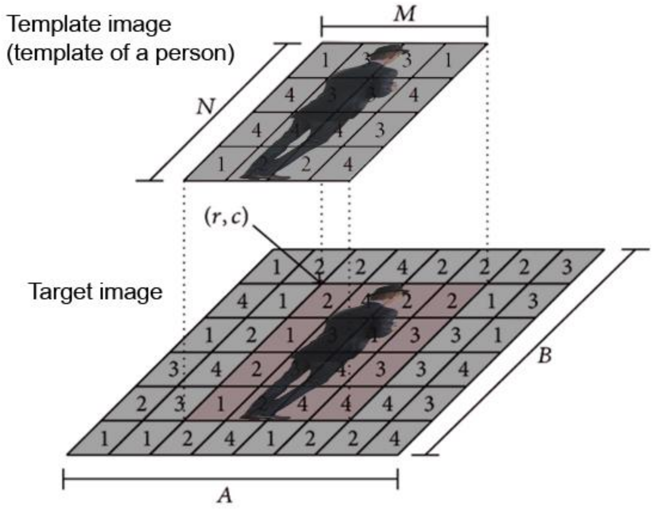

Fig. 1. The sample value of each pixel in the target and template images

Based on the assumption that the result of the matching of the difference of the histograms between the target object and the template object should be improved, and if we consider all the colors (red, green and blue), instead of turning them into grayscale by the presented Hsu and Dai [15], we can get the equation used to calculate the difference of the histograms of each level of colors matching to the target object and the template object. The calculation is done as follows:

For red bend,

$$D_R = \sum_{i}^{255} (HI_i^R - HJ_i^R)^2 \qquad (2)$$

for green,

$$D_G = \sum_{i}^{255} (HI_i^G - HJ_i^G)^2 \qquad (3)$$

for blue,

$$D_B = \sum_{i}^{255} (HI_i^B - HJ_i^B)^2 \qquad (4)$$

In the end deciding the difference between the histograms of RGB levels of the target object and the template object as it is given in (5) by calculating the sum of the difference of histograms of each level of colors matching to the target object and the template object, reflected from (2) to (4) and by normalizing it, using the sum of their square root values. The best matched image can be decided through finding the lowest value of the function.

$$D_B = \left(\sum_{i}^{255}(HI_i^R - HJ_i^R)^2 + \sum_{i}^{255}(HI_i^G - HJ_i^G)^2 + \sum_{i}^{255}(HI_i^B - HJ_i^B)^2\right) * \left(\sqrt{\sum_{i}^{255}(HI_i^R - HJ_i^R)^2} + \sqrt{\sum_{i}^{255}(HI_i^G - HJ_i^G)^2} + \sqrt{\sum_{i}^{255}(HI_i^B - HJ_i^B)^2}\right)^{-1} \quad (5)$$

III. The Implementation of the BSF-ABC in Object Detection

The BSF-ABC has been implemented for object detection, based on the matching of template. The aforementioned method has been described in the second part. Its aim is to find the matching (similarity) size global optimization. In other words, trying to find a possible solution, which is the coordinates of the flat of the upper left angle of the template image in correlation to the target image, which lower the value of the difference of RGB level histogram in (2). The implemented algorithm is presented in figure 2.

In figure 2 the initial solutions are generated. The parameters are taken as a nutrition source for the used/included bees. Every solution is implemented to move the template image in all the possible directions towards the target image. Afterwards, calculating value of the histogram of differences of RGB levels between target image and moved template image. Then the observer bees will choose the solutions which are based on the BSF-ABC method. The process will be repeated as many times as it is needed for the value of the difference to reach 0 or till the number of repetitions equals to MCN. The solutions which cannot lower the value of the difference of the histogram of RGB level in certain time period will be left out and new solutions will be created by scout bees.

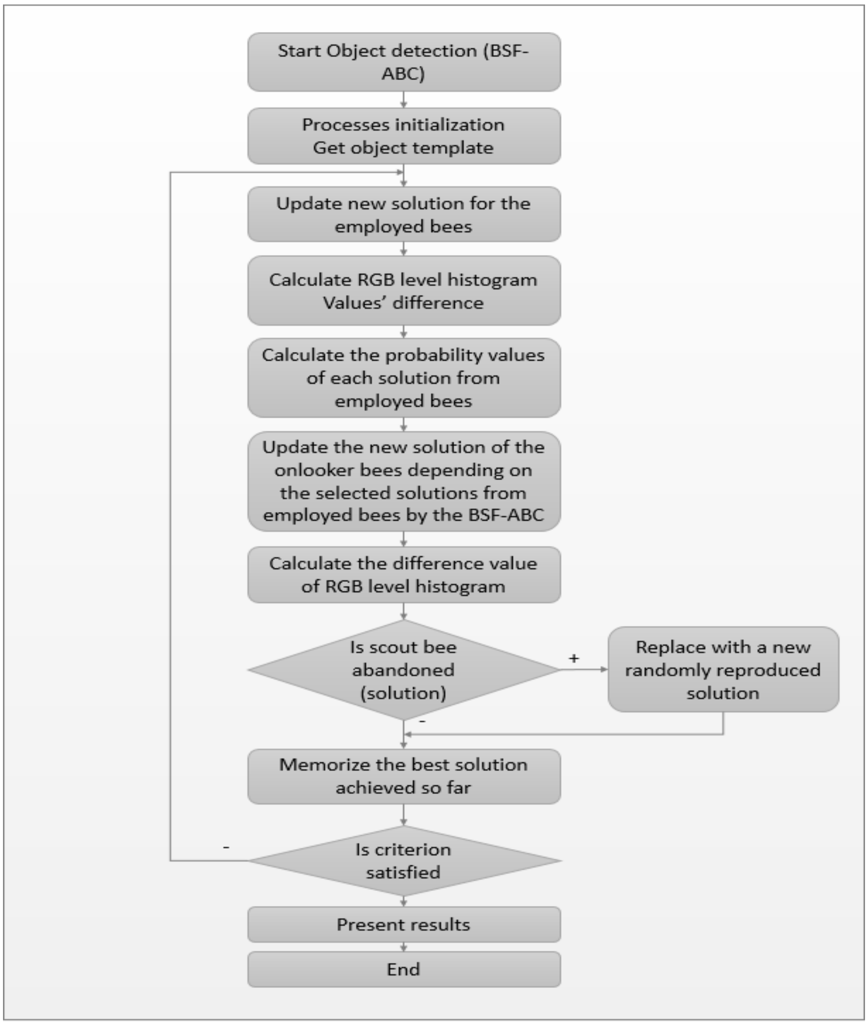

Fig.2. Object detection based on the BSF-ABC method.

IV. Conclusion

This work incorporates a suggestion on object recognition based on the matching of templates with the usage of the BSF-ABC method. The difference of the histogram of RGB level matching to the target object and the template object is presented here as a matching function. As well as, suggests opportunity to arrange the templates according to the characteristics of the environment. So, the system user is able to easily configure the recognition application.

The BSF-ABC algorithm speed with RGB histogram method have been compared with the previous works, including PSO with RGB histogram method, PSO with grayscale histogram method and PSO with normalized cross-correlation method. The accuracy of detection and calculation time being used in object detection, have been suggested as problem detection in this process.

The results got from the suggested methods show that the BSF-ABC with RGB histogram can detect objects more efficiently than the previously mentioned approaches, taking account the configuration feature, as well. Thus, we can conclude, that the BSF-ABC RGB histogram image matching is very effective in terms of both solution quality and algorithm work in real object recognition in the computer vision system.

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