Chapter 5
Swarm Intelligence for Biometric Feature Optimization

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ABSTRACT

Swarm Intelligence (SI) and bio-inspired computation has gathered great attention in research in the last few years. Numerous SI-based optimization algorithms have gained huge popularity to solve the complex combinatorial optimization problems, non-linear design system optimization, and biometric features selection and optimization. These algorithms are inspired by nature. In biometrics, face recognition is a non-intrusive method, and facial characteristics are probably the most common biometric features to identify individuals and provide a competent level of security. This chapter presents a novel biometric feature selection algorithm based on swarm intelligence (i.e. Particle Swarm Optimization [PSO] and Bacterial Foraging Optimization Algorithm [BFOA] metaheuristics approaches). This chapter provides the stepping stone for future researchers to unveil how swarm intelligence algorithms can solve the complex optimization problems to improve the biometric identification accuracy. In addition, it can be utilized for many different areas of application.

1. INTRODUCTION

Generally hard or complex optimization problems are defined as problems cannot be solved to optimality or to any guaranteed bound by any deterministic (exact) approach within a 'reasonable amount of time. These problems can be divided into numerous categories depending on whether they are continuous or discrete domain, constrained or unconstrained, mono or multi-objective function based static or dynamic. In order to find satisfactory solutions for these problems, swarm intelligence (SI) algorithm or

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bio-inspired metaheuristics approaches play important role to get optimal solution of problems. Swarm Intelligence (SI) is an innovative distributed intelligent paradigm for solving the hard or complex optimization problems that takes motivation from the collective behavior of a group of social insect colonies, Ant Colony Optimization (ACO), fish schooling and other animal societies. SI systems are typically consists of a population of individual or simple agents (an entity capable of performing/executing certain operations) interacting locally with one another and with their environment. The entities of such system with very limited (optimal solution of certain individual populations) individual capability can jointly or cooperatively perform many complex tasks necessary for their survival. Although, normally in SI system has no centralized control structure and power dictating how individual agents should behave local interactions between such agents often lead to the emergence of global and self-organized behavior (Boussaïda, 2013).

A metaheuristics approach is an algorithm designed to solve approximately a wide range of hard optimization problems without having to deeply adapt to each problem. Indeed, the Greek prefix ''Meta'', present in the name, is used to indicate that these algorithms are ''higher level'' heuristics, in contrast with problem-specific heuristics. Metaheuristics are generally applied to a problem for which there is no satisfactory problem-specific algorithm to solve them. They are widely used to solve complex problems in industry and services, in areas ranging from finance to production management and engineering. Almost all metaheuristics approaches share the following characteristics:

- They are nature-inspired (based on some principles from physics, biology or ethology) and they make use of stochastic components (involving random variables).
- They do not use the gradient or Hessian matrix of the objective function.

They have several parameters that need to be fitted to the problem at hand bio-inspired computation and swarm intelligence based algorithms have attracted significant attention in recent years for solving the complex and combinatorial optimization problems of data clustering, feature selection and maximization of matching scores for authentication of human in biometrics (Tan & Bhanu, 2006) computer vision, data mining and machine learning based algorithms.

Motivated from the natural and social behavioral phenomena, bio-inspired computation algorithms have significant research area during the recent years from both multidisciplinary research and the scientific research purpose. In the last thirty years, a great interest has been devoted to bio-inspired metaheuristics and it has encouraged and provides successful algorithms and computational simulated tools for dealing with complex and optimization problems (Karakuzu, 2009).

These approaches are motivated from natural processes generally start with an initial set of variables and then evolve to obtain the global minimum or maximum of the objective function and it has been an escalating interest in algorithms motivated by the behaviors of natural phenomena which are incorporated by many scientists and researchers to solve hard optimization problems. Hard problems cannot be solved to optimality, or to any guaranteed bound by any exact (deterministic) method within a 'reasonable'' time limit (Rajabioun, 2011), (Chih & Huang, 2011), (Baojiang & Shiyonga, 2007), (Dorig, Maniezzo, & Colorni, 1996), (Farmer & Packard, 1986), (Kima, Abrahamb, & Choa 2007), (Kirkpatrick, Gelatt, & Vecchi 1983), (Tang et al., 1996). It is computational problems such as optimization of objective functions (Du & Li 2008); (Yao, Liu, & Lin, 1999) pattern recognition (Yi et al., 2008), (Tan & Bhanu, 2006) control objectives (Chih &Huang, 2011), (Karakuzu, 2008), (Kim, Maruta & Sugie, 2008), image