Handling Flight Parameter Variations and Unmodeled Dynamics Using Neural Networks

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Kellogg Honors College Capstone 2012

Linear UAV controllers are insufficient
Most unmanned aerial vehicle (UAV) flight controllers used today rely on linearized models of the aircraft. These are needed for every state, which is impractical. Gain scheduling is used to handle changes in flight dynamics, but is computationally expensive and sometimes too slow or inaccurate.

The project goal is to make a robust nonlinear flight controller using neural networks
It should be possible to introduce artificial neural networks (ANN) into the flight control loop because of its ability to learn based on feedback. A simple multilayer perceptron (MLP), a type of ANN, was used to explore the capabilities of neural networks in this application.

Data was taken from Raptor 90 UAV
To train the MLPs, we use flight test data acquired by human-piloting a Raptor 90 helicopter UAV in a hover state. Data was collected by oscillating a control with increasing amplitude. Testing was done on sweeps that primarily exercised one of three parameters: roll, pitch, and yaw.

Results

Figure 1. A multilayer perceptron.

Figure 2. Raptor 90 Helicopter.

Figure 3. Graph of pitch sweep. Inputs: p, q. Output: δlon.

Figure 4. Graph of roll sweep. Inputs: p, q, r. Output: δlat.

In conclusion, neural networks are capable of understanding flight dynamics
These results show that even a basic MLP is able to cope with the flight dynamics of a UAV. The next step of the project will be to integrate into a flight controller and perform simulations.

Acknowledgments
Research was sponsored by
• National Science Foundation (Award #1102382)
• LSAMP Research Scholars Program