Document type
Article

Source type
Journal

ISSN
02683768

DOI
10.1007/s00170-021-07910-w

View more

International Journal of Advanced Manufacturing Technology • Open Access • 2021

Dual - stage artificial neural network (ANN) model for sequential LBMM-μEDM-based micro-drilling

Noor W.I.[a], Saleh T.[a], Rashid M.A.N.[a], Mohd Ibrahim A.[b], Ali M.S.M.[c]

Save all to author list

[a] Autonomous Systems and Robotics Research Unit (ASRRU), Department of Mechatronics Engineering, International Islamic University Malaysia, Kuala Lumpur, 53100, Malaysia

[b] Department of Mechatronics Engineering, International Islamic University Malaysia, Kuala Lumpur, 53100, Malaysia

[c] School of Electrical Engineering, Universiti Teknologi Malaysia, UTM, Johor Bahru, 81310, Johor, Malaysia

Abstract

Author keywords

Indexed keywords

Funding details

Abstract

A sequential process combining laser beam micromachining (LBMM) and micro electro-discharge machining (μEDM) for the micro-drilling purpose was developed to incorporate both methods' benefits. In this sequential process, a guiding hole is produced through LBMM first, followed by μEDM applied to that same hole for more fine machining. This process facilitates a more stable, efficient machining regime with faster processing (compared to pure μEDM) and a much better hole quality (compared to LBMMed holes). Studies suggest that strong correlations exist between the various input and output parameters of the sequential process. However, a mathematical model that maps and simultaneously predicts all these output parameters from the input parameters is yet to be developed. Our experimental study observed that the μEDM finishing operation's various output parameters are influenced by the morphological condition of the LBMMed holes. Hence, an artificial neural network (ANN)-based dual - stage modeling method was developed to predict the sequential process's outputs. The first stage of the dual - stage model was utilized to predict various LBMM process outputs from different laser input parameters. Furthermore, in the second stage , LBMM-predicted outputs (such as pilot hole entry area, exit area, recast layer, and heat-affected zone) were used for the final prediction of the sequential process outputs (i.e., machining time by μEDM, machining stability during μEDM in terms of short circuit/arcing count, and tool wear during μEDM). The model was evaluated based on the average RMSE (root mean square errors) values for the individual output parameters' complete set data, i.e., μEDM time, short circuit/arcing count, and tool wear. The values of average RMSE for the parameters as mentioned earlier were found to be 0.1272 (87.28% accuracy), 0.1085 (89.15% accuracy), and 0.097 (90.3% accuracy), respectively.

Author keywords

Artificial neural network ; Laser; Micromachining; Sequential; μEDM

Engineering controlled terms

Drills; Forecasting; Heat affected zone; Infill drilling; Laser beam machining; Laser beams; Mean square error; Micromachining; Wear of materials

Engineering uncontrolled terms

Artificial neural network models; Efficient machining; Finishing operation; Machining stability; Micro electro-discharge machining; Root mean square errors; Sequential process; Strong correlation

Engineering main heading

Neural networks

Funding sponsor	Funding number	Acronym
AOARD	BAA-AFRL-AFOSR-2016-0007	

Funding sponsor	Funding number	Acronym
Asian Office of Aerospace Research and Development		
Ministry of Higher Education, Malaysia See opportunities by MOHE ↗	FRGS/1/2018/TK03/UIAM/02/2	MOHE

Funding text 1
First of all, we thank Allah (SWT) for providing us with the ability to conduct this research. The authors also acknowledge the research support provided by the International Islamic University Malaysia. We also thank the Ministry of Higher Education Malaysia and the Asian Office of Aerospace Research and Development for their generous funding to carry out this research.
Funding text 2
This project was funded by the Ministry of Higher Education Malaysia (MOHE Grant No: FRGS/1/2018/TK03/UIAM/02/2) and the Asian Office of Aerospace Research and Development (AOARD Grant No: BAA-AFRL-AFOSR-2016-0007). Mir Akmam Noor Rashid was paid as a graduate research assistant (GRA) from the AOARD grant, and Wazed Ibne Noor was paid as a graduate research assistant from the MOHE grant.

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Saleh, T.; Autonomous Systems and Robotics Research Unit (ASRRU), Department of Mechatronics Engineering, International Islamic University Malaysia, Kuala Lumpur, Malaysia; email:tanveers@iium.edu.my