A NSGA-II based approach for multi-objective optimization of a reconfigurable manufacturing transfer line supported by Digital Twin: A case study

Ali, M.A.[a,*], **Alarjani, A.**[a], **Mumtaz, M.A.**[b]

[a]Department of Industrial Engineering, College of Engineering, Prince Sattam Bin Abdulaziz University, Alkharj, Saudi Arabia
[b]Department of Civil Engineering, College of Engineering, Imam Mohammad Ibn Saud Islamic University, Riyadh, Saudi Arabia

A B S T R A C T

In response to the wide range of customer demands, the concept of reconfigurable manufacturing systems (RMS) was introduced in the industrial sector. RMS enables producers to meet varying volumes of demand over varying time periods by swiftly adjusting its production capacity and functionality within a part family in response to abrupt market changes. In these circumstances, RMS are made to swiftly reconfigure their Reconfigurable Machine Tools (RMTs). RMTs are designed to have a variety of configurations that may be conditionally chosen and reconfigured in accordance with specific performance goals. However, the reconfiguration process is not an easy process, which entails optimization of several objectives and many of which are inherently conflictual. As a result, it necessitates real-time monitoring of the RMS's condition, which may be achieved by digital twinning, or the real-time capture of system data. The concept of using a digital replica of a physical system to provide real-time optimization is known as digital twin. This work considered a case study of discrete parts manufacturing on a reconfigurable single manufacturing transfer line (SMTL). Six manufacturing operations are required to be performed on the parts at six production stages. This work uses the Digital Twin (DT) based approach to assist a discrete multi-objective optimization problem for a reconfigurable manufacturing transfer line. This multi-objective optimization problem consists of four objective functions which is illustrated by using DT-based Nondominated Sorting Genetic Algorithm-II (NSGA-II). The innovative aspect of the current study is the use of a DT-based framework for RMS reconfiguration to produce the best optimum solutions. The produced real-time solutions will be of great assistance to the decision maker in selecting the appropriate real-time optimal solutions for reconfigurable manufacturing transfer lines.

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