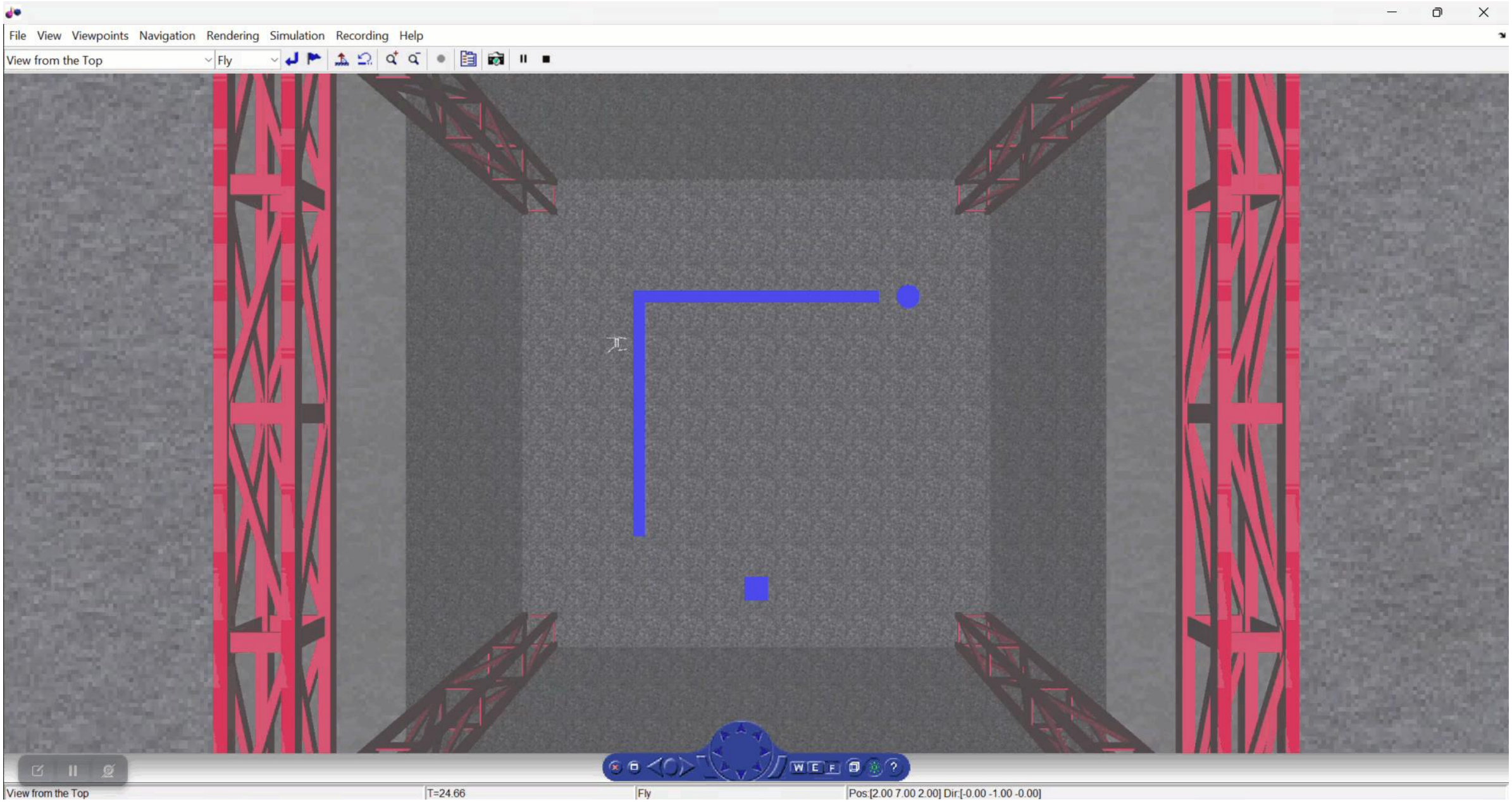
Simulink Game Day

with Drone Simulation

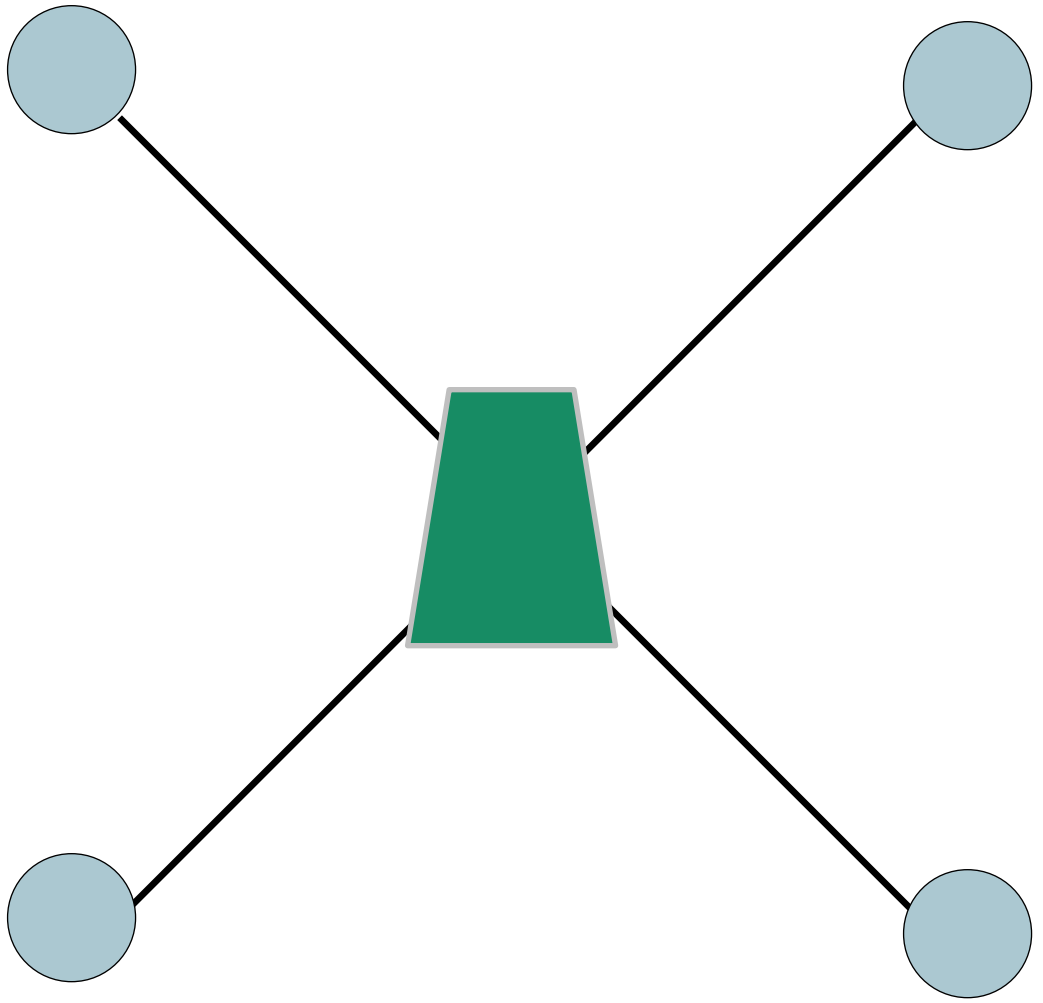
Agenda

- Quadcopters
- Simulink
- Planning the Path
- Perception
- Follow a Blue Line using Camera


File View Viewpoints Navigation Rendering Simulation Recording Help
View from the Top
Fly
