Multiobjective Cuckoo Search for Anticipating the Enemy's Movements in the Battleground

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ABSTRACT

Since ages nations have been trying to improve their military effectiveness by adopting various measures. Having an anticipatory system, which can not only accurately predict the most probable location for the enemy's base station but also finds the best route to that point, will lead to improved military operations. This paper aims to propose an integrated framework for developing an efficient anticipatory system. In the first phase of the framework, it proposes Anticipatory Multi objective Cuckoo Search (AMOCS) algorithm to identify the best probable location for deployment of enemy forces. For the second phase a hybrid CS-ACO algorithm is developed for obtaining the most suitable path to the location identified in the first phase. To test the proposed system, satellite image of regions with different terrain types namely plain/desert and mountainous respectively, are chosen. Experimental results demonstrate that the system makes accurate predictions.

Keywords: *Anticipatory System, Battlefield Planning, Hybrid Cuckoo Search-Ant Colony Optimization, Multi Objective Cuckoo Search*

INTRODUCTION

In present combat scenario, it has become imperative for military to have a computation system which can anticipate the probable actions of the enemy's maneuver and troop's mobilization. However, it is a very important and challenging task as it involves numerous parameters like transportation cost, logistics and connectivity. With increased computing power, researchers are in the process of adding an intelligent aspect to these systems using nature inspired techniques. These techniques have developed over the past few decades to effectually address problems across an extensive range of domains (Kari, 2008). Their competences to handle imprecision, uncertainty, vagueness and high dimensionality (Yang, 2011) make these techniques a prime contender for the development of anticipatory computation systems also.

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Here, we have perceived the problem of intelligent preparation of the battlefield as a multi objective optimization problem, and proposed a framework for developing an efficient anticipatory system with two fold objectives -i) To predict the enemy's deployment strategy, i.e., to recognize the most probable location for the enemy to position their forces, and ii) To find out the shortest and feasible route to the targeted enemy's base station from our nearest friendly base location. First objective is achieved by exploiting the intelligent tactic of brood parasitism and egg mimicry of cuckoo bird. The proposed algorithm is termed as Anticipatory Multi-objective Cuckoo Search (AMOCS). For the second objective, the Cuckoo Search (CS) (Yang, 2009) technique is combined with another well-known nature inspired meta-heuristics, Ant colony optimization (ACO) (Dorigo, 2005) to find the optimal path (safest and shortest path) (Brand, 2010) from our base station to the predicted enemy's site. For the validation of developed methods, the real time satellite image datasets are used. Integration of satellite and computer technology has greatly enhanced the information available to the commanders in the battlefield. Defense and security applications have come to rely on satellite imagery as a crucial source of information offering knowledge of the territory, discrete surveillance and frequent passes over any point on earth (Lillesand, 2004; Wilkinson, 2005). In order to cover the different types of terrains, experiments have been carried out with a plain/desert region of Alwar area, Rajasthan, India and mountainous region of the Patalganga area, Maharashtra, India.

Organization of the rest of the paper is as follows. Next section presents a brief literature review followed by the discussion for the need of anticipatory systems in the battleground and our motivation to carry out this work. The proposed frame work of the anticipatory system and the mathematical formulation for both the algorithms is presented in the next two sections followed by the details of two algorithms AMOCS and CS-ACO. Applicability of developed algorithms is tested by undertaking two case studies, details of which are presented in second last section. The conclusion of the paper is discussed in the last section with some suggestions for future work.

LITERATURE REVIEW

Multi-objective Evolutionary Algorithms (MOEAs) have started receiving attention from researchers to handle Multi-objective Problems (MOPs). Although the first MOEA was published in the mid-eighties (Schaffer, 1985), a substantial progress has been observed in the past decade. Different researchers surveyed the MOEAs based on assorted aspects. Among these surveys, some are mainly on generic methodologies (Fonseca,1995; Coello,2000; Veldhuizen,2000; Gong, 2009); some are on theoretical developments and applications (Coello,2005); some researchers focus on special methods for MOPs, for example simulated annealing (SA) (Suman,2006), particle swarm optimization (PSO) (Sierra, 2006), and memetic algorithms (Knowles, 2004). These newly developed MOEAs are attempted to solve problems in wide variety of problems like combinational problems (Ehrgott,2004; Jaszkiewicz,2011); engineering problems (Coello, 2005; Andersson,2000; Marler, 2004), scheduling problems (Lei, 2009), economic and finance problems (Tapia, 2007), automatic cell planning problems (Luna, 2010), traveling salesman problems (Lust, 2010), and preferences in MOPs (Coello, 2000). In 2011, Zhoua summarized latest developments on MOEAs mainly discussing the continuous MOPs, while the works on combinational MOPs was covered by Jaszkiewicz (2011). With the development of new evolutionary techniques, researchers are in the process of developing new MOEAs based on the novel EAs. This paper aims to handle MOP of battlefield using an EA cuckoo search introduced in 2009.