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A FUZZY HYBRID GA-PSO ALGORITHM FOR MULTI-OBJECTIVE AGV SCHEDULING IN FMS

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Abstract
An automated guided vehicle (AGV) is a mobile robot with remarkable industrial applicability for transporting materials within a manufacturing facility or a warehouse. AGV scheduling refers to the process of allocating AGVs to tasks, taking into account the cost and time of operations. Multi-objective scheduling is adopted in this study to acquire a more complex and combinatorial model in contrast with single objective practices. The model objectives are the makespan and number of AGVs minimization while considering the AGVs battery charge. A fuzzy hybrid GA-PSO (genetic algorithm – particle swarm optimization) algorithm was developed to optimize the model. Results have been compared with GA, PSO, and hybrid GA-PSO algorithms to explore the applicability of the algorithm developed. Model's feasibility and the algorithms' performance were investigated through a numerical example before and after the optimization. The model evaluation and validation was conducted through simulation via Flexsim software. The fuzzy hybrid GA-PSO surpassed the other methods, although obtaining less mean computational time was the only significant improvement over hybrid GA-PSO.
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Key Words: Automated Guided Vehicle, Scheduling, Multi-Objective Optimization, Genetic Algorithm, Particle Swarm Optimization, Fuzzy Hybrid GA-PSO

1. INTRODUCTION

AGVs are driverless mobile vehicles that are computer-controlled (usually battery operated) and equipped with different guidance systems (optical, magnetic, laser, etc.) for automated functionality [1]. AGVs are extensively used in flexible manufacturing system (FMS) for applications where long-distance horizontal transport of materials from/to multiple destination points is required and/or the material transport entails repetitive/predictable and/or dangerous tasks. Efficient scheduling of them would increase the productivity and reduce the delivery cost whilst the entire fleet is optimally utilized [2].

AGV scheduling refers to the process of allocating AGVs to tasks, taking into account the cost and required time for the operations [3, 4]. Although AGVs scheduling problem has been dealt with before [5-9], it is still an open area of research to improve it for real environment results by considering number of AGVs and their battery charge while minimizing the makespan. Makespan minimization keeps the resources utilization rate at a balanced level and results in a better implementation of expensive FMSs [8, 10]. In addition, performance of the AGV systems is heavily influenced by the number of vehicles employed, because AGVs are expensive devices that determining the type and the appropriate number of them in an FMS largely influences the profitability of the FMS [9, 11, 12], and the appropriate use of AGV's battery charge [13, 14]. Multi-objective scheduling of AGVs problem is NP hard; thus, a fuzzy hybrid GA-PSO that is a hybrid evolutionary algorithm has been applied to the proposed model in this study. GA and PSO are two well-known metaheuristic methods in optimization and both have remarkable capabilities such as 'balancing between exploration and exploitation' and 'combinatorial problem solving'. Hence, by integrating the advantages of the compensatory properties of PSO and GA their hybrid can yield better results [15-17].