W E F
View from the Top
T=24.66
Fly
Pos:[2.00 7.00 2.00] Dir:[-0.00 -1.00 -0.00]

Say Hello to Quadcopter!

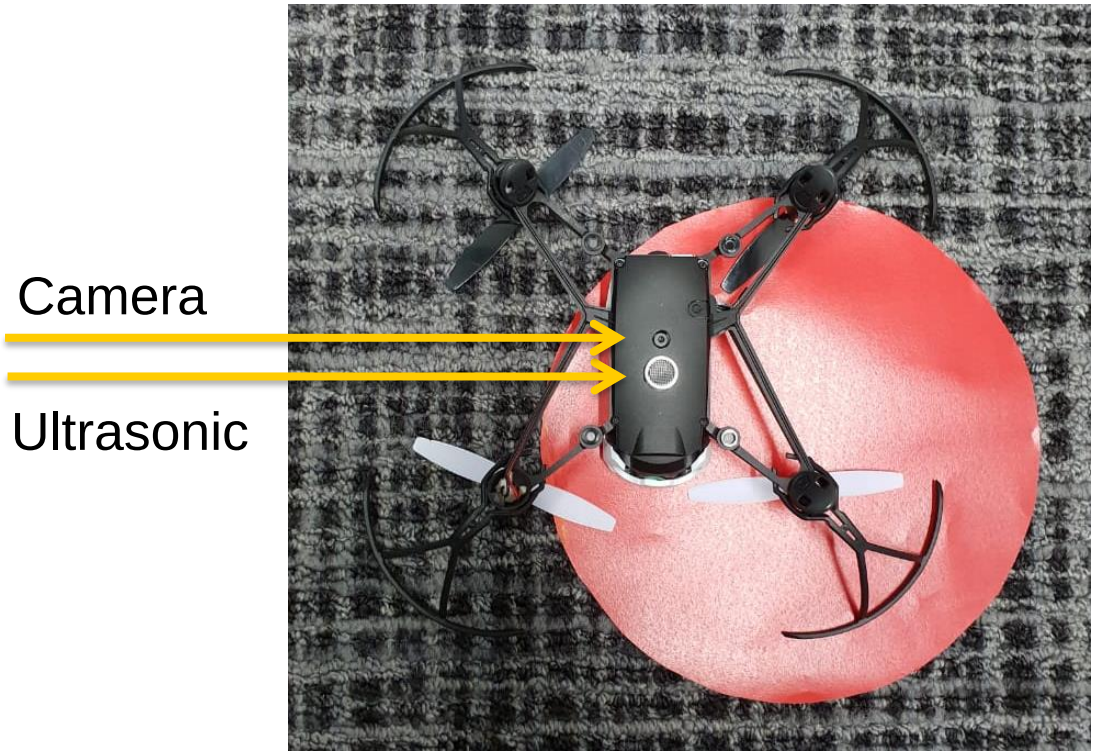
- A quadcopter is a drone with 4 propellers.
- The rotors connected to the propellers are used to generate lift and perform motion.
- Surveying, medicines, sports.



