Adaptive Neuro-Fuzzy Inference System Models for Force Prediction of a Mechatronic Flexible Structure - DTU Orbit (09/11/2017)

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This paper presents the results obtained from a research work investigating the performance of different Adaptive Neuro-Fuzzy Inference System (ANFIS) models developed to predict excitation forces on a dynamically loaded flexible structure. For this purpose, a flexible structure is equipped with acceleration transducers at each degree of freedom and a force transducer for validation and training. Two types of models were developed; the first type uses current accelerations only while the second type considers both the current accelerations and the historical values. The models are trained using data obtained from applying a random excitation force on the flexible structure. The performance of the developed models is evaluated by analyzing the prediction capabilities based on a normalized prediction error. The frequency domain is considered to analyze the similarity of the frequencies in the predicted and the original force signal. For a selection of the best models, a more advanced performance analysis is carried out. This includes application of the trained models to deterministic and non-deterministic excitation forces with different excitation frequencies and amplitudes. Additionally, the influence of the sampling frequency and sensor location on the model performance is investigated. The results obtained in this paper show that ANFIS models can be used to set up reliable force predictors for dynamical loaded flexible structures, when a certain degree of inaccuracy is accepted. Furthermore, the comparison study points out that the transducer location is crucial for the model performance. However, there exists no general solution for the final selection of models. The findings showed that the model type employing historical values gives better predictions when operating in their trained regions while the models using only current values have generally higher prediction errors in trained regions but are less sensitive to changes of the system dynamics history.

General information

State: Published
Organisations: Department of Mechanical Engineering, Solid Mechanics, Ecole Polytechnique de Montreal, EnBW Erneuerbare Energien GmbH
Authors: Achiche, S. (Ekstern), Shlechtingen, M. (Ekstern), Raison, M. (Ekstern), Baron, L. (Ekstern), Santos, I. (Intern)
Pages: 77-94
Publication date: 2016
Main Research Area: Technical/natural sciences

Publication information

Journal: Journal of Integrated Design & Process Science
Volume: 19
Issue number: 3
ISSN (Print): 1092-0617
Ratings:

BFI (2017): BFI-level 1

BFI (2016): BFI-level 1

Scopus rating (2016): CiteScore 0.43 SJR 0.176 SNIP 0.368

Web of Science (2016): Indexed yes

BFI (2015): BFI-level 1

Scopus rating (2015): SJR 0.231 SNIP 0.537 CiteScore 0.36

BFI (2014): BFI-level 1

Scopus rating (2014): SJR 0.136 SNIP 0.239 CiteScore 0.27

BFI (2013): BFI-level 1

Scopus rating (2013): SJR 0.229 SNIP 0.288 CiteScore 0.24

BFI (2012): BFI-level 1

Scopus rating (2012): SJR 0.152 SNIP 0.191 CiteScore 0.19

BFI (2011): BFI-level 1

Scopus rating (2011): SJR 0.102 SNIP 0.019 CiteScore 0.07

BFI (2010): BFI-level 1

Scopus rating (2010): SJR 0.105 SNIP 0.021

BFI (2009): BFI-level 1

Scopus rating (2009): SJR 0.101 SNIP 0.097

BFI (2008): BFI-level 1

Scopus rating (2008): SJR 0.134 SNIP 0.172

Scopus rating (2007): SJR 0.127 SNIP 0.249

Scopus rating (2006): SJR 0.124 SNIP 0.15

Scopus rating (2005): SJR 0.131 SNIP 0.169

Scopus rating (2004): SJR 0.103 SNIP 0.076
Scopus rating (2003): SJR 0.107 SNIP 0.004
Scopus rating (2002): SJR 0.161 SNIP 0.285
Scopus rating (2001): SJR 0.11 SNIP 0.033
Scopus rating (2000): SJR 0.101 SNIP 0
Original language: English
F orce prediction, ANFIS models, P erformance analysis, Cyber physical system, Mechatronics
DOIs:
10.3233/jid-2015-0017
Source: FindIt
Source-ID: 2291556967
Publication: Research - peer-review › Journal article – Annual report year: 2016