Ain Shams University
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Production Scheduling in Cellular Manufacturing

A Thesis
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Statement

This thesis is submitted in the partial fulfillment of Master degree in Mechanical Engineering, to Ain Shams University.

The author carried out the work included in this thesis, and no part of this thesis has been submitted for a degree or qualification at any other university.

Signature

Mohamed Mahmoud Saleh

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Abstract

Robotic cells are considered one of the strong options to increase productivity as robots have the capability of performing repetitive actions with high speed and accuracy. One of the difficulties related to robotic cells is selecting the optimum robot cycle and jobs sequencing.

Most of work was directed to robot moves scheduling and parts sequencing of two and three machines robotic cells. In this work four-machine robotic cell producing identical and different part types is studied opting minimize the cycle time.

A genetic algorithm was developed to solve the problem. The results of the developed genetic algorithm are compared with the optimal solution as obtained from a full enumeration of all possible cycles. The results showed that the developed genetic algorithm could solve the scheduling problem of four machines robotic cell reaching the optimal solution for most of the tested problems.

Key Words: Scheduling, Robotic Cells, Flexible Manufacturing Systems, Cellular Manufacturing.

Summary of the Master Thesis

"Production Scheduling in Cellular Manufacturing"

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Robotic cells showed great efficiency in increasing the productivity and reliability of manufacturing systems. Scheduling and control of these cells is considerably complex where most of the robotic cycles are NP hard. As much as the number of machines included in the cell increases, the number of NP hard increases which makes the scheduling of robotic cells becomes more challenging and considered one of the attractive research interests.

In the scheduling of robotic cell there are two main issues; to determine the schedule of the robot moves and sequencing of parts. Sometimes the sequencing of parts vanishes in cells producing identical parts. On the other hand, if there are different parts then finding the job sequence which minimizes the makespan becomes the main problem instead of the robot moves. But the most difficult problem to tackle in this class of scheduling problems is to optimize the robot moves along with job sequences.

Most of previous research in this field was directed to two or three machines cells. Limited work tackled the scheduling problem in four machines cells and it only gave a methodology for the extending to four machines cells and ideas for larger cells. In four-machine robotic cells there are 24 robot-move cycles, 18 of them are NP-hard problems.

The objective of this work is to solve the scheduling problem in four-machine blocking robotic cells producing identical and different part types

while minimizing the cycle time. The problem includes scheduling of robot moves and sequencing of parts simultaneously.

In order to achieve this objective, a genetic algorithm is developed to solve the problem. The solution is based on finding a parts' sequence for each robot move cycle using the developed genetic algorithm them the sequence with minimum cycle time is considered the best reached one. In order to test the nearness of the best reached sequence to the true optimal sequence, full enumeration of all possible sequences is made. The cycle times of the enumerated sequences is calculated for the 24 robot moves cycles and hence true optimum is reached.

Two problem sizes (5 and 8) are tested changing the travel time, loading and unloading times and processing time range. The results showed that the developed genetic algorithm could solve the problem reaching to the optimal solution in most of the tested problems. It also showed and analyzed the effect of the ratio between the mean processing time and the travel time on determining the optimum robot moves cycle and defining their regions of optimality.

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