Sensors on a Quadcopter

Parrot Mambo

- Ultrasonic Sensor
  - To calculate altitude
- Camera
  - To capture the view
  - To calculate horizontal velocities
- Pressure Sensor
  - To calculate altitude
- Inertial Measurement Unit (IMU)
  - 3-axis accelerometer
  - 3-axis gyroscope

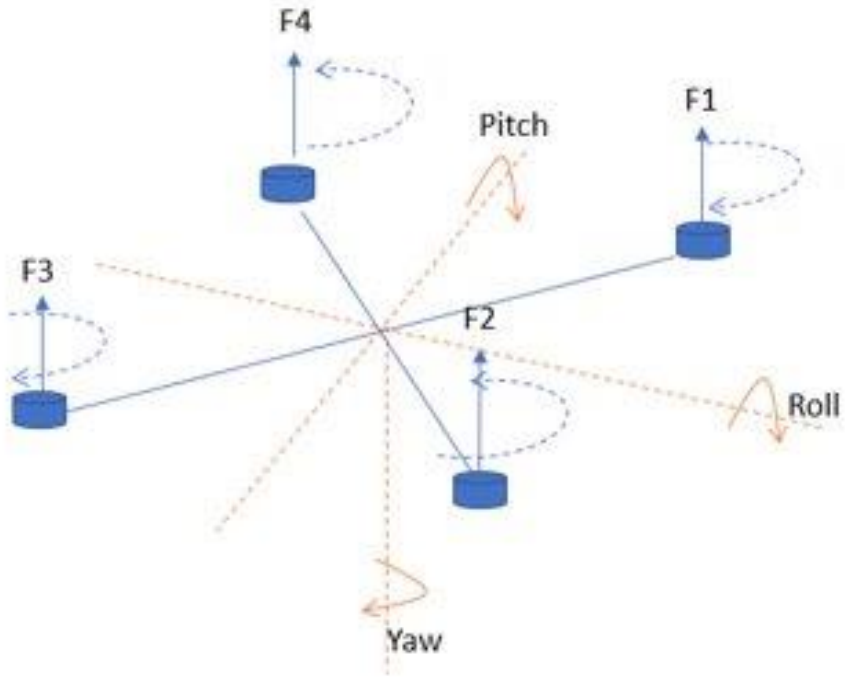


Actuators on a Parrot Mambo

- 4 motors to control the propellers
- Provide motor commands
  - Command drone to move in specific directions
  - Decide which motor to send command to and what value to send

Drone motions

- 6 ways of motion
  1. Up-down
  2. Left-right
  3. Forward-backward
  4. Rotation around X-axis: Roll
  5. Rotation around Y-axis: Pitch
  6. Rotation around Z-axis: Yaw

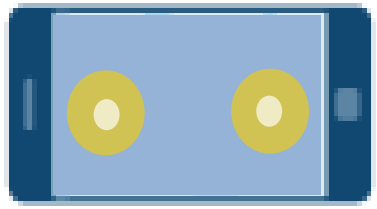


- What will we control?
  - Thrust, Pitch, Roll, Yaw

The role of a controller

Parameters controlled independently:

