Chapter 10
Fusion of Gravitational Search Algorithm, Particle Swarm Optimization, and Grey Wolf Optimizer for Odor Source Localization

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ABSTRACT

This chapter concerns the problem of odor source localization by a team of mobile robots. A brief overview of odor source localization is given which is followed by related work. Three methods are proposed for odor source localization. These methods are largely inspired by gravitational search algorithm, grey wolf optimizer, and particle swarm optimization. Objective of the proposed approaches is to reduce the time required to localize the odor source by a team of mobile robots. The intensity of odor across the plume area is assumed to follow the Gaussian distribution. Robots start search from the corner of the workspace. As robots enter in the vicinity of plume area, they form groups using K-nearest neighbor algorithm. To avoid stagnation of the robots at local optima, search counter concept is used. Proposed approaches are tested and validated through simulation.

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INTRODUCTION

Multi Robot System

Multi robot system can be defined as a group of homogeneous or heterogeneous robots working together to achieve the desired goal. The ability of a multi-robot system to detect, locate or follow a target either in known or unknown area, has various valuable applications in real life. Applications of target searching include search and rescue after disaster, toxic gas detection, narcotics or explosives localization and so on. For instance, the use of autonomous robots for search task in dangerous environment has been receiving consistent attention. Searching using a team of mobile robots, instead of a single robot has potential advantages (viz. fault tolerance, accuracy) and also has numerous challenges (viz.coordination, communication, collision avoidance.

Target Searching

The problem of target localization concerns with the navigation of one or more robot towards the target source. Target may be static or mobile, intensity of plume may be constant or plume may vary, number of target may be one or many. Depending on the target a broader spectrum of target locating problems have emerged ranging from odor source localization (Jatmiko et al. 2011), target localization and tracking (Ramya et al. 2012), search and rescue (Liu, Y., & Nejat, G. 2013) and so on.

Odor Source Localization

Localization of an odor source can be seen as a behavioral problem which differs from animal to animal. Some animal senses the fluid concentration (lobster), some makes use of residues on the surface, while others can trace the plume in air (moths) or can use combination of information (dogs). Information of odor is widely used by animals for information exchange, finding mates and searching for food in nature. Advancement in the area of robotics and sensor technology has motivated researchers to use robots for odor source localization in environment harmful for human beings.

The process of odor source localization can be divided into three phases: odor plume finding, plume following and odor source declaration. During plume finding, robots keep on moving in workspace to encounter the plume area. Once the plume is find robots enter in the second phase i.e. plume following. In this phase robots follow the plume to find the odor source. Odor source declaration is the process of declaring that source has been found.

In order to make robots work, set of rules need to be defined. Such rules can be formulated in the form of an algorithm. Many species in the environment follow