Design and implementation of real-time scheduling algorithms for flexible manufacturing systems

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Abstract: The objective of this research is to design and implement real-time scheduling algorithms for flexible manufacturing systems. Four CNC machines with a load/unload station and a conveyor belt are combined as a flexible manufacturing system. Three fuzzy-based scheduling algorithms have been developed for operation sequencing, task sequencing and routing. LabVIEW environment has been used for the system modelling and testing. Several case studies have been carried out to test and verify the flexibility of the system and the effectiveness of the proposed schedulers. The obtained results indicate that the proposed scheduling algorithms for sequencing and routing are promising for such FMS. The performances of the proposed fuzzy scheduling algorithms are compared with those obtained from published literature.

Keywords: Flexible manufacturing systems, Scheduling algorithms, Fuzzy logic, Routing flexibility, LabVIEW simulation.

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1 Introduction

The concept of flexible manufacturing allows systems to be responding in the case of changes according to the production requirements of the markets to meet customer demand (Singh et al., 2014). The term flexibility, which is the main goal of advanced production technology, means "the ability of a system to cost effectively varies its output within a certain range and given timeframe" (Business Dictionary, 2016). A flexible manufacturing system (FMS) is a computer-controlled system consisting of programmable numerically controlled (CNC) machines, tools, load/unload stations, inspection stations, automated material handling system, and a real-time control system. The main features of FMS are flexibility in machine use, material handling, operation, system volume, and system routing (El-Tamimi et al., 2012). The flexibility of any FMS depends upon several variables such as: production planning activities, available equipments and tools, and the implemented control methodology. If these variables are used efficiently, a FMS could help to minimize machine setup time, reduce the manufacturing cycle time, increase productivity, improve quality, and reduce the total cost of the product. New advances in computer technology together with the FMS concepts can be applied to efficiently manufacture low to medium volume production of goods with considerable low cost. The performance of any FMS can be enhanced by careful production planning and scheduling of resources. This can be achieved by using computer intelligence in developing real-time scheduling and routing algorithms to allow jobs that travel along several routes through various machines (Al-Aubidy et al., 2015). The goal of scheduling is to make efficient use of available resources over a certain period of time to meet required performance; this can be achieved by applying knowledge-based scheduling (Priore et al., 2015).

Scheduling is a decision-making process and represents the short-term control level in manufacturing systems. "It deals with the allocation of resources to tasks over given time periods and its goal is to optimize one or more objectives" (Pinedo, 2015). Scheduling can be divided into four types; timing, sequencing, routing, and priority setting. The scheduling methodology depends mainly on the architecture of the FMS and concepts used in the design of the applied algorithms.