1. Altitude
2. Pitch
3. Roll
4. Yaw

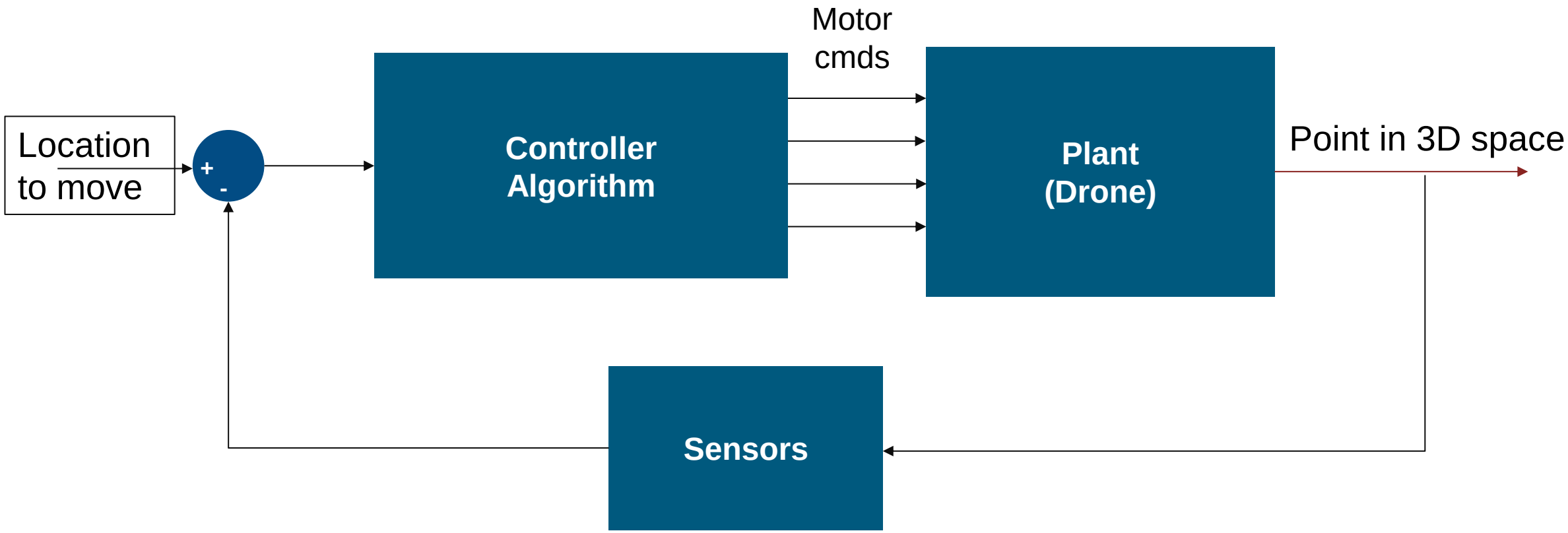


Commands

Drone

Controller

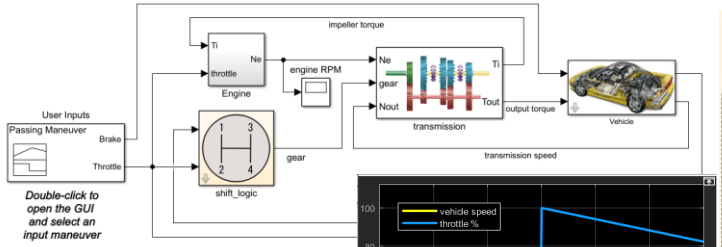
Modelling a drone

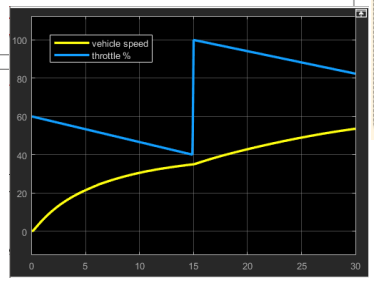


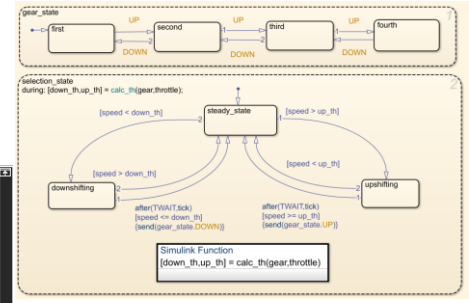
SIMULINK®

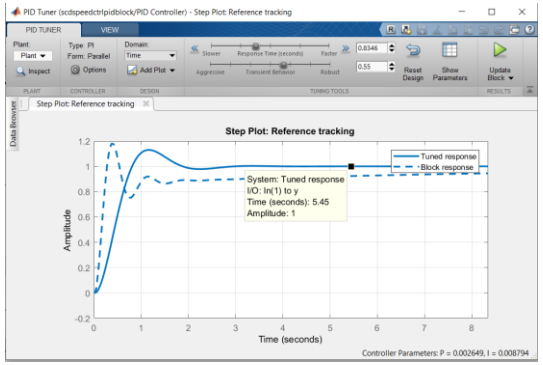
Modeling, simulation, and embedded systems

