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Estimation of optimal machining control parameters using artificial bee colony

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Abstract Modern machining processes such as abrasive waterjet (AWJ) are widely used in manufacturing industries nowadays. Optimizing the machining control parameters are essential in order to provide a better quality and economics machining. It was reported by previous researches that artificial bee colony (ABC) algorithm has less computation time requirement and offered optimal solution due to its excellent global and local search capability compared to the other optimization soft computing techniques. This research employed ABC algorithm to optimize the machining control parameters that lead to a minimum surface roughness (R_a) value for AWJ machining. Five machining control parameters that are optimized using ABC algorithm include traverse speed (V), waterjet pressure (P), standoff distance (h), abrasive grit size (d) and abrasive flow rate (m). From the experimental results, the performance of ABC was much superior where the estimated minimum R_a value was 28, 42, 45, 2 and 0.9 % lower compared to actual machining, regression, artificial neural network (ANN), genetic algorithm (GA) and simulated annealing (SA) respectively.

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Introduction

The manufacturing industries nowadays face many challenges such as market competition, expensive machining cost, customer high request and complexity of the product. For manufacturers, the main objective is to produce high quality of product with less cost and time constraints. Today, modern machining processes are widely used in manufacturing industries because it has some advantages (for example in terms of cost) compared to traditional machining processes (Ridwan et al. 2012; Mokhtar and Xu 2011; Zain et al. 2012a). According to Nagendra Parashar and Mittal 2007, traditional machining processes are costly and inefficient because it is incapable to machine the materials cost-effectively because of the tools is harder than the workpiece. The alteration or new traditional machining methods are also needed because in several cases, the methods might not be operated. Roy and Mehnen (2008) suggest that new method need to be developed in order to guarantee fast, safe and cost efficient production. The modern machining process can be categorized into four types which are (i) mechanical (e.g. abrasive waterjet (AWJ), ultrasonic machining (USM)), (ii) chemical (e.g. chemical machining (CHM)), (iii) electrochemical (e.g. electrochemical machining (ECM), electrochemical grinding (ECG)) and (iv) thermoelectric (e.g. electrobeam machining (EBM), laserbeam machining (LBM)).

AWJ machining was considered in this research to compute a minimum R_a value. (Zain et al. 2012b) AWJ used a high powerful flow of water in order to cut the workpiece. The high pressure of water (usually more than 900 mph) enables it to cut metal, non-metal, composite and heat sensitive workpiece. The advantage of AWJ is that it never gets dry

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