

Chapter XXXIV

An Improved Particle Swarm Optimization for Indoor Positioning

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ABSTRACT

Particle Swarm Optimization (PSO) is a newly appeared technique for evolutionary computation. It was originated as a simulation for a simplified social system such as the behavior of bird flocking or fish schooling. An improved PSO algorithm (IPSO) is introduced to solve the nonlinear optimization for indoor positioning. The algorithm achieves the optimal coordinates through iterative searching. Compared with standard PSO algorithm, the algorithm converges faster and can find the global best position. The error of position estimated by this algorithm is smaller than that estimated in Taylor Series Expansion (TSE) and Genetic Algorithm (GA). Thus this algorithm is proven to be a fast and effective method in solving nonlinear optimization for indoor positioning.

INTRODUCTION

The popularity of wireless access infrastructure and mobile devices satisfy requirements to access the required services ubiquitously. Meanwhile, providing additional value-added services based on wireless access infrastructure gets more and more interest. Mobile positioning is one of the possibilities. Many domains get benefits from indoor positioning of mobile units to provide useful applications and services, such as museum tour-guide, hospital health-care and location-based handoff. In the network base architectures, the network receives signals from mobile unit and utilizes necessary operation to evaluate position of mobile unit. The position estimations rely on different techniques: Received Signal Strength Indicator (RSSI), Angle of Arrival (AOA), Time of Arrival (TOA), Time Advance (TA), Time Difference of Arrival (TDOA), location fingerprinting or hybrid TDOA/AOA (Hata & Nagatsu, 1991; Jakes, 1994; Turin, Jewell & Johnston, 1972; Knapp & Carter, 1976; Izzo, Napolitano & Paura, 1994). However, not all techniques are suitable for indoor positioning because of the complexity in indoor environment.

The Particle Swarm Optimization (PSO) algorithm is a new sociologically inspired stochastic optimization algorithm introduced by Kennedy and Eberhart (1995) (Eberhart & Kennedy, 1995; Eberhart & Shi, 2001; Ratanaweera, Halgamuge & Watson, 2004; Foy, 1976; Kennedy, 2000; Angeline, 1998; Shi & Eberhart, 1998; Kennedy, 1997; Shi & Eberhart, 1998; Shi & Eberhart, 1999). The PSO algorithm is easy to implement, has few parameters, and has been shown to converge faster than traditional techniques like Genetic Algorithm (GA) for a wide variety of benchmark optimization problems. By initializing a random particle swarm, each particle keeps track of its coordinates in the problem space. It is demonstrated that PSO algorithm gets better results in a faster, cheaper way compared with other methods. In past several

years, PSO has been successfully applied in many research and application areas.

In this chapter we suggested to utilize an improved PSO (IPSO) to solve nonlinear optimization in TOA techniques. This chapter is organized as following sections. In the background, the standard PSO algorithm and proposed IPSO algorithm is briefly presented first. Second, the general idea of position estimated in IPSO is demonstrated. Third, the process of utilizing IPSO to resolve nonlinear optimization in TOA technique is explained in detail. Fourth, the simulated results are discussed and compared. In the end, summarization and conclusion are given.

PRELIMINARIES

As the preliminary of our work, the process of the IPSO algorithm is briefly illustrated as follows:

1. A population of particles with random positions and velocities is initialized in the problem space.
2. For each particle evaluate the optimization fitness function F_i . Then two compares will be executed. Firstly compare current particle's fitness evaluation with fitness evaluation of particle's local best position. If current value is better, then set fitness evaluation equal to the current value and the local best position equal to the current position in problems space. Secondly compare fitness evaluation with fitness evaluation of the population's global best position. If current value is better than the previous value of fitness evaluation, then reset to the current particle's array index and value.
3. In standard PSO, the velocity and position of the particle i are updated based on following equations:

$$\begin{aligned} v_{ix}^{t+1} &= \omega * v_{ix}^t + c_1 * r_1 * (p_{ix} - x_i^t) + \\ & c_2 * r_2 * (p_{gx} - x_i^t) \end{aligned} \quad (1)$$

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