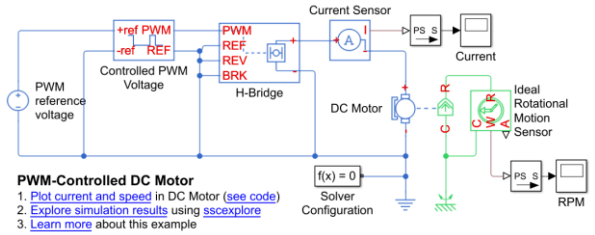
- Platform for **Model-Based Design**
  - **Block diagram** modeling
  - **Simulation** of physical systems
  - Automatic **code generation**
- **Applications** in:
  - Control systems
  - Signal processing
  - Communications systems

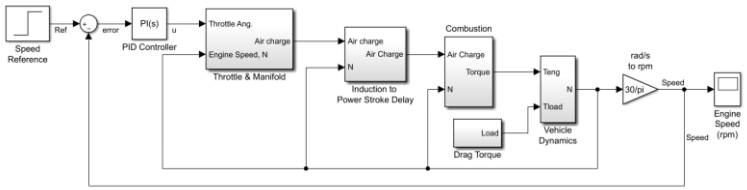


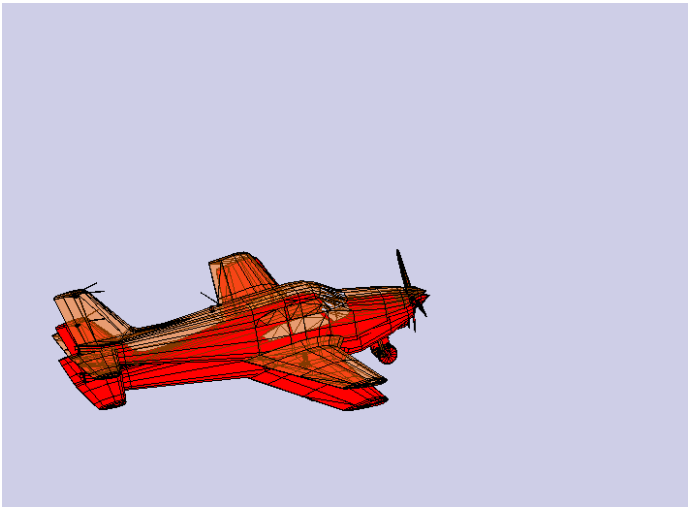












The leading environment for modeling, simulating and implementing dynamic and embedded systems

