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Vibration Signals Extracted Features for Product Quality Prediction in Pulsed Laser Cutting

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Introduction

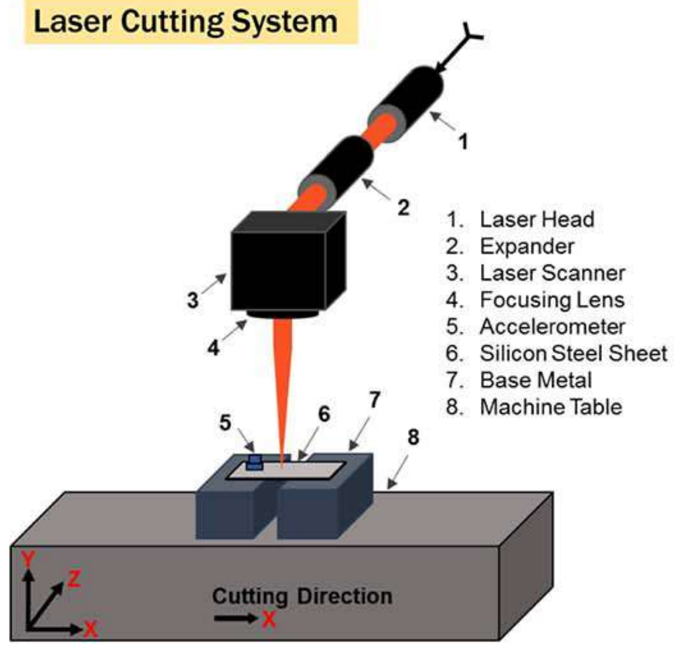
- Laser cutting is considered a method of non-contact machining and has become an alternative technique for machining thin silicon steel sheets
- Predict the cutting quality and obtain the optimal parameter in laser cutting operations was not an easy task due to the dynamic nature of the laser cutting process.
- Most work reviewed in the literature considers only the relation between laser processing parameters with the cut edge of the laser cutting product.
- Limited studies aimed at systematically investigating the data-driven approach by adopting vibration sensing signals correlating to the quality of laser machining.

Research Objective

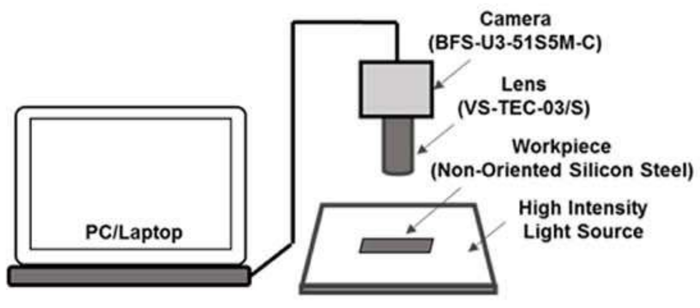
- This study aimed to compare the performance of three machine learning (ML) models, including support vector regression (SVR), random forest (RF), and extreme learning machine (ELM) for kerf width prediction of pulsed laser cutting.
- Selected features from the optimal base wavelet transformation of vibration signals from the optimal base wavelet selection were adopted as the inputs to the ML models.
- Averaged kerf width of a straight cut of a 0.1 mm-thickness silicon steel sheet was chosen as the output.
- In the first stage, the effects of varying the validation data size and data randomness analyses were investigated using training data. In the second stage, the prediction accuracy of these machine learning models on testing data was compared.

