VUT 700 SPECTO project overview

Pavel Zikmund, Jan Pejchar
Institute of Aerospace Engineering, Faculty of Mechanical Engineering, Brno University of Technology. Technická 2, 616 69 Brno, Czech Republic, +420 541 143 687, zikmund@fme.vutbr.cz

Abstract

The paper gives overview of VUT 700 SPECTO unmanned system development. The airplane VUT 700 SPECTO is small experimental airplane with maximum take-off weight 20 kg. It was designed at the Institute of Aerospace Engineering at Brno University of Technology. Project is framed mainly as master and PhD students' practical work. The paper covers a period from measurement system design through in-flight testing to measurement evaluation. Objective of this project phase was to upgrade remote controlled airplane to an UAV test bed with identified aerodynamic characteristics.

A measurement system was developed particularly for the airplane. Sensor Data Acquisition Unit (SEDAQ) originates from cooperation with colleagues from Faculty of Information Technology. Two versions of SEDAQ were created. The current second version is able to process and save simultaneously 20 channels at 100Hz sampling rate. This frequency is adequate for the airframe dynamic response measurement. Several sensors were installed aboard the airframe. A Vane for angle of attack measurement is one of them. It is mounted on a tube which also scans total pressure. Attitude information is provided by specifically developed inertial measurement unit. It consists of three axis accelerometer, three axis gyroscope and three axis magnetometer. Thermometer, static pressure gauge and flaps deflection registration complete the current measurement setup.

The main focus of testing was mathematical model improvement and analytical aerodynamic analysis validation. Preliminary aerodynamic analysis was done because of handling qualities estimation. The study was based on analytical approach commonly used for manned airplanes. VUT 700 SPECTO is out of the typical manned aircraft size range and it can evoke additional errors. Flight testing also requires different preparation and execution in comparison with piloted flight. Generally it is more difficult to carry out prescribed manoeuvres. Actually, it is very challenging for the Radio Control (RC) pilot to achieve even steady horizontal flight for a relevant timeframe. Therefore RC flight measurement method is described in the paper. It includes also control input design to get demanded response. Flight measurements carried out for aerodynamic characteristics identification need proper input. 3-DOF simulation was used to search for input design with suitable dynamic response.

Two identification methods were used to obtain aerodynamic characteristics of the airplane: Error Equation Method and Output Error Method. First mentioned method is very simple, therefore it was used for initial value definition for the more elaborate Output Error Method. This approach is characterized by iterative nature and requires passable initial values of estimated parameters. Outcomes of the two aforementioned methods are compared and assessed in the current paper.

The results of in-flight test evaluation were used for the RC flight simulator model development. Furthermore, the determined aerodynamic characteristics are foreseen to be used during Hardware In the Loop (HIL) autopilot training and setup. Eventually, the characteristics and control laws will be implemented into the autopilot stabilization and guidance system, converting it from black-box controller to dynamic-model-based controller.

The autopilot has been already successfully tested on a smaller platform and is prepared for integration into the VUT700 SPECTO airframe. Following this step, the SPECTO aircraft will be instrumented with various payloads and used for cooperation with research partners. Apart from that, the airframe will continue to serve as a test bed for on-going projects such as Telepresence system development and Gust load investigation, among others.