# Getting Started with EGH446 Simulation Environment

## Description

This simulation environment contains several toolboxes to allow the simulation of ground and aerial robots. This includes:

- Mobile Robotics Simulation Toolbox [1].
- 2D kinematic models for robot geometries such as differential drive, three, and four-wheeled vehicles, including forward and inverse kinematics
- Configurable lidar and object detector simulators
- Visualization of robotic vehicles and sensors in occupancy grid maps
- MATLAB and Simulink examples and documentation

## System Requirements

This version of the toolbox has been tested in MATLAB 9.6 or newer (R2019a or R2022 or newer).

Product dependencies are:

- MATLAB
- Simulink
- Stateflow
- Robotics System Toolbox
- Navigation Toolbox
- Control System Toolbox + Model Predictive Control Toolbox (optional)
- Reinforcement Learning Toolbox + Deep Learning Toolbox (optional)
- Simscape + Simscape Multibody (optional)

## Before you start

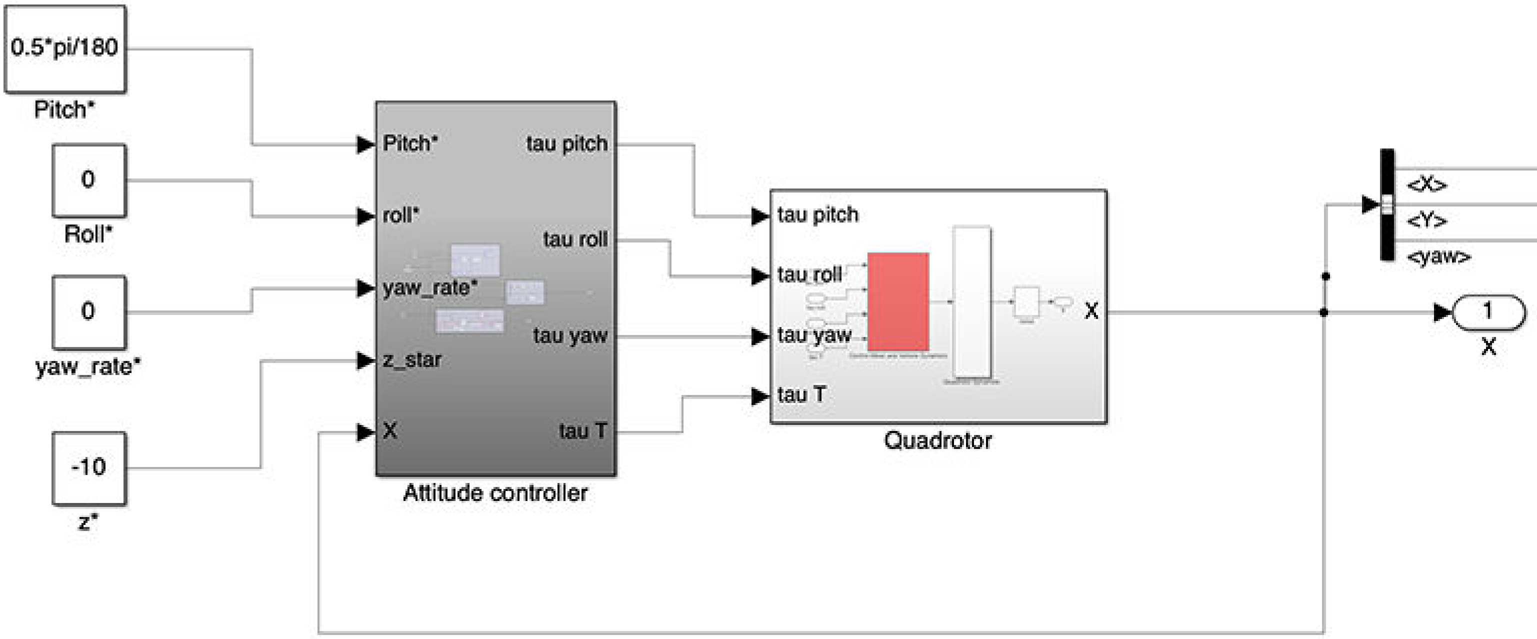
Before you are able to use the hyperlinks and examples in this guide, you must execute startupAerial or startupGround. This will add to your current path all directories and functions linked to this guide.

## How to Start an Aerial Robot

In the source directory, execute

```
startupAerial
```

this should bring a simulink environment as shown below




- The block **Vehicle Viewer** display waypoints and vehicle trajectory
- The block **Attitude controller** provides basic stabilisation for the quadrotor

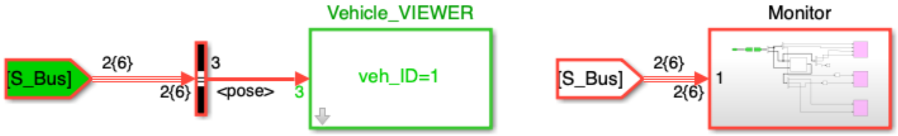
Please note that this environment contains the dynamics and controls of a standard quadrotor. The quadrotor states are affected by noise (white noise). It has a basic automatic control that stabilises angular velocities, attitude angles and altitude. Executing the simulink environment will cause the drone to drift by default unless a controller is used to follow a given reference value. You may need to adjust reference attitude values, desired altitude and/or turn rate to familiarise yourself with the quadrotor behaviour.

