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Crack Growth Life Prediction of a Fighter Aircraft Wing Splice Joint Under Spectrum Loading Using Random Forest Regression and Artificial Neural Networks with Hyperparameter Optimization

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Abstract : There are heaps of analytical methods to estimate the crack growth life of a component. Soft computing methods have an increasing trend in predicting fatigue life. Their ability to build complex relationships and capability to handle huge amounts of data are motivating researchers and industry professionals to employ them for challenging problems. This study focuses on soft computing methods, especially random forest regressors and artificial neural networks with hyperparameter optimization algorithms such as grid search and random grid search, to estimate the crack growth life of an aircraft wing splice joint under variable amplitude loading. TensorFlow and Scikit-learn libraries of Python are used to build the machine learning models for this study. The material considered in this work is 7050-T7451 aluminum, which is commonly preferred as a structural element in the aerospace industry, and regarding the crack type; corner crack is used. A finite element model is built for the joint to calculate fastener loads and stresses on the structure. Since finite element model results are validated with analytical calculations, findings of the finite element model are fed to AFGROW software to calculate analytical crack growth lives. Based on Fighter Aircraft Loading Standard for Fatigue (FALSTAFF), 90 unique fatigue loading spectra are developed for various load levels, and then, these spectrums are utilized as inputs to the artificial neural network and random forest regression models for predicting crack growth life. Finally, the crack growth life predictions of the machine learning models are compared with analytical calculations. According to the findings, a good correlation is observed between analytical and predicted crack growth lives.

Keywords : aircraft, fatigue, joint, life, optimization, prediction.
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