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Studying Flight Dynamics With the myVTOL NI miniSystem for NI myDAQ (Pioneer Release)

Overview

This tutorial uses the myVTOL (Vertical Take-Off and Landing) NI miniSystem, NI myDAQ, and NI LabVIEW system design software to learn fundamentals of basic flight dynamics with a vertical take-off and landing plant. You can directly explore fundamental concepts to control the system to hover, take off, and land vertically. By the end of this tutorial, you will be able to perform the following:

- Measure the position of the device
- Control the variable fan
- Maintain equilibrium of the device using the fan

To recreate the experiment in your lab or dorm, download the example program and follow the tutorial.

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Background on Vertical Take-Off and Landing (VTOL)

The jet fighter aircraft are vulnerable because of their reliance on an airbase and runway to travel from one location to the next. In the 1950s, the VTOL plane was seen as a way to overcome this problem, because a VTOL aircraft can hover, take off, and land vertically. It could operate from basically anywhere and required no runway. This classification includes fixed-wing aircraft as well as helicopters and other aircraft with powered rotors.

The challenge with designing a VTOL aircraft is maintaining a thrust–to-weight ratio to lift from the ground with thrust vector pointed downward during takeoff and pointed backward during normal flight. The plane lifts only if the thrust-to-weight ratio is above one. To lower the plane, the thrust–to-weight ratio must be less than one. You must control the thrust of the plane to establish the position to lift off and safely land.

What Is the myVTOL?

The myVTOL by Pitsco Education is an NI miniSystem for NI myDAQ that teaches flight control. The vertical take-off and landing system uses a variable PC fan to create the lift for the one degree of freedom (DOF) plant. The flight distance of fan is measured using an analog Hall Effect sensor. The system teaches the fundamentals of basic flight dynamics, motion control, and proportional integral derivative (PID) control. Students can directly explore fundamental concepts to control the system to hover, take off, and land vertically to understand the applications similar to a helicopter or harrier jet.

Understanding the Connections on the myVTOL

Here is a quick snapshot of the connections between the myVTOL and NI myDAQ:

myVTOL	NI myDAQ Connection
Analog Hall Effect Sensor	Analog Input 0 (AI 0)
Variable DC Fan	Analog Output 0 (AO 0)

Setting Up the Experiment

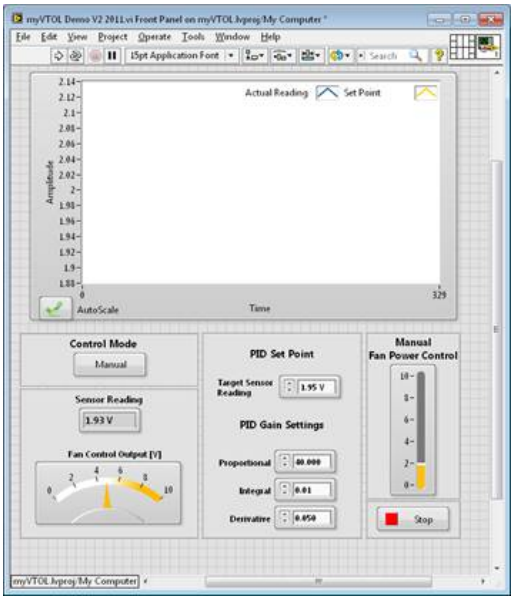
1. Place the myVTOL platform on a flat surface.
2. If not already connected, screw in the gold weight on the end of the arm.
3. Connect to the 9 VDC power source *or* place a 9V DC battery. If using a 9V DC battery, ensure the polarities of the battery match the battery holder.
4. Set the switch to ON for myVTOL.
5. Ensure that the NI myDAQ is connected to the computer and active with your computer.
6. You are now ready to measure and control the vertical take-off and landing plant.

Running the Experiment

1. Download the myVTOL_basic VI.

2. Open the VI in LabVIEW.

3. The front panel will look like this:



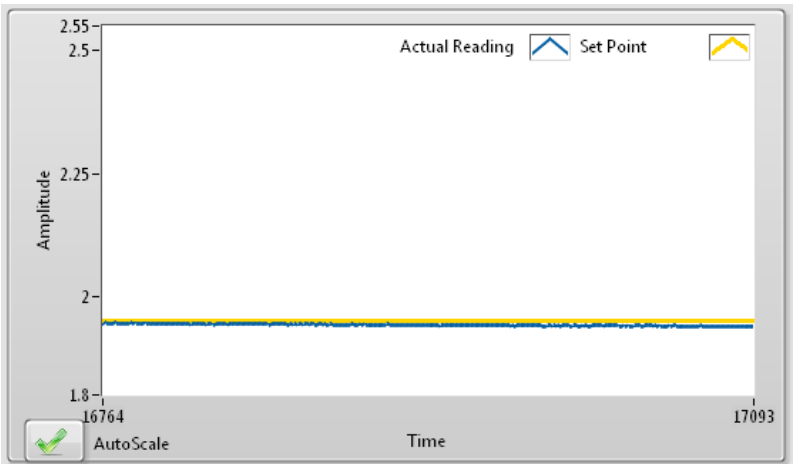
4. Set the *Control Mode* to Manual.

5. Run the VI.

6. Calibrate the position of the VTOL. Use your hand to move the VTOL arm until the fan is at a flat equilibrium level. Record the value of the *Sensor Reading*.

7. Set the *Target Sensor Reading* to the value of the equilibrium level just recorded. This establishes the desired set point for the system.

8. Control the speed of the fan by increasing and decreasing the *Manual Fan Power Control* until the position of the fan measured by the *Actual Reading* matches the *Set Point*. The lines on your graph for the *Actual Reading* and the *Set Point* will overlap when the values match.



9. Power down the VTOL arm by decreasing the *Manual Fan Power Control* until the position of the fan measured by the *Actual Reading* reaches 0.

Challenge: Set the Control Mode to Automatic and manually tune the PID Gain Settings to control the location of the fan and reach equilibrium.

Resources

Get the myVTOL NI miniSystem for NI myDAQ

What Is an NI miniSystem?

What Is NI myDAQ?

Pioneer Release

NI miniSystems in Pioneer Release allow users in higher education (university/college) to purchase units so they can "ramp up" on integrating NI miniSystems into courses as soon as they are available. National Instruments collects active feedback from users of NI miniSystems in Pioneer Release to acquire sufficient feedback for suppliers and partners before the next release. NI miniSystems in Pioneer Release are stable but not feature complete and will most likely require the use of custom programming to fully meet customer application needs. For this reason, it is recommended that customers self-qualify to participate in the Pioneer Release by obtaining basic LabVIEW training (LabVIEW Core 1 and 2). Participants have access to standard training discounts that can be viewed at ni.com/training.

During the Pioneer Release of an NI miniSystem, support is provided via emails to minisystems@ni.com or by posting to a private NI Discussion Forum. To get access to the Forum for yourself or other customers, please contact National Instruments using the above email address.