

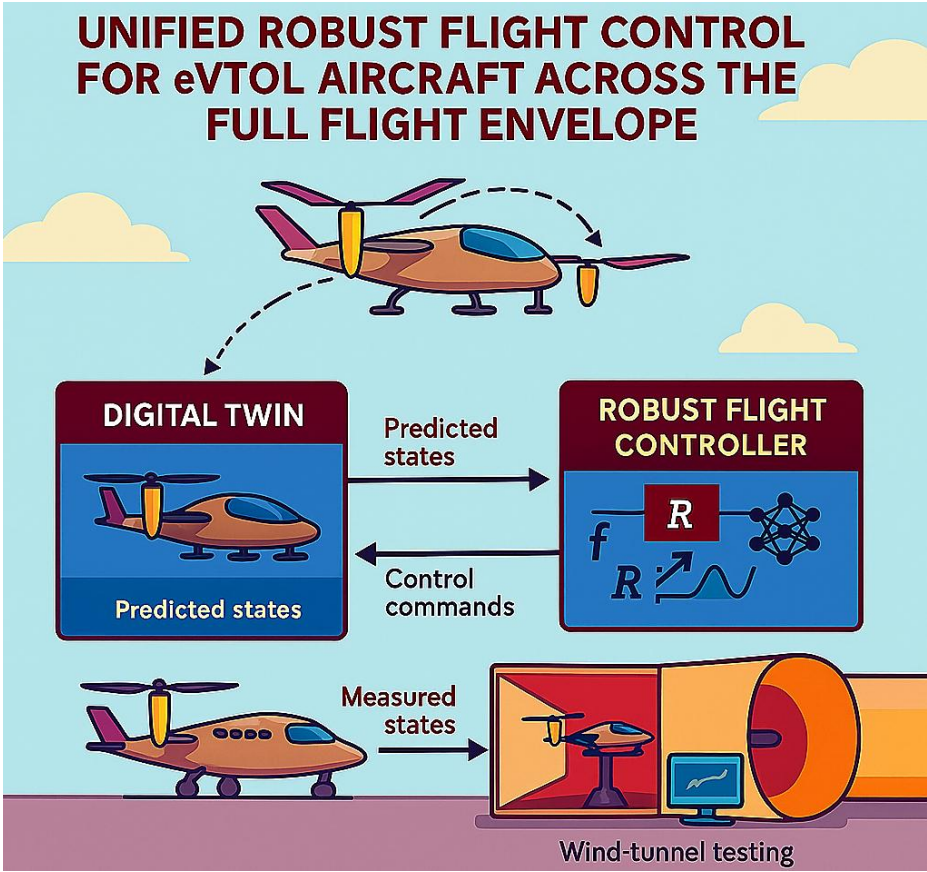
Unified Robust Control for eVTOLs Across the Full Flight Envelope

Dr. Davood Asadi
Senior Lecturer in Flight Dynamics and Control
Davood.asadihendoustani@uwe.ac.uk



Research Overview

- Electric Vertical Take-Off and Landing (eVTOL) aircraft promise safe, quiet, and sustainable air mobility in urban environments. However, **flight control across the full envelope —from vertical lift to forward flight —**remains a major challenge due to rapid aerodynamic and propulsion-mode changes.
- This research develops a **unified robust and intelligent control framework** capable of stabilizing and commanding eVTOLs seamlessly through **hover, transition, and cruise** phases, integrating nonlinear control, fault tolerance, and aerodynamic adaptation.



Industry Relevance

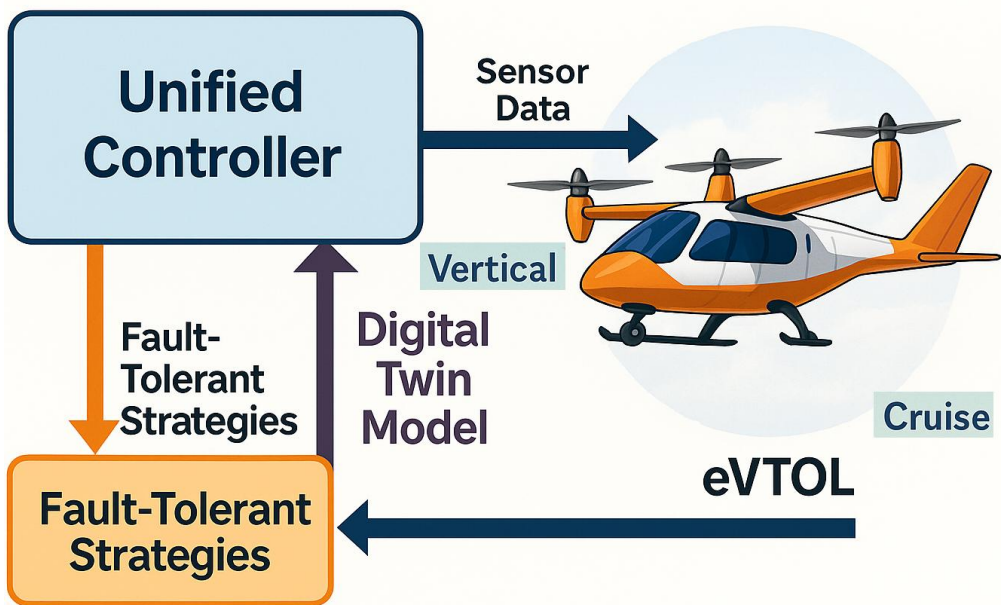
- **Urban Air Mobility (UAM):** Enables safe, stable flight of eVTOLs under uncertain wind, turbulence, or actuator degradation
- **Certification Support:** Contributes to control-safety validation for next-generation air taxis and logistics drones

Methods & Technologies

- **Dynamic Modeling:** Aerodynamic and propulsion modeling across hover, transition, and cruise phases using 6DOF flight equations
- **Unified Fault Tolerant Control:** Combines a digital twin with nonlinear adaptive control and fault-detection mechanisms to realize a unified controller that maintains stability and performance across the entire flight envelope
- **Scaled eVTOL Wind-Tunnel Experiments and Flight Tests:** Physical testing of a scaled eVTOL prototype in UWE Bristol's/ Bristol University's subsonic wind tunnel to replicate real aerodynamic and propulsion conditions during transition flight, followed by verification through flight tests on the scaled platform.

Innovations

- **Single-controller architecture** replacing conventional mode-based switching.
- **Full-Envelope eVTOL Control** Through Robust Intelligent Design
- **Robust fault-tolerant** adaptation to motor faults or aerodynamic uncertainties.
- **Integrated digital twin** enabling real-time testing and certification-oriented verification.



Opportunities

- **Collaboration with eVTOL and UAM developers** to integrate the unified controller into test vehicles.
- Partnerships for **hardware-in-the-loop testing and flight data collection**.
- Exploring **joint funding** via EPSRC, Innovate UK, or Future Flight Challenge.
- Open to **industrial MSc projects and PhD co-supervision** in flight control and certification.

