3 DOF HOVER

The 3 DOF Hover system is ideally suited to study control concepts and theories relevant to real world applications of flight dynamics and control in vertical lift off vehicles.

STUDY FLIGHT DYNAMICS AND CONTROL OF VERTICAL LIFT-OFF VEHICLES

The 3 DOF Hover experiment provides an economical test bed to understand and develop control laws for flight dynamics and control of vehicles with vertical lift off.

HOW IT WORKS

The 3 DOF Hover consists of a planar round frame with four propellers. The frame is mounted on a three degrees of freedom pivot joint that enables the body to rotate about the roll, pitch and yaw axes. The propellers are driven by four DC motors that are mounted at the vertices of the frame.

The propellers generate a lift force that can be used to directly control the pitch and roll angles. The total torque generated by the propeller motors causes the body to move about the yaw axis. Two of the propellers are counter-rotating, so that the total torque in the system is balanced when the thrust of the four propellers is approximately equal.

The voltage signals going to the motors, as well as the pitch and yaw encoder signals are transmitted through a slip ring. The slip ring removes the need for wires and allows for 360 degrees free motion about the yaw axis. Furthermore, it reduces the amount of friction and loading about the moving axis.

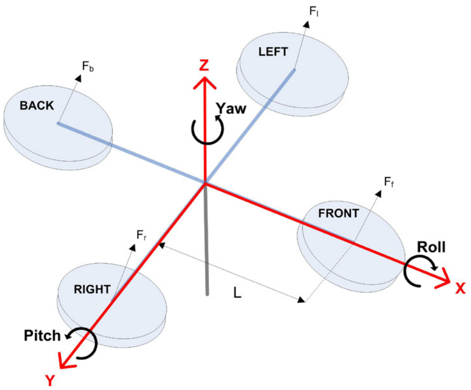


Figure 1
An example of a free body diagram for the 3 DOF Hover provided in the courseware. Students can use this model to study forces interacting with the hover and the direction conventions.

System specifications on reverse page.

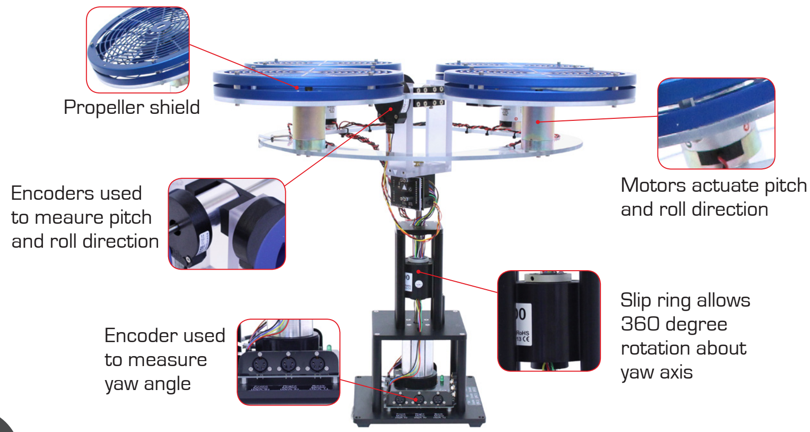
3 DOF HOVER WORKSTATION COMPONENTS

3 DOF Hover plant
Q8-USB data acquisition device
VoltPAQ-X4 four channel linear voltage amplifier
QUARC real-time control software for MATLAB®/Simulink®
Laboratory Guide and User Manual (provided in digital format)
Sample pre-built controllers and complete dynamic model

3 DOF Hover workstation

SYSTEM SPECIFICATIONS

3 DOF Hover



CURRICULUM TOPICS PROVIDED

- Derivation of simple dynamic model
- State space representation
- State feedback control
- LQR control design
- Control parameter tuning

FEATURES

- Three degrees of freedom (3 DOF) - body rotates about pitch and yaw axes
- Propellers driven by high-quality Pittman DC motors
- High-resolution optical encoders for precise position measurements
- Slip ring allows infinite motion about the yaw axis
- Easy-connect cable and connectors
- Precise, stiff and heavy-duty machined components
- Fully compatible with MATLAB®/Simulink® and LabVIEW™
- Fully documented system model and parameters provided for MATLAB®/Simulink®, LabVIEW™ and Maple™
- Open architecture design, allows users to design their own controller

DEVICE SPECIFICATIONS

Device mass	3.46 kg
Device height (ground to top of base)	45 cm
Helicopter body mass	1.39 kg
Helicopter body length	48 cm
Base dimensions – W x L	17.5cm x 17.5 cm
Encoder resolution (in quadrature)	8192 counts/rev
Pitch angle range	75 (± 37.5 deg)
Yaw angle range	360 deg
Motor / propeller force-thrust constant	0.119 N/V
Motor / propeller torque thrust constant	0.0036 N.m/V
Propeller diameter	20.3 cm
Propeller pitch	15.2 cm
Motor armature resistance	0.83 Ω
Motor current-torque constant	0.0182 N.m/A

COMPLETE WORKSTATION COMPONENTS

Plant	3 DOF Hover
Control design environment	Quanser QUARC® add-on for MATLAB®/Simulink® Quanser Rapid Control Prototyping (RCP) Toolkit add-on for LabVIEW™
Documentation	User Manual and Laboratory Guide
Real-time targets	Microsoft Windows® and NI CompactRIO
Data acquisition devices	Quanser Q8-USB, QPIDe, or equivalent NI DAQ device supported by QUARC NI CompactRIO with four Quanser Q1-cRIO modules
Amplifier	Quanser VoltPAQ-X4 linear voltage amplifier

The linear state space model and a sample controller(s) are supplied