Cooperative Search and Rescue with Swarm of Robots Using Binary Dragonfly Algorithm

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***Abstract*— This paper presents development and evaluation of an intelligent algorithm for swarm mobile robots cooperation. This algorithm can be shared between collections of robots to cooperate in order to achieve search and rescue tasks. A binary dragonfly algorithm has been modified by considering two more behaviors; obstacle avoidance and communication constrains. The implemented algorithm has been tested to check its performance in reaching the best solution and to reach an optimal solution within relatively shorter time. The performance of the robotic dragonfly algorithm has been compared with other search and rescue algorithms and the obtained results demonstrate its features in cooperation to reach a single objective.**

Keywords: *Swarm robotic, Multi-robots collaboration, Optimization techniques, intelligent algorithms, Search and rescue.*

1. INTRODUCTION

Recently, mobile robots are widely used to achieve different tasks such as searching and rescuing, especially in dangerous environments. It is clear that each simple mobile robot in its working area has a simple role, but the collection of mobile robots can be arranged to perform complex tasks. The need for effective techniques that assist in search and rescue problems has been increased to reduce human's fatalities and injuries [1]. The major replacement was in using robots and integrating their features to reach the victim within shorter time. Several researches [2-5] proposed various algorithms to solve search and rescue problems in a trial to replace human involvements in such dangerous situations. Particle Swarm Optimization [6], Ant Colony Optimization [7], Artificial Fish Swarm Optimization [8], and other techniques were used vastly and resulted in number of benefits and drawbacks.

Most available approaches deal with searching algorithms of multi robots in a simulated environment. Few published papers deal with limited number of real robots (two or three mobile robots) and ignoring optimality and computational problems [9]. The major replacement was in using robots which was evolved to the use of swarm of robots in order to integrate their features to reach the victim within shorter time. Coucerio and his group [6] developed Darwinian Particle Swarm Optimization [DPSO] approach to control a group of robots for search and rescue problems. It is an enforcing multi-hop network connectivity algorithm based on DPSO, and it is denoted as RDPSO (Robotic DPSO). It benefits from the dynamically partitioning of the whole robots population and decreasing the amount of information exchanging. Couceiro et.al [10] applies the equations of Fractional Order DPSO (FODPSO) in order to control the convergence rate of the robots. A control algorithm for target search and trapping of swarm robots inspired by bacteria chemotaxis has been developed by Yage et. al [11]. However, Dadgar, et. al [12] worked with unknown environments in target search of multi-robot problem. Their goal were to propose an algorithm based on PSO and the extension of PSO which they worked on is adaptive robotic PSO which focus on a single search problem and it works as the controlling mechanism of robots. Moreover, Nakisa et. al [13] represent the multi-swarm particle swarm optimization with local search on multi-robot search system. The goal is to reach the optimal solution of a given target without falling in the sub-optimal solution which is the main problem of this method in a complex environment with static obstacles.

This paper is focusing on the search and rescue problem using swarm of robots and tries to propose an enhanced solution with respect to the searching time. By looking for a time-efficient meta-heuristic algorithm, it has to be applied to swarm of robots. It is expected to obtain an enhanced solution that is able to reach the target within relatively shorter time. The main objective of this work is to adopt a meta-heuristic algorithm for swarm of robots taking into account the constraints of the robotic environment. Moreover, to obtain accurate swarm of robots, it is required to obtain the optimal solution to achieve a single task in the field of search and rescue. Finally, a suitable simulator on MATLAB has been used to simulate the proposed solution for validation, and then applying these solutions on mobile robots in a real environment.

The rest of the paper is organized as follows; the general concepts of search and rescue issues are given in section 2. The design principle of the binary dragonfly algorithm is given in section 3. This algorithm has been modified to deal with swarm robots as described in section 4. A multi robot simulator is used as a virtual environment to check performance of the proposed algorithm is given in section 6, while evaluation of the simulation results are discussed in section 6. Finally, conclusion and some suggested future work are given in section 7.