بسم الله الرحمن الرحيم

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تم رفع هذه الرسالة بواسطة / سامية زكى يوسف

بقسم التوثيق الإلكتروني بمركز الشبكات وتكنولوجيا المعلومات دون أدنى مسئولية عن محتوى هذه الرسالة.

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Ain Shams University

Faculty of Engineering

Mechanical Engineering Department
(Mechatronics)

Performance Enhancement of Advanced Manufacturing Centers Using IIoT

Thesis submitted in partial fulfillment of the requirements of the degree of
Doctor of Philosophy in Mechanical Engineering
(Mechatronics Engineering)

By

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Master of Science in Mechanical Engineering

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Ain Shams University-Faculty of Engineering

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Statement

This thesis is submitted as a partial fulfillment of Doctor of Philosophy in Mechanical Engineering Engineering, Faculty of Engineering, Ain shams University.

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

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Publications in the fulfillment for the requirements of Ph.D. degree in Mechanical Engineering (Mechatronics) entitled: "Performance Enhancement of Advanced Manufacturing Centers Using IIoT"

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Abstract

With the arising of the recent industrial revolutions 4.0 and 5.0, the relatively old term of intelligent concept has been replaced by smart one. The difference lies within the potential power of data that leverages knowledge. Whereby, the industrial systems/sub-systems induce a kind of smartness behavior termed factory or machine awareness.

In that context, manufacturing renders more attention to the advances in the Internet of Things (IoT) within the industrial sector to create the Industrial Internet of Things (IIoT). The IIoT exploits the manufacturing environmental hidden data to establish smart factories. In that, the manufacturing system must have the ability to define its core information, expose the corresponding value, and drive an achievable action based on such information. This glossary applies terms such as Cyber-Physical Systems (CPS), Digital Twins (DTs), Big Data, and Cloud Computing (CC) to invoke the IIoT. Coming from diverse disciplines, CPS has to be able to cooperate with machines and manufacturing available resources to convert the current achievable machine term of multi-disciplinary to trans-disciplinary. CPS gives rise to the data engineering field to feed the Big Data engine. Such a system struggles in fronts of the CPS real-time interaction and the data processing approach.

The current thesis discusses a novel approach to tackle one of the IIoT main problems in manufacturing. The study focuses on CPS-machine integration to unfold the dynamic data of the manufacturing. The study considers the energy consumption profile of a machine as life-cycle data to indicate the state of a machine. That data could be then processed to form an example Big Data information source. Seeking manufacturing enhancement, the system functions such information to optimize an advanced integrated problem of manufacturing scheduling-based application.

The system now has to deal with numerous problems resulting from multiple aspects: the CPS communication-based, the selected data, the application-based algorithm, and the manufacturing severe noisy environment. The CPS benefits from signal analysis and enhancement techniques to reduce cloud storage in order to yield more salient information.

In the application phase, the system designs a case built-in meta-heuristic-based optimization algorithm considering the application requirements. The algorithm has been designed to aspire system knowledge through multiple aspects of the available resources as possible.

The algorithm is programmed to suit the data schema concepts, taking into consideration the data size, the encryption of the alternative resources, and the speed of the evolution progress. In that, major enhancements have been applied to a two-stage algorithm of the Particle Swarm Optimization (PSO) followed by a Tabu Search (TS). The optimization-based algorithm is deployed as a parallel implementation platform. The enhancements of the modified PSO-TS use coded data to comply with the system's robustness and reliability.

The experiments express promising results supporting the modified two-stage meta-heuristic-based optimization. This allows the machine's station to reconsider the station dynamic changes mapping the optimization term into a manufacturing reality environment, not an ideal environment. The study opens the possibilities to include more hidden data using the designed CPS and the programming structure concepts.

Keywords: IIoT, Industry 4.0, Cyber-Physical Systems, Heuristic-based Algorithms, Particle Swarm Optimization, Tabu Search, Genetic Algorithms, Flexible Job Shop Scheduling, Dynamic Job Shop Scheduling.