Characteristics of Machining Data and Machine Learning Models- A Case Study

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Abstract: Advancement of technologies in computing such as internet of things, cloud computing, and artificial intelligence drive manufacturing industries to adopt and implement automation in production. One of the key technologies or preferable methods to increase the productivity is implementing prediction models or machine learning (ML) algorithms in production. This article is aimed to show a comprehensive review on AI implementation in machining of materials, and to present methodology in prediction model development. The characteristic of experimental data and the key attributes in the model development are presented and discussed with a case study.

1. Introduction

Industry 4.0 is a holistic approach of utilizing internet of things (IoT) and internet of services (IoS) where resources are connected together in cyber physical system (CPS). Industry 4.0 has been adopted in developed countries and some developing countries in the recent years. Having the components such as Cyber-Physical Systems (IoT and IoS), Augmented reality, Virtual reality, Autonomous robots, Cloud computing, the Industry 4.0 perfectly conducts digital manufacturing for the satisfaction of the customers or clients. The practice of Artificial Intelligence (AI) and Machine Learning (ML) ranges from big giant applications to the tiniest deployment of the technologies. Both are commonly practiced in the social media networks, business operations, and marketing. Their contribution in manufacturing sectors is however limited for various reasons. They may be constrained by budget, support from stockholders including the Government, limited resources, and facilities etc., in the worst-to-worst case, because of the unawareness of their usability, credibility and benefits.

Wagner et al.,[21] detailed how industry 4.0 impacts lean manufacturing system Cagnetti et al.,[3] presented challenges in implementing industry 4.0 and how new technological philosophy can be implemented in lean manufacturing. Kolla et al.,[13] presented challenges in small and medium scale industries (SMEs) and discussed how hybrid model consisting of lean manufacturing and industry 4.0 technologies will help SMEs, while readiness and maturity model was presented Schumacher et al.,[19]. Ortt et al.,[18] reviewed research articles published in this area in a last decade and discussed the implementation method. Gallo et al.,[8] conducted a systematic review on tools for implementing industry 4.0 in lean manufacturing system.

Autonomous material handling, numerical controlled machining, robotic assistance is included in automation of manufacturing process. Numerical controlled machining is preferred to use in order to have dimensional accuracy in near-net shape. No doubt, how robust product is manufactured, some machining processes must be conducted in the production of industrial products. For instance, drilling and boring of hole, tapping, screwing are very common processes applied in the production. Conventional machining processes have been replaced by numerical controlled machining Machine selection, cutter selection, cutting parameters setting, process planning is controlled in automation.

One of the challenges in the machining is to avoid geometrical errors and poor surface integrities, for which different algorithms have been attempted in the past. Though AI and machine learning algorithms have been developed and implemented in recent decades, many different sectors have not started to utilize them for different applications. manufacturing industries are one of the key sectors where AI technologies must be implemented. Because this sector is a backbone of the economy of the Nation. If AI is rightly applied in this sector, productivity can be greatly improved, and profit can be increased. Recently, prediction model development or application of machine learning algorithms in the production gets research interest.

2. Related Literature on Machine Learning Models for Machining Data

Automation and smart manufacturing are not same and equal, they have distinct meaning and context of method. Automation can be implemented with minimal number of sensors and robust control system. It is to conduct the manufacturing process with no or minimal intervention of human. While smart manufacturing is more focusing on connecting many different elements such as men, machines, tools and sensors together through a network called cyber physical system (CPS) and carry out the process and decision making with no human involvement. Some research articles published on artificial intelligence (AI) implemented turning operation is presented in Table 1. Though turning is very common machining process being taken in industries, only a limited number of research articles have been published. The reason could be that turning is limited to cylindrical component, while milling can be applied to non-cylindrical components. Also, literature review has proclaimed that prediction models have been developed for metal materials. Though there is high priority for polymeric materials in

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