

# Zeppelin Simulation Guide



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Everything you need to know (and what I wish I would have known) before working with the simulation.

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## Current State

The model that is known work well is the autopilot (zeppelin\_chap6.mdl). In its current state, it is able to follow a heading at a given airspeed and height. Because Dr. Beard worked through it with me, I'm fairly confident that this one works well. There will be some tuning for sure, but that will be discussed later.

The model entitled "zeppelin\_chap10.mdl" is what is currently being worked on. In essence, the autopilot from zeppelin\_chap6.mdl was put into a sub-function, called "Autopilot". The goal of this model is to follow a given path or orbit. The altitude doesn't translate well from the functions to the simulation. You'll see what I'm referring to when you run it.

## Important Variables

$V_a$  = Vehicle speed relative to air

$H_c$  = desired height

$\Theta_c$  = commanded pitch angle (where pitch angle is the tail pitch)

$\Delta_e$  = elevator command

$\Delta_t$  = throttle command (0 to 1)

$\Delta_a$  = aileron command (not used since the blimp won't be rolling)

$\Delta_r$  = tail bias angle command

Note: Anything with an “\_c” represents commanded, and anything with an “\_d” signifies desired.

## Important Files

### Param.m

Here you'll find all of the parameters for the simulation. **Always run this before running the animation.**

### Forces\_moments.m

This file takes all of the states (roll, pitch, yaw, velocities, angular rates, elevator angle, throttle, tail bias angle, and wind info) and outputs the forces and torques (moments) in each of the x, y and z directions.

### Mav\_dynamics.c

Remember to mex this if you change anything ("mex mav\_dynamics.c"). It's already been "mexed" on Windows, Mac, and Linux. This translates the forces and moments into new states based on the physics of the aircraft.

### Aircraft Animation Parameters

To find these, right click on the "draw aircraft" Simulink block and choose "Edit Mask". Under the Initialization tab, you'll find where all of the coordinates are Vertices and Faces are defined. We do it this way as opposed to in the code so that the simulation doesn't have to re-compute the vertices/faces during every loop. Note: The flapping tail animation code is in "plotZeppelin.m" for "zeppelin\_chap6.mdl" and "drawPathError.m" for "zeppelin\_chap10.mdl".

### State Variables Plot

This function outputs all of the state variables into easy to interpret graphs. They are your best friend for diagnosing which states are working.

### Path\_manager.m (zeppelin\_chap10.mdl only)

Defines the path for the zeppelin (either a vector or an orbit). The "if 0"/"if 1" statement switches between the line and the orbit. For a line, change it to "if 1" and for an orbit, change it to "if 0". The parameters for the line/orbit are defined in here, including starting point, and a unit vector in the case of the line, and a center of orbit and radius for the orbit function. These are passed into path\_follow.m

### Path\_follow.m (zeppelin\_chap10.mdl only)

This function reads in both the states and the desired path. From these two inputs, it calculates error and integrates it out. The outputs are the commanded airspeed ( $V_{a\_c}$ ), the commanded height ( $h\_c$ ), and the commanded heading ( $\psi\_c$ ).

### Airspeed\_from\_pitch/airspeed\_from\_throttle/altitude\_from\_pitch\_loop/heading\_loop/pitch\_loop.mdl

These loops were used to turn the autopilot. Some of the loops aren't implemented. You may not use these to tune your gains.

## Troubleshooting

1. Re-run param.m
2. Insert break point and step through.
3. Ask Dr. Beard 😊