

System Identification of Meridian Unmanned Aerial System

*Shawn Keshmiri, Mark Ewing, and Richard Hale
The University of Kansas*

The unsteady and nonlinear aerodynamic characteristics of the Meridian unmanned aerial system in the presence of wind shear are investigated using the recorded test data during flights in Polar Regions. The Meridian UAS is designed to provide an aerial platform for ice-penetrating radar developed for research in Polar Regions. The Meridian Unmanned Aerial Vehicle (UAS) is a 499 kg (1,100 pounds), long range, high endurance autonomous aircraft designed, built, and flight tested by the University of Kansas Aerospace Engineering Department for the NSF Center for Remote Sensing of Ice Sheets (CReSIS). The Meridian has nine successful flights in its record, six of them autonomous, including flights in Antarctica and Greenland. Fig. 1 shows a photograph of the Meridian flight test from the NEEM snow runway in Greenland.



Figure 1: The Meridian UAS-Greenland

The time-dependent boundary layer; aircraft configuration and edge-separated vortex lag; unsteady up-wash and down-wash; dynamic stall; and unsteady environmental disturbances all have primary effects on nonlinear and unsteady aerodynamics of UASs. Among the environmental disturbances, wind and turbulence are the most common ones to affect aircraft dynamics. In particular, windshear, with its magnitude and/or direction varying with time, will excite the unsteady aerodynamics and make the vehicle difficult to control. Every year turbulence related accidents have also been reported. Polar Regions present unique challenges in terms of weather and climate, and hence UAS operation. To improve the control and operation of the UASs, it is essential to accurately model the nonlinear and unsteady aerodynamic effects. In this paper aerodynamic characteristics of the Meridian UAS in the presence of wind shear are investigated using flight test data recorded during a flight tests in Antarctica and Greenland Polar Regions. A model identification method called Fuzzy Logic Modeling is utilized to set up the aerodynamic models without assuming the functional relations. The aircraft's oscillatory stability and control derivatives are found to be significantly impacted by the environmental disturbances. The exhibited highly oscillatory motion in the manual-control mode is analyzed and identified with a new energy method. The main purpose of this paper is to determine the reasons for and characteristics of oscillations that occurred in the flight for improvement of autopilot design and ground operator training.

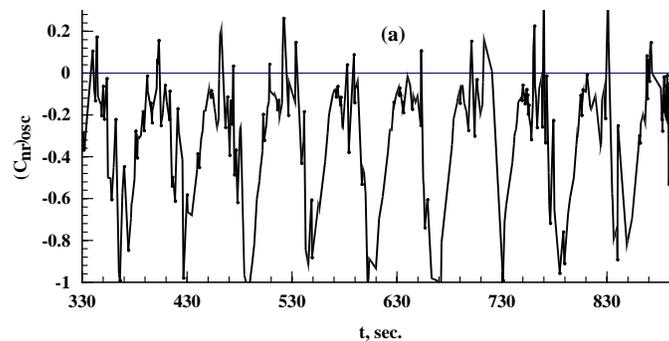


Figure 2: Unsteady and Nonlinear Yaw Damping Derivative