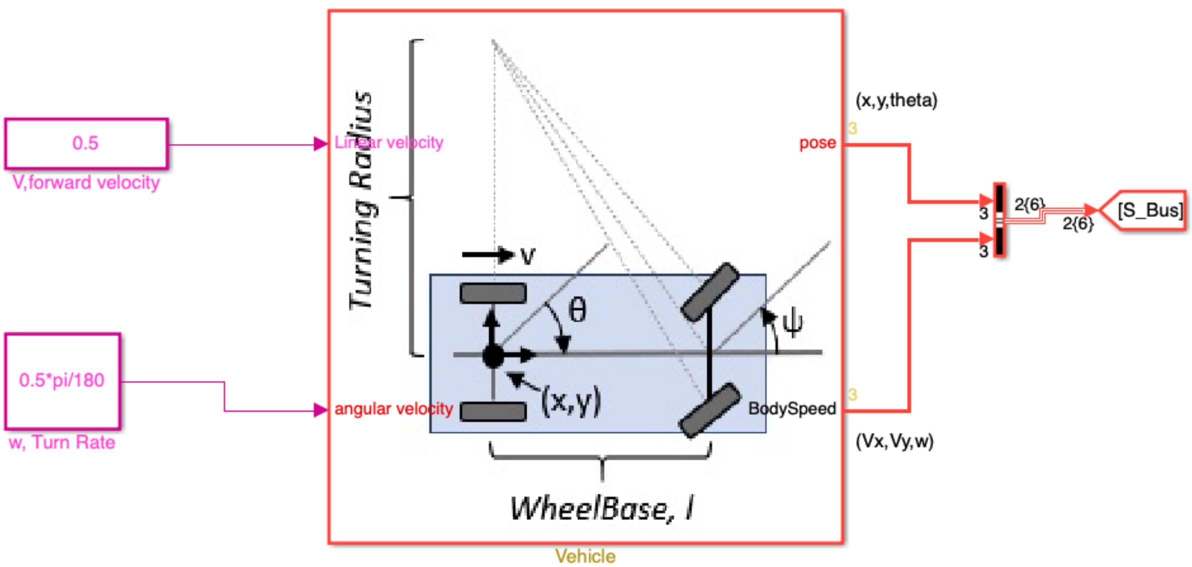
## How to start a Ground Robot

In the source directory,  execute

```
startupGround
```

this should bring a simulink environment as shown below

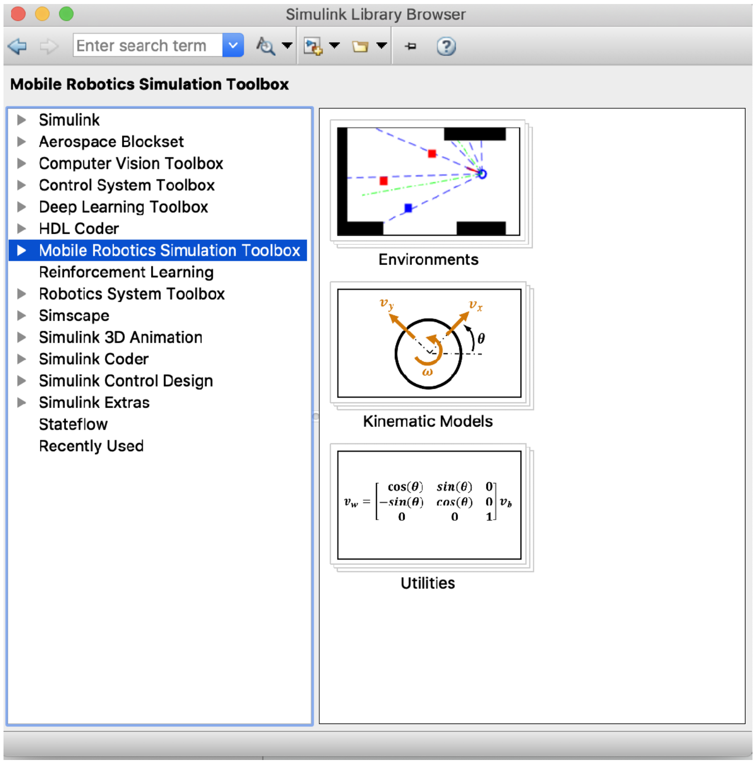



- The block **Vehicle Viewer** display waypoints and vehicle trajectory.
- The block **Monitor** can be used to plot (observe) some of the states.

Please note that this environment contains the dynamics and internal regulators (linear and angular veocity controllers) for a ground **Ackermann** type robot. The robot state is affected by noise (white Gaussian noise with zero mean). The robot accepts linear velocity commands [-5 , 5] m/s and turn rates [-pi/2 , pi/2] rad/s.

## Library Componets




The environment provides a number of simulink blocks to

- Simulate sensors and detectors
- Ground robot models
- Utilities for conversion

These block can be used to add a laser to your robot and simulate object detection among other tasks.

## Mobile Robotics Simulation Toolbox Documentation

Kinematic Models

- Differential Drive
- Triple Omniwheel
- Generic Omniwheel
- Four-Wheel Steering
- Four-Wheel Mecanum

Environment Models

- Robot Visualizer
- Multi-Robot Environment

Sensor Models

- Lidar Sensor
- Multi-Robot Lidar Sensor
- Object Detector
- Robot Detector

## Examples

For simple examples outlining usage of individual models, sensors, or visualizers, please refer to the documentation links above.

Additional examples, can be found in the `examples` directory of the toolbox.

Simulink Examples

- Waypoint following using the Pure Pursuit Algorithm (Differential Drive)

Application Examples

- Robot Soccer Simulation
- Navigation Behavior with Vector Field Histogram (VFH) Obstacle Avoidance
- Navigation Behavior with Reinforcement Learning Based Obstacle Avoidance

## References

[1] Mobile Robotics Simulation Toolbox. Copyright 2018-2019 The MathWorks, Inc. https://github.com/mathworks-robotics/mobile-robotics-simulation-toolbox