A New Approach of Midrange Exploration Exploitation Searching Particle Swarm Optimization for Optimal Solution

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***Abstract*—The conventional Particle Swarm Optimization (PSO) was introduced as an optimization technique for real applications such as image processing, tracking, localization, and scheduling. However, conventional PSO still has its limitation in finding optimal solutions and is always trapped in the local optima. Therefore, the concept of conventional PSO was unsuitable to be used in dynamic problems. In order to address these issues, we have introduced a novel enhancement approach known as Midrange Exploration Exploitation Searching Particle Swarm Optimization (MEESPSO) to categorize the particle into resident particles and migrant particles according to midrange value. A migrant particle will execute the process of exploration to other search spaces, meanwhile resident particles went through the process of exploitation accordingly to the best solution. The comparison result shows that MEESPSO has the talent to increase the accuracy in a real application.**

Keywords — PSO, MEESPS, Dynamic Environment

I. INTRODUCTION

Particle Swam Optimization (PSO) [1] was a searching algorithm that was applied to real problems such as scheduling [2], traveling salesman problems [3], [4], image processing [5], tracking [6], [7] and localization [8]. However, the dynamic environment in real problem still brings challenges to PSO due to the changes in data over time [9], [10], the size of search space [11], [12] and the velocity in solving the issues in real-time [13].

For instance, a large search space requires more particle exploration. The lack of exploration in the search space can cause particles to be more easily trapped into local optima [14], [15]. This problem may cause the searching results are not optimum. Therefore, the enhancement concept in exploration is necessary in order to avoid the particles from being trapped into local optima [16].

However, excessive exploration can cause the search for optimal solutions to become longer [17]. The searching that takes more time will make the algorithm unsuitable to be applied in real-time applications [18]–[20]. This is because the algorithm in the real-time application should be able to sense the environment changes and be able to react faster accordingly to the changes [21], [22]. Thus, a balance particle exploitation is important to speed up the search for optimal value.

Moreover, the concept of conventional PSO makes the particles do not have properties of self-adaptation in their performance [18], [19], [23]–[25]. Where, the particles are only attracted to the global best without competing to each other. Thus, this concept will cause particle loss of the diversity to explore and exploit to a new search area [26], [27]. This concept is not suitable in a dynamic environment. In a dynamic environment, the self-adaptation ability is required to adapt to the changes that occur. This self-adaptation is a way of avoiding the particle from being stuck in the same position until the end of the iteration [18], [28]. Therefore, the enhancement of particle performance was needed for the process. In which, this concept can allow the particle to explore a new search space area and able to avoid the premature convergence caused by the trapped particle [29].

Furthermore, the dynamic changes may cause the outdated of the particle's memory [30]–[32]. In which, the changes in the environment may cause the previous global best position of PSO to become invalid [33]. This will be misleading information to the particles and the particle will continue searching for a poor solution. Thus, the particle's memory needs to re-evaluate based on the new changes in data and explore a new global best to find the new optimum solution and produce an accurate searching result [34]. Hence, the main challenge of PSO in a dynamic environment is to obtain the best optimal solution and prevent the particles from being trapped in the local optimal.

The subsequent sections of the paper are structured as follows. Section 2 discuss the related word of this paper. Section 3 present proposed variant of PSO. The outline of the experimental setup is presenting in Section 4. Meanwhile, Section 5 revels the results of the new enhancement algorithm with the existing variant in PSO. Finally, section 6 includes the conclusion of the study.

II. RELATED WORK

In recent years, PSO has extensively studied to extend the issue of particles getting trapped in local optima particularly in dynamic environment. Once such improvement is the Differential Evaluation Particle Swarm Optimization (DEPSO) algorithm, which combines the concepts of PSO and Differential Evaluation (DE) [35]. DEPSO has shown promising results in reducing the digital filters in dynamic environment by generating a new child from the mutation of the parent with weight error. Where in this concept, the child and the parent will be competing for the best place. The results indicate that DEPSO exhibited fast convergence in smallest number of iterations. However, DEPSO faced a challenge as the children were unable to outperform their parents, leading to an increase in the complexity of DEPSO due to its fundamental concept having a lesser impact. Due to this problem the convergence rate of DEPSO was faster and may also lead to the premature convergence. This issue will limit the ability of the particle to be explore in new