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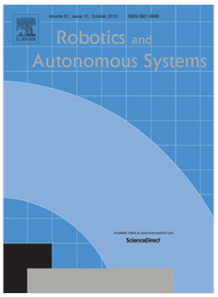

Scheduling of two-machine robotic rework cells: In-process, post-process and in-line inspection scenarios

Mehdi Foumani, Kate Smith-Miles, Indra Gunawan

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Scheduling of two-machine robotic rework cells: in-process, post-process and in-line inspection scenarios

Mehdi Foumani[a*], Kate Smith-Miles[a], Indra Gunawan[b1]

[a]*School of Mathematical Sciences, Monash University, Clayton, Victoria 3800, Australia*
[b]*Entrepreneurship, Commercialisation, and Innovation Centre, University of Adelaide, Adelaide, SA 5005, Australia*

Abstract

This study focuses on the domain of a two-machine robotic cell scheduling problem under three inspection scenarios. We propose the first analytical method for minimizing the partial cycle time of cells with in-process and post-process inspection scenarios, and then we convert this cell into a multi-function robotic cell with in-line inspection scenario. For the first scenario, parts are inspected in one of the production machines using multiple sensors, while the inspection process is performed by an independent inspection machine for the second scenario. Alternatively, the inspection can be performed by a multi-function robot for the third scenario. A distinguishing characteristic of this robot is that it can perform inspection of the part in transit. However, the robot cannot complete the part transition and load it on the next destination machine if it identifies a fault in the part. The stochastic nature of the process prevents us from applying existing deterministic solution methods for corresponding scheduling problems. In the first stage, we present a heuristic method that converts a multiple-sensor inspection system into a single-sensor inspection system. The expected cycle times of two different cycles are derived based on a geometric distribution, and then the maximum expected throughput is pursued for in-process and post-process inspection sensors, respectively. In the second stage, we develop the inspection system into an in-line inspection system using a multi-function robot. Finally, we determine if it is technically feasible and profitable to replace the in-process (or post-process) inspection scenario with the in-line inspection scenario.

Keywords: Scheduling; cyclic production; robotic cell; manufacturing; inspection

1. Introduction

The cellular manufacturing system (CMS) has been identified as a critical part of the manufacturing and service industries. CMS considerably decreases cycle time, work in process, and manufacturing cost. A cell is the smallest unit of a CMS which is composed of material handling devices, computers, production machines, sensors, and other standalone equipment such as

*Corresponding author. Email: mehdi.foumani@monash.edu

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