AUGMENTED SYSTEMS FOR PERSONAL AIR VEHICLES

PhD in Automation, Robotics and BioEngineering (1st year)

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Introduction

Issue:
Congestion problems in the transportation system have led to regulators considering implementing drastic changes in **methods of transportation** for the general public.
Possible solution:
Combine the best of ground-based and air-based transportation and produce a ***personal air transport system***.

Project

- Investigate the interaction between a pilot with limited flying skills and ***augmented vehicles*** that are part of the ***personal air transport system***.
- Verify if it is possible to reach similar performance to a highly-trained pilot, also in dangerous environmental or demanding conditions.

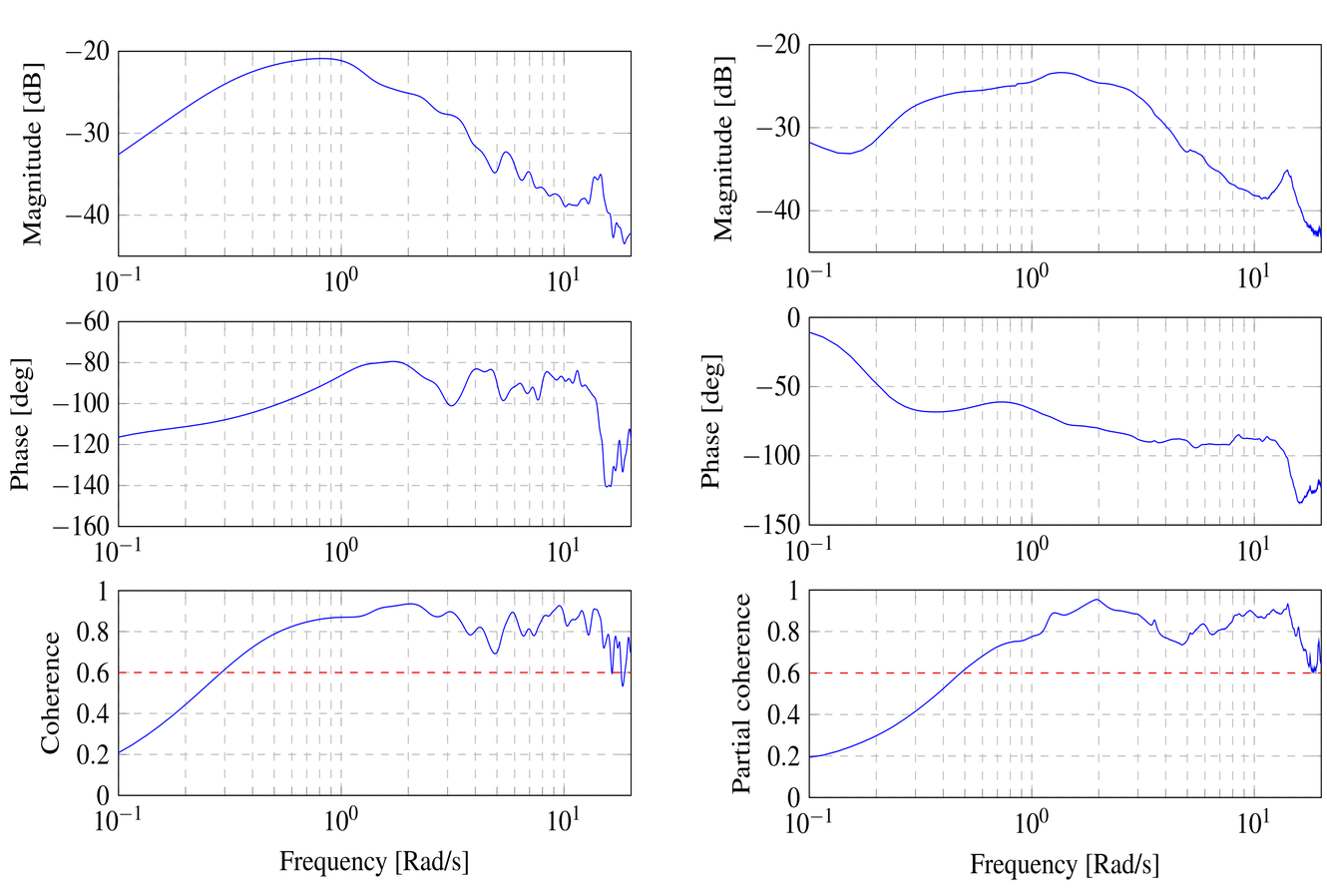
Identification phase

The **first phase** of the project is the identification of a **rigid body dynamic model** of a *light-weight* helicopter considered cinematically closed to a *personal air vehicle.* A ***Robinson R44 Raven II*** was chosen.

inputs
Pilot controls:
- Cyclic
- Collective
- Pedals

outputs
- Position (x, y, z)
- Attitude (ϕ, ϑ, ψ)
- Angular rates (p,q,r)
- Linear accelerations (a_x, a_y, a_z)

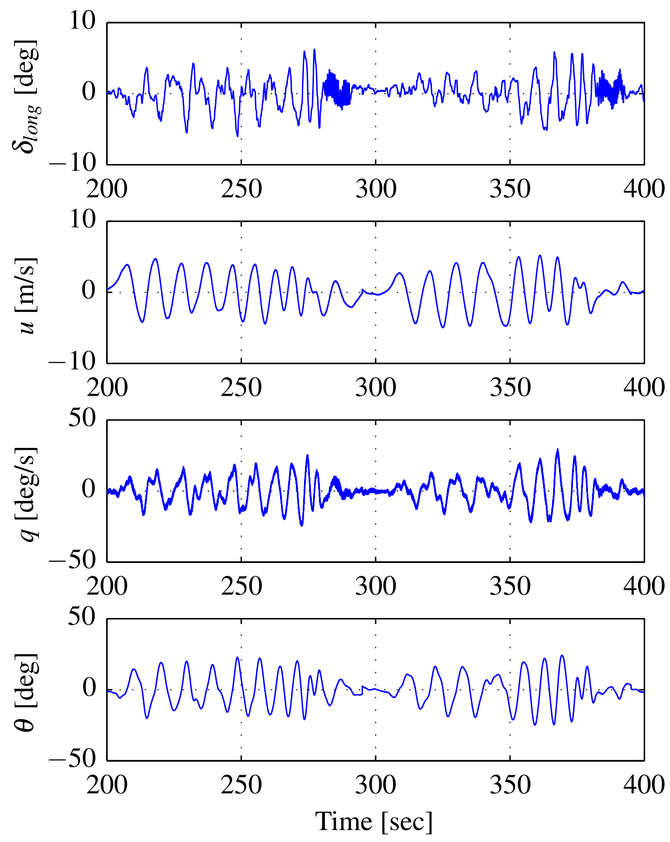
Helicopter input-output **couplings** and inputs **correlations** need to be taken into account to compute the actual frequency responses.



- Bode plots of the pitch axis SISO frequency response **q/δ_{long}** (on the right picture **couplings** and **correlations** are considered and the **composite windowing method** is applied)

Collection of data [1]

Example of *piloted frequency sweep maneuvers* (longitudinal axis in the picture) collected for implementing a **frequency domain identification method**



Ongoing work and next steps

- **MIMO parametric identification** to create a *fully-coupled rigid-body* **state-space model [2].**
- Implementation of **augmented systems** to enhance the stability and maneuverability of the helicopter model.
- Implementation of ***handling qualities*** and ***human performance evaluations*** in piloted closed-loop control tasks with and without augmented systems by making use of a CyberMotion Simulator.

Publications

[1] Geluardi, S., Nieuwenhuizen, F. M., Pollini, L., and Bülthoff, H. H., “Data collection for developing a dynamic model of a light helicopter”, European Rotorcraft Forum, Moscow, September 2013.

[2] Geluardi, S., Nieuwenhuizen, F. M., Pollini, L., and Bülthoff, H. H., “Frequency domain system identification of a light helicopter in hover”, AHS Conference, Montréal, May 2014.