Chapter 8
An Improved Artificial Bee Colony Algorithm for the Object Recognition Problem in Complex Digital Images Using Template Matching

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ABSTRACT

In this paper, the authors present an improved Artificial Bee Colony Algorithm (ABC) for the object recognition problem in complex digital images. The ABC is a new metaheuristics approach inspired by the collective foraging behavior of honey bee swarms. The objective is to find a pattern or reference image (template) of an object somewhere in a target landscape scene that may contain noise and changes in brightness and contrast. First, several search strategies were tested to find the most appropriate. Next, many experiments were done using complex digital grayscale and color images. Results are analyzed and compared with other algorithms through Pareto plots and graphs that show that the improved ABC was more efficient than the original ABC.

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1. INTRODUCTION AND RELATED WORK

Object recognition plays an important role in computer vision applications. It is challenging to recognize an object from visual information, since the recognition has to be invariant to changes in the object's appearance and environmental conditions. Considering that the object detection is one of the major tasks in the computer vision area, many techniques were proposed to detect patterns and retrieve information in images, by using low level features of the image or of a segmented region of it. Currently, common examples of object recognition in images can be found in areas such as industry, security, engineering, medical diagnosis and others. In general, recognition of objects in images using traditional search algorithms is computationally expensive. For many real-life applications, these algorithms should normally be executed in real-time. Hence, fast algorithms are essential at all stages of the recognition process in images (Pawar & Talbar, 2009). This fact suggests the use of fast algorithms based on metaheuristics. Recently, besides the traditional image processing techniques, several methodologies based on computational intelligence have been developed and applied to the object recognition problem, so as to reduce the computational cost and to improve the efficiency. Amongst them, metaheuristic population-based optimization algorithms, such as those from the Swarm Intelligence area, were successfully applied to that problem. For example, the algorithm Ant Colony Optimization algorithm (ACO) was applied for image thresholding (Zhao et al., 2008) and Particle Swarm Optimization (PSO) for object classification problems (Evans & Zhang, 2008).

The challenge of object recognition is to develop the ability to recognize objects even with significant variations in visual appearance due to changes in the form and color of the object, such as geometrical transformations, partial occlusions, and changes in illumination and contrast.

Generally, evolutionary computation algorithms, such as genetic algorithms (GAs) and others have been used in computer vision systems mainly to find optimized parameters, whilst actual image processing tasks have been handled by other standard methods. For instance, Pawar and Talbar (2009) investigated the effectiveness of several techniques for object recognition in digital images. Swets et al. (1995) developed a technique using a GA to combine the image segmentation and object recognition steps for a complex scene.

Silva, Lopes, and Lima (2008) as well as Perlin, Lopes, and Centeno (2008) presented two metaheuristic approaches, one based on Compact Genetic Algorithm (CGA) with elitism and mutation (emCGA) and the other based on Particle Swarm Optimization (PSO) for the object recognition problem. Results showed that both methods can be efficiently applied to practical situations with reasonable computational costs. This work follows the same direction, investigating a new metaheuristic approach for the same problem.

In recent years, a number of metaheuristic algorithms based on specific intelligent behaviors of honey bees swarms were proposed. They have been applied to several real-world problems, mainly to solve combinatorial problems (Karaboga, 2009). For instance, Tereshko and Loengarov (2005) proposed a collective decision model considering a bee colony as a dynamical system where intelligent decision-making arises from an enhanced level of communication among individuals. In their work, they discussed how the information exchange between the individuals leads to globally intelligent selection of food sources in an unpredictable environment. Karaboga (2005) proposed the Artificial Bee Colony (ABC) algorithm, based on the foraging behavior of real bees, and later compared its performance with other evolutionary and swarm based algorithms using a very large set of numerical functions (Karaboga & Akay, 2009). Karaboga and Basturk (2008) concluded that the ABC algorithm is a robust optimization algorithm that can be efficiently used in the