

## Unified Coordinate System Approach for Swarm Search Algorithms in Global Information Deficit Environments

**Authors :** Rohit Dey, Sailendra Karra

**Abstract :** This paper aims at solving the problem of multi-target searching in a Global Positioning System (GPS) denied environment using swarm robots with limited sensing and communication abilities. Typically, existing swarm-based search algorithms rely on the presence of a global coordinate system (vis-à-vis, GPS) that is shared by the entire swarm which, in turn, limits its application in a real-world scenario. This can be attributed to the fact that robots in a swarm need to share information among themselves regarding their location and signal from targets to decide their future course of action but this information is only meaningful when they all share the same coordinate frame. The paper addresses this very issue by eliminating any dependency of a search algorithm on the need of a predetermined global coordinate frame by the unification of the relative coordinate of individual robots when within the communication range, therefore, making the system more robust in real scenarios. Our algorithm assumes that all the robots in the swarm are equipped with range and bearing sensors and have limited sensing range and communication abilities. Initially, every robot maintains their relative coordinate frame and follow Levy walk random exploration until they come in range with other robots. When two or more robots are within communication range, they share sensor information and their location w.r.t. their coordinate frames based on which we unify their coordinate frames. Now they can share information about the areas that were already explored, information about the surroundings, and target signal from their location to make decisions about their future movement based on the search algorithm. During the process of exploration, there can be several small groups of robots having their own coordinate systems but eventually, it is expected for all the robots to be under one global coordinate frame where they can communicate information on the exploration area following swarm search techniques. Using the proposed method, swarm-based search algorithms can work in a real-world scenario without GPS and any initial information about the size and shape of the environment. Initial simulation results show that running our modified-Particle Swarm Optimization (PSO) without global information we can still achieve the desired results that are comparable to basic PSO working with GPS. In the full paper, we plan on doing the comparison study between different strategies to unify the coordinate system and to implement them on other bio-inspired algorithms, to work in GPS denied environment.

**Keywords :** bio-inspired search algorithms, decentralized control, GPS denied environment, swarm robotics, target searching, unifying coordinate systems

**Conference Title :** ICMASRAI 2021 : International Conference on Multi-Agent Systems, Robotics and Artificial Intelligence

**Conference Location :** New York, United States

**Conference Dates :** January 28-29, 2021