The Classification of Impact Signal of 6 DOF Cobot by Means of Machine Learning Model

Gavin Lim Jiann Kai, Ahmad Fakhri Ab. Nasir, Anwar P. P. Abdul Majeed, Mohd Azraai Mohd Razman, Ismail Mohd Khairuddin, and Lim Thai Li

Abstract Collaborative robot (Cobot) has seen a rise in adoption rate in the industry as the Industry 4.0 era marches in. Cobot were introduced to replace human operators in harsh environments or repetitive work processes. The health condition monitoring of these cobot have not been standardized due to lack of widely available standardized fault dataset and the high complexity of diagnostic. This study aims to use machine learning algorithms as a mean to identify the cobot pick and place process offset error using vibrational signals. The vibrational sensor was attached to the end effector of the cobot where the vibration signal of 3 axis were collected. The features were then extracted, standardized, and 544 features were selected from 2337 features based on a hypothesis testing method. The dataset was then spilt into training and testing by a ratio of 80:20. Three machine learning models namely, the *k*-Nearest Neighbors (*k*-NN), Neural Network (NN), and Support Vector Machine (SVM) classifier were tested, and the classification accuracy of the models was analyzed. A grid search approach was used to identify the best hyperparameter for each model. The model with the highest classification accuracy of 95.2% was the MLP model compared to SVM (92.4%) and kNN (79%). Therefore, it could be established from the study that a comparable classification efficacy is attainable through the identification of significant features. The findings are non-trivial, particularly with respect to the implementation of the developed classifier in real-time.

Keywords Machine learning · Condition-based monitoring · Feature selection

G. L. J. Kai · A. P. P. A. Majeed · M. A. M. Razman (✉) · I. M. Khairuddin
Faculty of Manufacturing and Mechatronic Engineering Technology, Universiti Malaysia Pahang, 26600 Pekan, Pahang, Malaysia
e-mail: mohdazraai@ump.edu.my

A. F. Ab. Nasir
Faculty of Computing, Universiti Malaysia Pahang, 26600 Pekan, Pahang, Malaysia

A. F. Ab. Nasir · A. P. P. A. Majeed
Centre for Software Development and Integrated Computing, Universiti Malaysia Pahang, 26600 Pekan, Malaysia

L. T. Li
TT Vision Holdings Berhad, 11900 Plot 106, Sungai Hilir Keluang 5, Bayan Lepas FIZ.4, Pulau Pinang, Bayan Lepas, Malaysia

I. M. Khairuddin et al. (eds.), *Enabling Industry 4.0 through Advances in Mechatronics*, Lecture Notes in Electrical Engineering 900, https://doi.org/10.1007/978-981-19-2095-0_47