2024 20th IEEE International Colloquium on Signal Processing & Its Applications (CSPA) | 979-8-3503-8231-0/24/$31.00 ©2024 IEEE | DOI: 10.1109/CSPA60979.2024.10525420

Effect of Mixing Time and Frequency-Domain Objectives in Detecting Problematic Vibration on Unmanned Aerial Vehicles via Barnicle Mating Optimization

Fatimah Dg Jamil
Faculty of Electrical and Electronics Engineering Technology
Universiti Malaysia Pahang Al-Sultan Abdullah
Pahang, Malaysia
fatimahdaing96@gmail.com

Mohammad Fadhil Abas
Faculty of Electrical and Electronics Engineering Technology
Universiti Malaysia Pahang Al-Sultan Abdullah
Pahang, Malaysia
mfadhil@umpsa.edu.my

Mohd Sharif Zakaria
Faculty of Electrical and Electronics Engineering Technology
Universiti Malaysia Pahang Al-Sultan Abdullah
Pahang, Malaysia
sharifpolisas@gmail.com

Norhafidzah Mohd Saad
Faculty of Electrical and Electronics Engineering Technology
Universiti Malaysia Pahang Al-Sultan Abdullah
Pahang, Malaysia
norhafidzah@umpsa.edu.my

Mohd Hisyam Mohd Ariff
Faculty of Electrical and Electronics Engineering Technology
Universiti Malaysia Pahang Al-Sultan Abdullah
Pahang, Malaysia
hisyam@umpsa.edu.my

***Abstract*— Problematic vibration detection from Unmanned Aerial Vehicles (UAVs) as a flaw detection and identification (FDI) method has become a viable instrument for evaluating the health and condition of a UAV. The goal of this work is to demonstrate the impact of integrating frequency-domain and time-domain analysis as time-domain and frequency-domain objectives. a suggested fitness function that combines the time and frequency domains with a mixing variable. Root Mean Squared Error (RMSE), Mean Absolute Error (MAE), and detection time are used to test and assess the fitness function with the Barnicle Mating optimization (BMO) Algorithm optimization technique. To evaluate the efficacy of the suggested fitness function and BMO, 51 sets of data were gathered using software in the loop (SITL) techniques. The test findings demonstrate that the best MAE range outcomes with the least increase in RMSE and detection time were obtained by combining 25% and 75% of the time- and frequency-domain objectives, respectively.**

Keywords—Problematic Vibration, Barnicle Mating Optimization, Mixed Domain Analysis, Root Mean Square Error, Mean Absolute Error.

I. INTRODUCTION

Unmanned aerial vehicles, or UAVs, are becoming more and more crucial in a range of applications, such as fault identification and structural health monitoring. An effective method for evaluating the state and health of a UAV is vibration detection using unmanned aerial vehicle (UAV) technology for fault detection and identification (FDI).

The significance of sensor optimization and positioning in UAV applications has been shown by earlier studies. Researchers' attention has been sparked by the use of optimization techniques for state estimation and issue detection in UAVs. For instance, the significance of optimum estimation in deriving information about the UAV state was emphasized in a paper titled "Optimal control and state estimation for unmanned aerial vehicle under random vibration and uncertainty" [1]. In order to demonstrate the application of neural networks in vibration-based fault detection, "Vibration-Based Fault Detection in Drones Using Artificial Intelligence" established a fault detection approach based on multirotor arm vibration [2].

Moreover, the integration of vibration energy-based observability assessment for sensor location was highlighted in a paper on the "Optimization and control application of sensor placement in aeroservoelastic of UAV" [3]. In addition, a study titled "A Path Planning Method with Perception Optimization Based on Sky Scanning for UAVs" highlights the necessity of optimization in UAV operations by demonstrating the potential to maximize sensor node lifetime [4].

Additionally, research has been done on the integration of optimization algorithms and computer vision for the measurement of structural vibration using unmanned aerial vehicles (UAVs). A brief evaluation highlighted the developments and uses of computer vision from unmanned aerial vehicles in structural dynamics, highlighting the possibility for novel measurement techniques [5]. The application of convolutional neural networks and Bayesian optimization for vibration measuring was demonstrated in a paper named "A Bridge Vibration Measurement Method by UAVs Based on CNNs and Bayesian Optimization", highlighting the potential for sophisticated techniques in UAV-based vibration detection [6].

Other works on FDI formulate the solution based on the combination of Extended Kalman Filter (EKF) and Bhartacharya distance [7], and the combination of Artificial Neural Network (ANN) and EKF [8]. Besides that other combinations of ANN are also used for FDI such as radial basis function neural network (RBFNN) [9]. None of the papers above researched optimization algorithms in FDI.

The goal of this work's suggested methodology is to demonstrate how well time- and frequency-based data analysis can be used to identify troublesome vibrations for

This research is funded by Universiti Malaysia Pahang Al-Sultan Abdullah under research grant RDU220359. Corresponding author: mfadhil@umpsa.edu.my