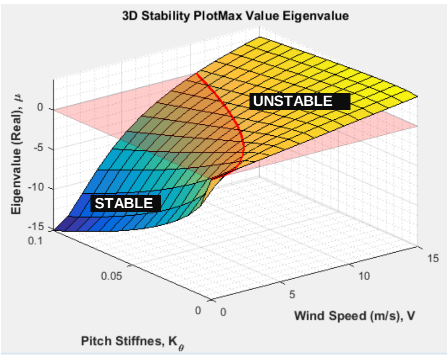
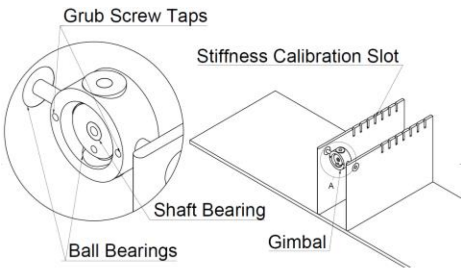
The Centre for
Power Transmission
and Motion Control

UNIVERSITY OF BATH

Research Project

ACTIVE CONTROL OF WHIRL FLUTTER





Motivation

Tiltrotor aircraft are able to transition between helicopter and aeroplane modes by changing the inclination of their proprotors from vertical to horizontal. They combine the advantages of vertical/short take-off and landing (V/STOL) capabilities with the speed, comfort, efficiency, payload capacity, range, and endurance associated with conventional fixed-wing airplanes. These hybrid aircraft present unique advantages in both military and commercial domains such as improved medical aid/evacuation operations, and as a result, have been targeted by the aerospace community as a focus of sustained research.

The Problem

The rotor-nacelle systems found in tiltrotors are susceptible to whirl flutter in forward flight. This condition involves an aeroelastic coupling of the pitching and yawing modes of the nacelle caused by precessional behaviour arising from the aerodynamic loads applied at the proprotor. This coupling is gyroscopic in nature, and can compromise tiltrotor operation beyond critical flight speeds. The occurrence of whirl flutter can lead to unstable vibrations and ultimately to catastrophic damage to the aircraft.

Active Solutions

Active vibration suppression techniques can stabilise the response of the nacelle-rotor systems through the introduction of controllable aerodynamic loads. The system can monitor the state of operation in real-time and manipulate the stability boundaries using an optimised control system to counteract the vibrations. This project focuses on the use of active control on trailing edge wing flaperons and wing-embedded mini-tabs to mitigate flutter.

Future work

Building on a validated whirl flutter model, future work will seek to extend this model to a representative wing-nacelle-rotor system. Feedback control will be used to demonstrate active stability augmentation in simulations and experiments.

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