ABSTRACT

SÁ, Alan Oliveira de. *Collaborative Localization in Swarm Robotics*. 2015. 128f. Dissertação (Mestrado em Engenharia Eletrônica) – Faculdade de Engenharia, Universidade do Estado do Rio de Janeiro, Rio de Janeiro, 2015.

Many applications of Swarm Robotic Systems (SRSs) require that a robot is able to discover its position. The location information of the robots is required, for example, to allow them to be correctly positioned within a predefined swarm formation. Similarly, when the robots act as mobile sensors, the position information is needed to allow the identification of the location of the measured events. Due to the size, cost and energy source restrictions of these devices, or even limitations imposed by the operating environment, the straightforward solution, *i.e.* the use of a Global Positioning System (GPS), is often not feasible. The method proposed in this work allows the estimation of the absolute positions of a set of unknown nodes, based on the coordinates of a set of reference nodes and the distances measured between nodes. The solution is achieved by means of a distributed processing strategy, where each unknown node estimates its own position and helps its neighbors to compute their respective coordinates. The solution makes use of a new method called Multi-hop Collaborative Min-Max Localization (MCMM), herein proposed, aiming to improve the quality of the initial positions estimated by the unknown nodes in case of failure during the recognition of the reference nodes. The positions refinement is achieved based on the Backtracking Search Optimization Algorithm (BSA) and the Particle Swarm Optimization (PSO), whose performances are compared. To compose the objective function, a new method to compute the confidence factor of the network nodes is introduced, the Min-max Area Confidence Factor (MMA-CF), which is compared with the existing Hops to Anchor Confidence Factor (HTA-CF). Based on the proposed localization method, four algorithms were developed and further evaluated through a set of simulations in MATLAB® and experiments in swarms of type *Kilobot* robots. The performance of the algorithms is evaluated on problems with different topologies, quantities of nodes and proportion of reference nodes. The performance of the algorithms is also compared with the performance of other localization algorithms, showing improvements between 40% to 51%. The simulations and experiments outcomes demonstrate the effectiveness of the proposed method.

Keywords: Localization; Swarm Robotic System; Swarm Intelligence; Wireless Sensor Network; Particle Swarm Optimization; Backtracking Search Optimization Algorithm.