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ORIGINAL PAPER

A Review of Multi-holes Drilling Path Optimization Using Soft Computing Approaches

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Abstract In today's competitive environment, optimization is considered as an important element for maintaining and improving both aspect of manufacturing such as quality and productivity. In multi-holes drilling process, 70% of the machining time involved the tool movement and tool switching. Various researches had been conducted to reduce the tool movement and switching time. This paper reviews the research publications on the drilling path optimization using soft computing approaches. In particular, this review focuses on four main aspects; drilling application areas, problem modeling, optimization algorithms and objective functions of drilling path optimization. Based on the review, the researchers' interest in this area is still growing. However, the existing researches were limited to implement, modify and hybridized the well-established optimization algorithms. Furthermore, there is a lack of awareness to consider the environmental and sustainable issues in the existing research. In future, the researcher is suggested to give focus on energy consumption that related with sustainable manufacturing and also to explore the potential of new meta-heuristics algorithms that can lead to significant in reduction machining time.

Keywords Drilling process · Toolpath optimization · Soft computing

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1 Introduction

Computer numerically controlled (CNC) machine has been implemented since the previous decades in order to realize full automation in machining. CNC machine tools require less manpower, give more noteworthy improvements in productivity, and improve the quality of the final product [1]. Milling process is the most well-known metal removal process. It is generally used to mate with other parts in automotive, aerospace, die and machinery design as well as in manufacturing industries. One of the popular machining modes for CNC milling is for drilling multi-holes on the workpiece [2].

Drilling is widely used in machining processes for various purposes [3]. Drilling is defined as cutting process that used a drill bit to cut a circular cross-section hole in metallic and nonmetallic materials [4–6]. This process is very important in the industries like automotive, aircraft and aerospace, dies or mold, home appliances, medical and electrical equipment [4]. Normally, holes produced by drilling are larger than the drill diameter and depending on its applications so that the drilled holes will subjected to other operations such as reaming or honing to better surface finish and accuracy of dimensional [7].

Additionally, the type of drill is selected according to the job upon several factors, [8] considered the type of machine tools, workpiece materials, setup, diameter of the hole and also the composition and hardness of workpiece. Moreover, there are six steps are taken in CNC drilling operation as discussed in [9]. Roughly at first, the workpiece is designed in Computer Aided Design and Computer Aided Manufacturing (CAD/CAM) software. Then, the machining tools and parameters are determined in CAD/CAM software. Next, the process plan and machining code is generated using CAD/CAM software. After that, the machining code

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