Chapter 4
Swarm Optimization

ABSTRACT

In this chapter, one of the optimization algorithms based on swarm behaviour of agents in search space called swarm particle optimization (PSO) is introduced. Also, a description about how to use PSO for neural network training is provided.

4.1 SWARM INTELLIGENCE

Another part of the research of Huzly, H. (2006) is about Swarm Intelligence (SI). A part of her description in her research in provided here: "SI is the latest of an artificial intelligence technique based around the study of collective behaviour in decentralized and self-organized systems. The idea of SI came from systems found in nature, including ant colonies, bird flocking and animal herding that can be effectively applied to computationally intelligent system. SI systems are typically made up from a population of agents interacting locally with one another and with their environment and local interactions between such nodes often lead to the emergence of a global behaviour. There are two major techniques in SI, which are the Ant Colony Optimization (ACO) and Particle Swarm Optimization (PSO). The ACO algorithm is a probabilistic technique for solving computational problems to finding good paths through graphs. They are inspired by the behaviour of ants in finding paths from the colony to food. While PSO (which is the focus of this project) is a technique where all the particles (or solutions) move to get better results. PSO is a new branch of the soft computing paradigms called evolutionary algorithms (EA)

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(Ismail, W., and shamsuddin, S. M., 2008). EA includes genetic algorithms (GA), evolutionary programming (EP), evolutionary strategies (ES) and genetic programming (GP). Before PSO, the most popular technique in evolutionary computing is Genetic Algorithm (GA). GA is widely used to determine BP learning parameters and weight optimization to make the convergence rate faster and avoid from being trapped in the local minima."

4.2 PARTICLE SWARM OPTIMIZATION

The original PSO algorithm is discovered through simplified social model simulation (Shi, 2004). PSO is a simple concept adapted from nature decentralized and self-organized systems such as choreography of a bird flock and fishing schooling. PSO is a population-based algorithm in which individual particles work together to solve a given problem. In PSO, physical position is not an important factor. The Population (or swarm) and the member called particle is initialized by assigning random positions and velocities and potential solutions are then flown through the hyperspace. The particles learn over time in response to their own experience and the experience of the other particles in their group (Ferguson, 2004). As mentioned before, PSO was introduced by Kennedy and Eberhart.

However in 1995, nowadays this concept has been explored by many other researchers around the globe and has been applied in many applications. Below are some application examples using PSO for optimization:

1. Application of Particle Swarm Optimization to design the electromagnetic absorbers by Suomin Cui* and Daniel S. Weile. (2005) Dept. of Electrical & Computer Engineering, University of Delaware. The synchronous PSO was applied to optimize multilayer coatings and polygonal absorbers for wide band frequency and/or wide incident range.
2. Human Tremor Analysis Using Particle Swarm Optimization by Russell C., Eberhart, and Xiaohui Hu (1999) where they present methods for the analysis of human tremor using particle swarm optimization. Two forms of human tremor are addressed which are essential tremor and Parkinson's disease.
3. Particle Swarm Optimization methods for pattern recognition and image processing by Mahamed G. H. Omran (2004) where PSO has been used to classify objects into different categories.