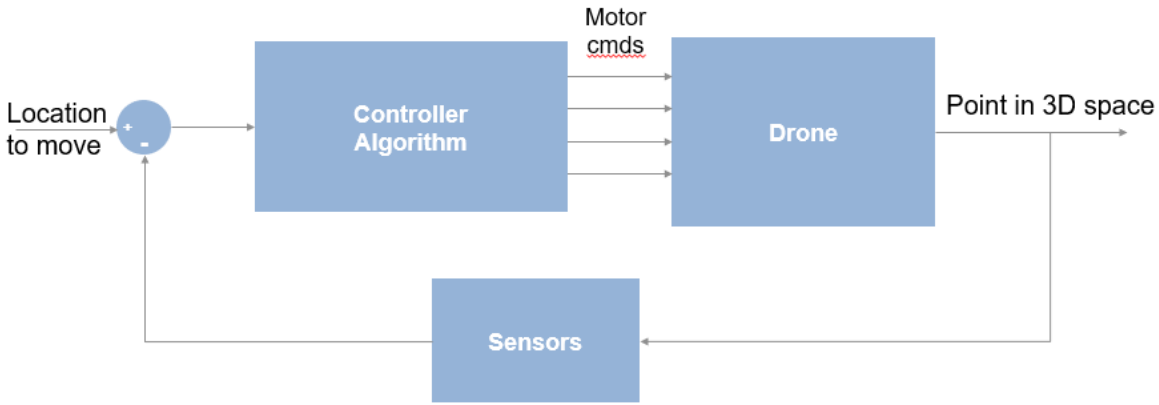
MATLAB and Simulink Robotics Arena

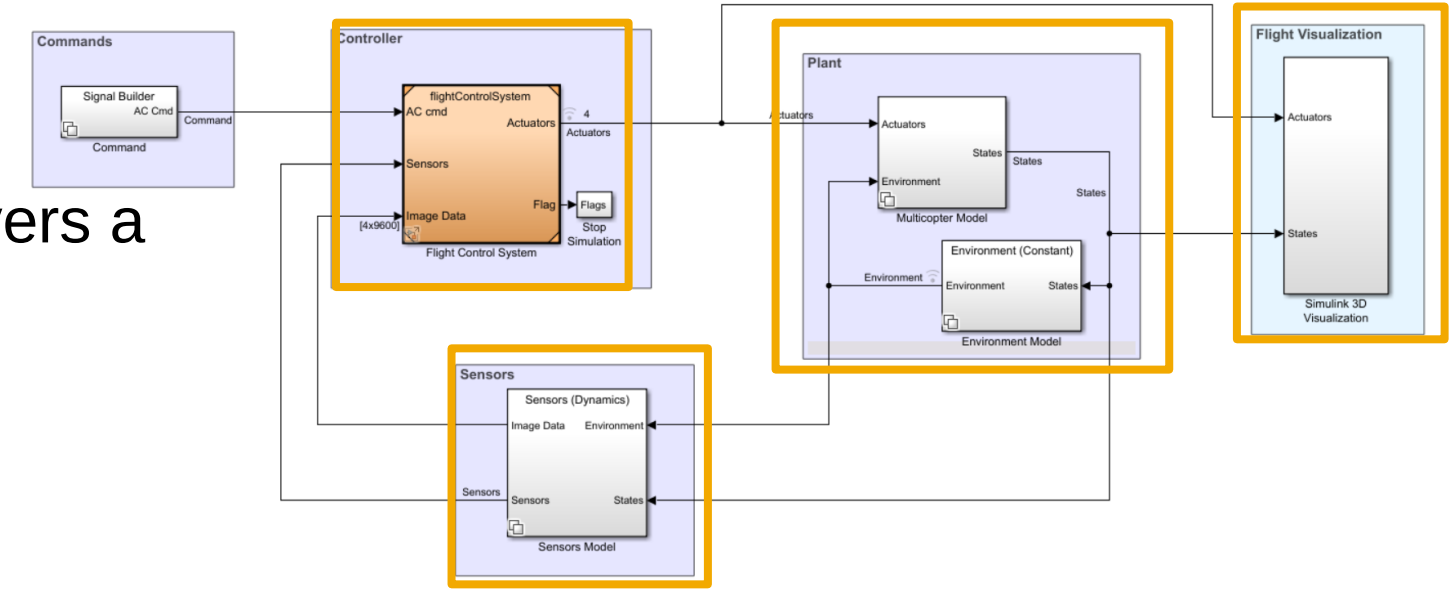
Modelling a drone

Simulink

What do we have in the model?

