Classification of weld penetration condition through synchrosqueezed-wavelet analysis of sound signal acquired from pulse mode laser welding process

M.F.M. Yusof, M. Ishak, M.F. Ghazali
Faculty of Mechanical and Automotive Engineering Technology, Universiti Malaysia Pahang, 26600 Pekan, Pahang, Malaysia

ABSTRACT

Monitoring weld condition using acoustic method is quite challenging due to some factors, hence the importance to further explore the use of signal analysis method not only to diminish the effect of noise, but more importantly, to obtain a distinct correlation with weld condition. The main goal of this work is to determine the significance of the feature extracted from synchrosqueezed-wavelet analysis in classifying sound signals that derived from varied weld penetration conditions. In achieving the aim, sound signal was acquired during pulse mode laser welding process with variation in peak power and pulse width that produced half penetration and full penetration weld joints. The trends of time domain, frequency domain, and wavelet analysis features of the acquired sound from half and full penetration welds were compared prior to the support vector machine (SVM) classification analysis. The comparison between all the features displayed a clear distinction in signals between half and full penetration welds for the case of features extracted from synchrosqueezed-wavelet analysis. In SVM binary classification analysis, the use of same feature as input recorded 96.94 % of average classification accuracy, which appeared to be the highest. Additionally, comparison with band power, exhibited 27.7 % improvement in classification precision. From these findings, it is concluded that the use of features extracted from synchrosqueezed-wavelet analysis as input for classification of sound signals from various penetration conditions is indeed significant. This work contributes to an alternative way in dealing with random sound signals in view of developing an efficient weld penetration monitoring system in future.

KEYWORDS

Air-borne acoustic signal; Pulse mode laser welding; Synchrosqueeze wavelet transform; Support vector machine; Weld penetration condition

ACKNOWLEDGEMENTS

The authors would like to thanks to Universiti Malaysia Pahang for providing a support on this project under research grant RDU1803171 and RDU180314.