Aerospace Europe Conference 2023
Joint 10th EUCASS – 9th CEAS Conference

Abstract #XXX *(to be filled by the organizers)*
Preferred Topics: AEROFLIPHY / FDGNCAV / UAVFUT *(3 maximum from the list of topics)*
Corresponding author: SANT'ANA Vitor
e-mail of corresponding author: vitortsantana94@gmail.com
Type: Oral / Poster *(select)*
Status of corresponding author: Regular / Student *(select)*
For student corresponding author: student member of one of the following:
3AF / AAAR / AIAE / AIDAA / CzAeS / DGLR / FTF / NVvL / PSAA / RAeS / SVFW / EUROAVIA

Title

Reduced-Scale Generic Future Fighter Aerodynamic Model Using Neuro-Fuzzy Hybridized with Differential Evolution

Authors

Vitor SANT'ANA[1], Petter Krus[2], Roberto Mendes Finzi Neto[3]*

** Corresponding author*
[1] PhD Guest Student at Department of Management and Engineering, Linköping University, 58183 LINKÖPING, Sweden, vitortsantana94@gmail.com
[2] Department of Management and Engineering, Linköping University, 58183 LINKÖPING, Sweden, petter.krus@liu.se
[3] Laboratory of Mechanical Structures, Universidade Federal de Uberlândia, Uberlândia, Brasil, finzi@ufu.br

Keywords: Aerodynamics, Flight Mechanics, Fuzzy Rule-Based System, Machine Learning

Abstract

The aid of machine learning and artificial intelligence in the field of aerodynamics domain has been increased to reduce the cost of high-fidelity models. This work is an extension of [1], which the author developed an aerodynamic model using numerical results, which can be considered a high-fidelity model inside the numerical simulation domains, nonetheless it is a low fidelity when it is extrapolated to the physical experiments.

This work presents a low cost and high-fidelity aerodynamic model using experimental flight data of a reduced scale Generic Future Fighter (GFF). To accomplish the objective, a machine learning technique takes place to understand the flight mechanics of the remote controlled GFF. The Neuro-Fuzzy, first presented by [2], combined with Differential Evolution [3] is used to train the experimental data acquired with Pixhawk.

The final model consists of a Fuzzy Rule-Based System (FRBS), with membership functions in Gaussian shapes for input variables, and equations for the outputs. With arbitrary information about the input variables, if they belong to the range of trained set data, it is possible to predict the forces and moments for the presenting aircraft.

This aerodynamic model is a system identification for a specific aircraft, which is capable to describe the behavior of GFF with the input variables values. Furthermore, the possibilities are still being studied about the application of the present technique, one of them as future work is to develop a model simulation with the trained aerodynamic model, which can become a reduced-scale flight test simulator for new fighters. According to [4], the subscale flight testing cannot meet all similarity conditions, but still can be used to aid the full-scale project with relaxed similarities constraints.

References

[1] V. Sant'Ana, I. Staack, R. M. Finzi Neto. Lateral-directional aerodynamic modeling for numerical results using Neuro-Fuzzy with Differential Evolution. In 33rd International Congress of the Aeronautical Sciences, Stockholm, 2022. ICAS.

[2] Jang JS, Sun CT. Neuro-fuzzy modeling and control. Proceedings of the IEEE. 1995 Mar;83(3):378-406.

[3] Storn R, Price K. Differential evolution-a simple and efficient heuristic for global optimization over continuous spaces. Journal of global optimization. 1997 Dec 1;11(4):341.

[4] A. Sobron, D. Lundström, P. Krus. A review of current research in subscale flight testing and analysis of its main patrical challenges. Aerospace 2021, 8(3), p. 74.