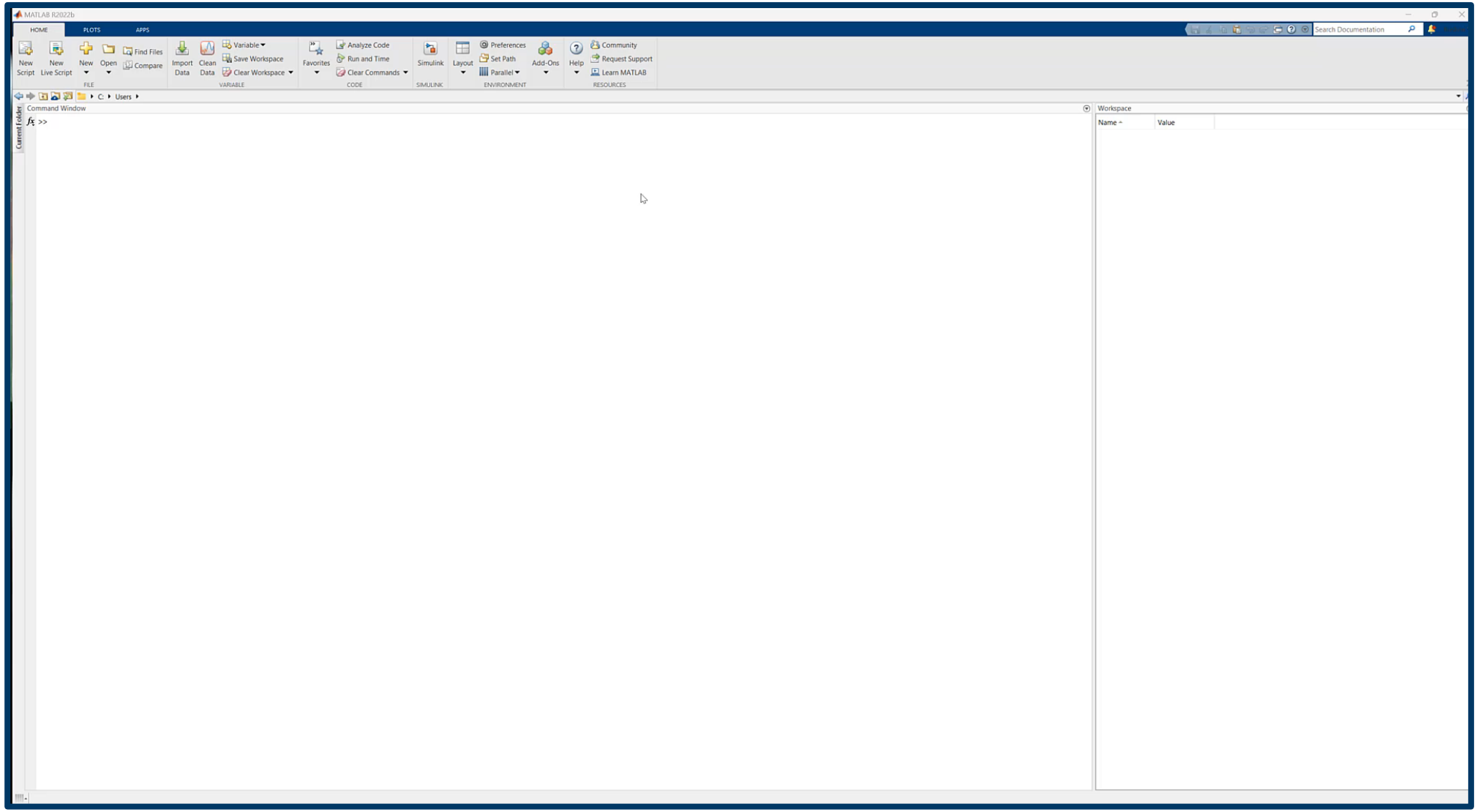
- Model of a Parrot Mambo Minidrone
  - Plant
  - Sensors
- Visualization environment
- Design of a controller that hovers a drone