Experimental Procedure

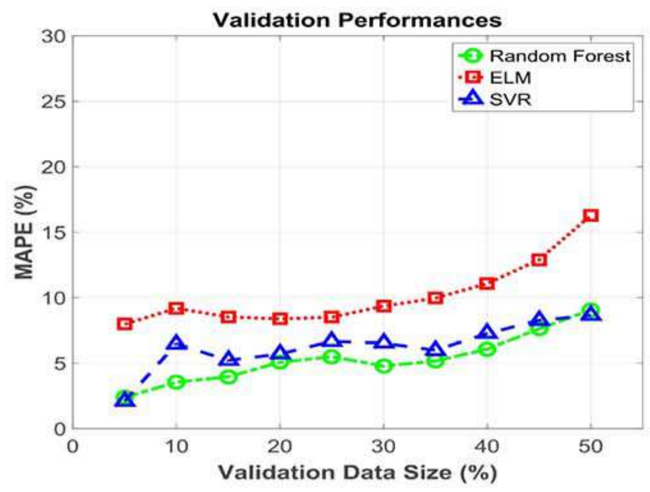
Laser Cutting System



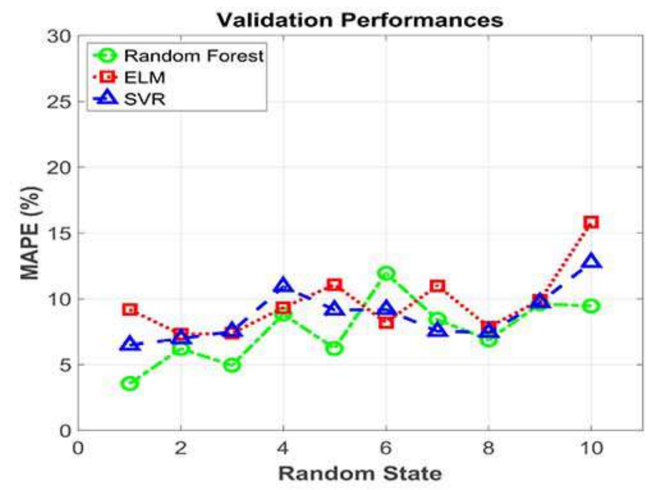
Machine Vision System



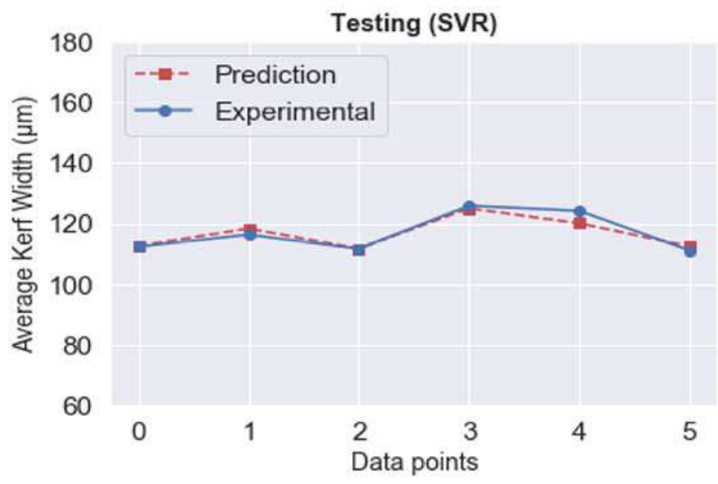
Prediction Results

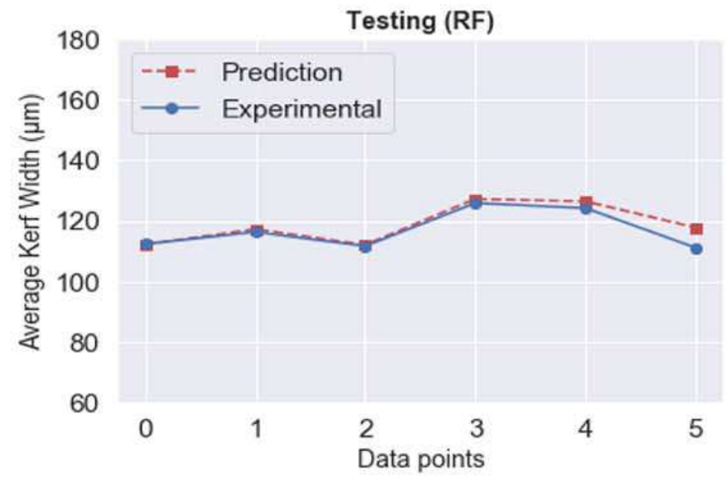


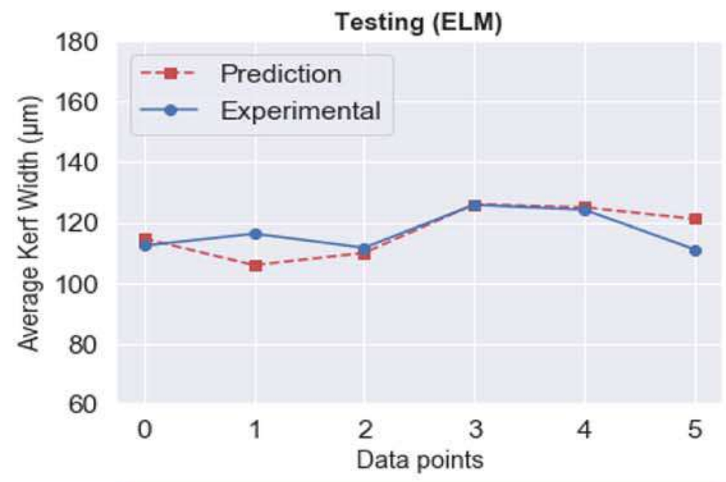
Validation Data Size Analysis



Random State Analysis







Holdout Testing Data Analysis

Conclusion

In summary, the selected vibration features from the optimal base wavelet selection combined with the random forest (RF) model are efficient for forecasting the straight kerf width of the workpiece by pulsed laser cutting.

This work has been published

Kusuma, A.I., Huang, YM. Performance comparison of machine learning models for kerf width prediction in pulsed laser cutting. Int J Adv Manuf Technol (2022).

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