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Simultaneous scheduling of machines and automated guided vehicles: graph modelling and resolution*

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Abstract

This paper deals with scheduling in automated manufacturing environments and more especially with the problem of simultaneous scheduling of machines and identical automated guided vehicles (AGVs) which are well known difficult to solve problems and can be considered as an extension of the job shop problem. Therefore, the studied problem can be modelled as a job shop where the jobs have to be transported between machines by AGVs. The objective is to provide an efficient resolution scheme with the objective of minimizing the makespan. This article introduced a framework based on a disjunctive graph to modelize the joint scheduling problem and on a memetic algorithm for jobs sequence generation on machines, AGVs sequence generation and vehicles assignments to transport operations. Computational results are presented for a benchmark literature instances. New upper bounds are found, showing the effectiveness of the presented approach.

Key words: FMS, Job-Shop, Transport, Job-shop

1 Introduction

Automated Guided Vehicles (AGVs) are among various advanced material handling techniques that are finding increasing applications today. They can be interfaced to various other production and storage equipment and controlled through an intelligent computer control system. Both the scheduling of operations on machines as well as the scheduling of AGVs are essential factors contributing to the efficiency of the overall flexible manufacturing system (FMS) [1]. An increase in the performance of the FMS under consideration would be expected as a result of making the scheduling of AGVs an integral part of the overall scheduling processes.

The considered FMS scheduling problem has the same structure as introduced in 1993 by Ulusoy and Bilge [2] and successively studied by [3][4][5][6][7]. It is concerned with the simultaneous scheduling of machines and AGVs in a flexible manufacturing environment where set of different machines perform different tasks and a set of identical AGVs perform material handling and transportation tasks between machines. The problem addressed in this paper thus falls into the classification of NP-complete combinatorial problems for which efficient optimal solution procedures do not exist [8]. Scheduling can be done in a static mode (off-line scheduling) prior to

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