Handling Flight Parameter Variations and Unmodeled Dynamics Using Neural Networks

Alexander Gutierrez*

Dr. Subodh Bhandari†, Dr. Fang "Daisy" Tang*, Dr. Amar Raheja*, Kevin Ortega*

*Computer Science Department, Cal Poly Pomona †Aerospace Engineering Department, Cal Poly Pomona

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.

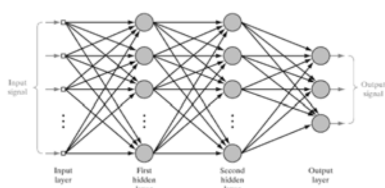

Figure 1. A multilayer perceptron.

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.

Figure 2. Raptor 90 Helicopter.

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.

Sensors

- roll (p)
- pitch (q)
- yaw (r)
- x acceleration (N_x)
- y acceleration (N_y)
- z acceleration (N_z)

Controls

- longitudinal cyclic (δlon)
- lateral cyclic (δlat)
- tail rotor (θ_{0T})
- collective (θ_{0M})

Results

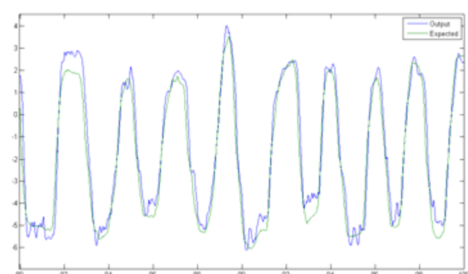

Figure 3. Graph of pitch sweep. Inputs: p, q. Output: δlon.

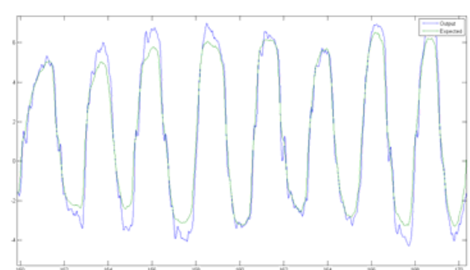

Figure 4. Graph of roll sweep. Inputs: p, q, r. Output: δlat.

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