ABSTRACT

Wireless Sensor Network (WSN) is a kind of ad hoc network that consists of autonomous sensors with low cost, low energy sensing devices, which are connected by wireless communication links. These sensor nodes are tiny in size and possess limited resources namely processing, storage, sensing and communication. They are usually deployed in large numbers over the region of interest for object monitoring and target tracking applications. The densely deployed sensors are expected to know their spatial coordinates for effective functioning of WSNs. Location awareness plays an important role in high-level WSN applications like locating an enemy tank in a battlefield and locating a survivor during a natural calamity and in certain low-level network applications like geographic routing and data-centric storage. Localization is a fundamental problem which can be defined as the process of finding the position of the sensor nodes or determination of spatial coordinates of the sensor nodes. Localization is especially important when there is an uncertainty on the exact location of fixed or mobile devices.

Sensor Node Localization is considered today as one of the most important issues in a Wireless Sensor Network (WSN) as it is formulated as an NP-Hard optimization problem. The determination of physical

co-ordinates of a group of sensor nodes in a WSN serves as one of the challenging problems and is referred to as the localization problem. The location information plays a vital role for coverage, deployment of sensor nodes, routing and target tracking applications. In most of the applications of sensor networks, the information gathered by sensors will be meaningful only when the location of the sensor nodes is known. Many applications such as routing and target tracking are all location dependent. This work aims at determining the location of the sensor nodes with very high precision. Range-free algorithms sometimes use the mobile anchors for localization. Range-free algorithms are not costly but they provide coarse-grained accuracy. Mobile Anchor Positioning (MAP), a range-free localization method used in this work uses the content of messages received from anchor nodes to estimate the location of unknown sensor nodes. As the anchors move through the network, they broadcast their location as beacon packets. The sensor nodes use the location information of beacon packets obtained from mobile anchors as well as the location packets from neighbouring nodes to calculate their location.

Localization in Wireless Sensor Networks is intrinsically an unconstrained optimization problem. Evolutionary algorithms are local search methods, capable of efficiently solving complex constrained or unconstrained optimization problems. Our proposed evolutionary approaches for Localization are MAP with Genetic Algorithm (MAP-GA), MAP with

Particle Swarm Optimization (MAP-PSO) Algorithm, MAP with Genetic Simulated Annealing (MAP-GSA) Algorithm, Differential Evolution with MAP (DE-MAP) Algorithm, Cuckoo Search with MAP (CS-MAP) Algorithm, Modified Cuckoo Search with MAP (MCS –MAP) Algorithm and Firefly Optimization Algorithm with MAP (FOA–MAP). We have incorporated the proposed algorithms using the results of MAP algorithm as input to each of them in order to enhance the location accuracy further and to analyze the performance of MAP-GA, MAP-PSO, MAP-GSA, DE-MAP, CS-MAP, MCS–MAP and FOA-MAP approaches respectively with regard to MAP. Root Mean Square Error (RMSE) is used as a performance metric to compare between the proposed evolutionary approaches.

Some of the evolutionary algorithms are getting trapped into local minimum. Therefore, we solved this problem by proposing a hybrid evolutionary algorithm i.e. Genetic Algorithm with Simulated Annealing (GSA) and applied it for mobile anchor localization. In order to avoid getting trapped into local minimum as well as to provide faster convergence, we have applied recent meta-heuristic techniques such as CS-MAP, MCS–MAP and FOA-MAP over the results of MAP. Moreover, a good meta-heuristic technique will be able to employ heuristics methods by guiding them over the search space in order to exploit its best capabilities to achieve better solutions. Simulation results verify the fact that out of the proposed evolutionary approaches mentioned for localization with mobile anchors, Firefly

Optimization Algorithm with Mobile Anchor Positioning (FOA–MAP) seems to be the effective meta-heuristic localization approach when compared to the other proposed approaches in bringing down the localization error to a greater extent and also for providing faster convergence.