Abstract
Creation of training data using data driven modeling for fault detection

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Reliable fault detection is required to ensure the safe operation of future urban air mobility (UAM) vehicles. Realistic flight data is needed to test and evaluate fault detection algorithms, and many state-of-the-art methods in machine learning require large amounts of data. Operational data from existing systems are typically used to design such algorithms, but designing for systems that do not yet exist, such as UAM vehicles, presents specific challenges.

Traditional detailed system identification for unmanned aerial vehicles can be costly and requires expertise and resources. There are cases where a system is already in place, but the dynamics are not known in detail, like for a single prototype of a UAM. System identification and simulations can evaluate a system's performance and viability. A data-driven method is presented for approximating a multirotor unmanned aerial vehicles (UAV) system matrix using dynamic mode decomposition with control (DMDc) [1]. This approach is tested and verified by utilizing data collected from the sensors of a Pixhawk 4 from flight tests of a octocopter UAV with a maximum take-off mass of up to 25 kg. This method shall demonstrate the necessary sensors to approximate the dynamics of other systems like UAM vehicles.

This paper presents a method for creating a data set to aid the design of fault detection algorithms by simulating a UAM vehicle in Simulink. The vehicle is simulated in six degrees of freedom, applying the dynamics generated by DMDc and traveling autonomously using full-state feedback along a randomly generated route. In a Monte Carlo simulation, random faults, like drivetrain faults or excessive vibrations, are injected into the simulations via state machines. Additionally, performance degradation will be implemented for algorithms focusing on maintenance intervals. This includes modeling component wear, such as drivetrain wear and battery degradation.

The result is a dataset containing time-series flight data of the system states, labeled to indicate whether a fault occurred and the wear status of each component. The generated data is a basis for future work on designing fault detection using machine learning methods such as autoencoder-type neural networks and support vector machines. The generated data will be open source to encourage further research.

[1] Proctor, J. L., Brunton, S. L., and Kutz, J. N., "Dynamic Mode Decomposition with Control," SIAM Journal on Applied Dynamical Systems, Vol. 15, No. 1, 2016, pp. 142–161.

Biography

Samuel Lesak

Samuel Lesak MSc is an aeronautical engineer with extensive knowledge of control engineering, flight mechanics, machine learning, and the application of MATLAB and Simulink. He completed his bachelor's and master's degrees in aeronautics at FH Joanneum in Graz. He gained professional experience in R&D simulation and control engineering, where he developed simulation models for urban air mobility (UAM) drones. He is currently working at FH Joanneum in Graz, Austria, as a researcher in the Intelligent Systems Lab research group.