Let's have a look at
the Simulink model

Add-Ons


MATLAB R2022b
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PLOTS
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Search Documentation
New Script
New Live Script
New
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FILE
Import Data
Clean Data
Variable
Save Workspace
Clear Workspace
VARIABLE
Favorites
Analyze Code
Run and Time
Clear Commands
CODE
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Set Path
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Add-Ons
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Community
Request Support
Learn MATLAB
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Model & Simulation

In the command line: parrotMinidroneCompetitionStart

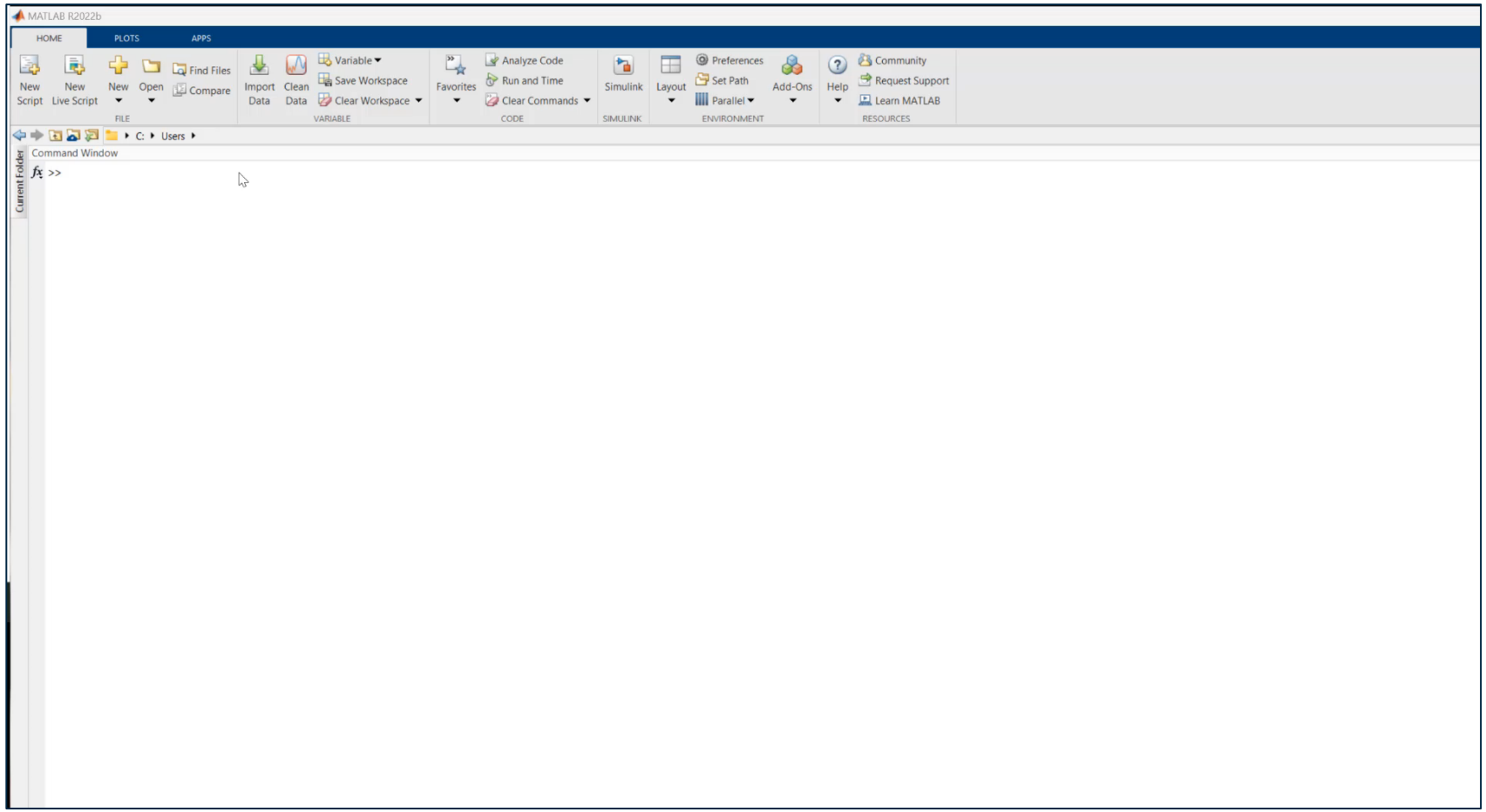
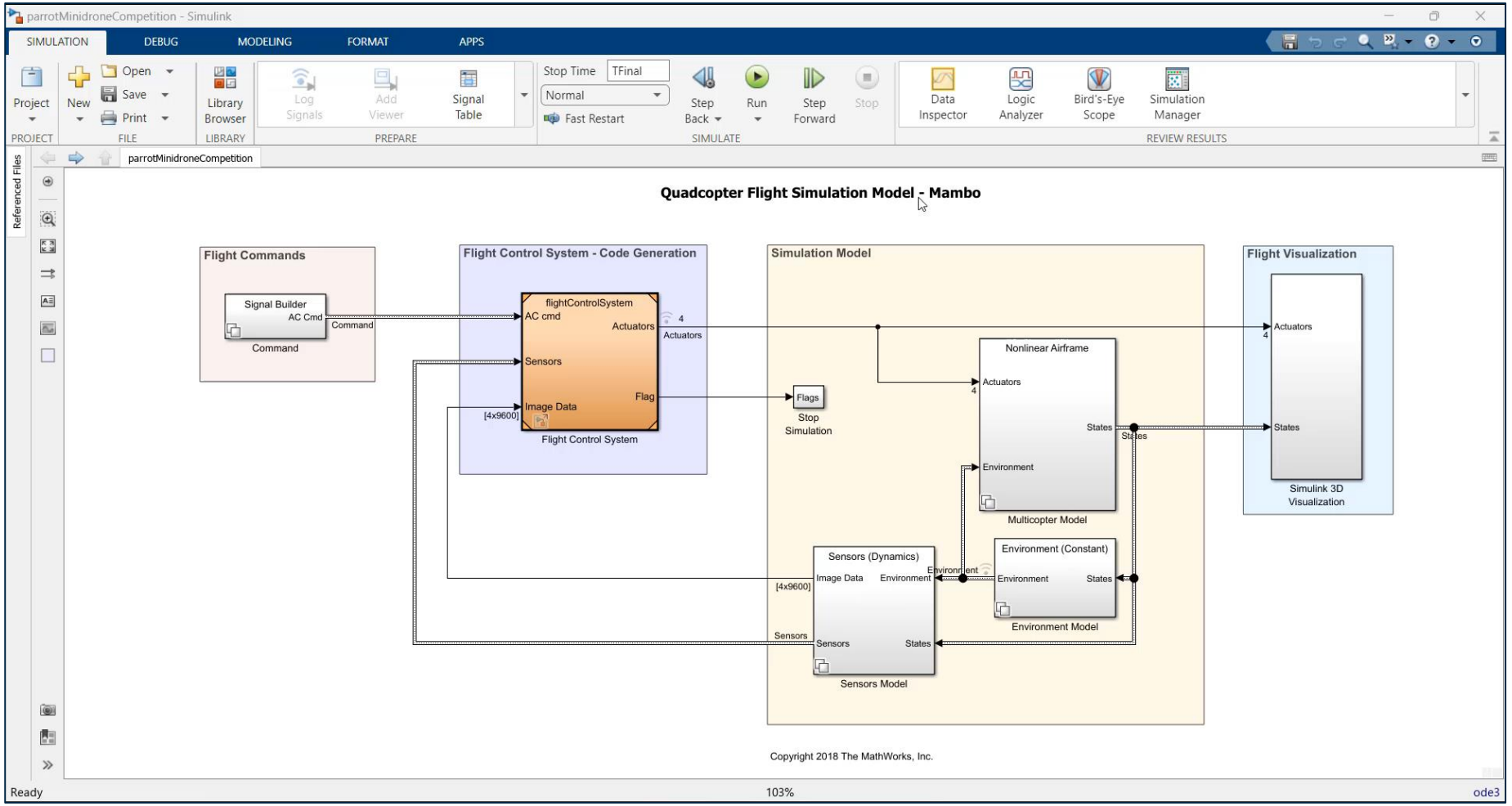
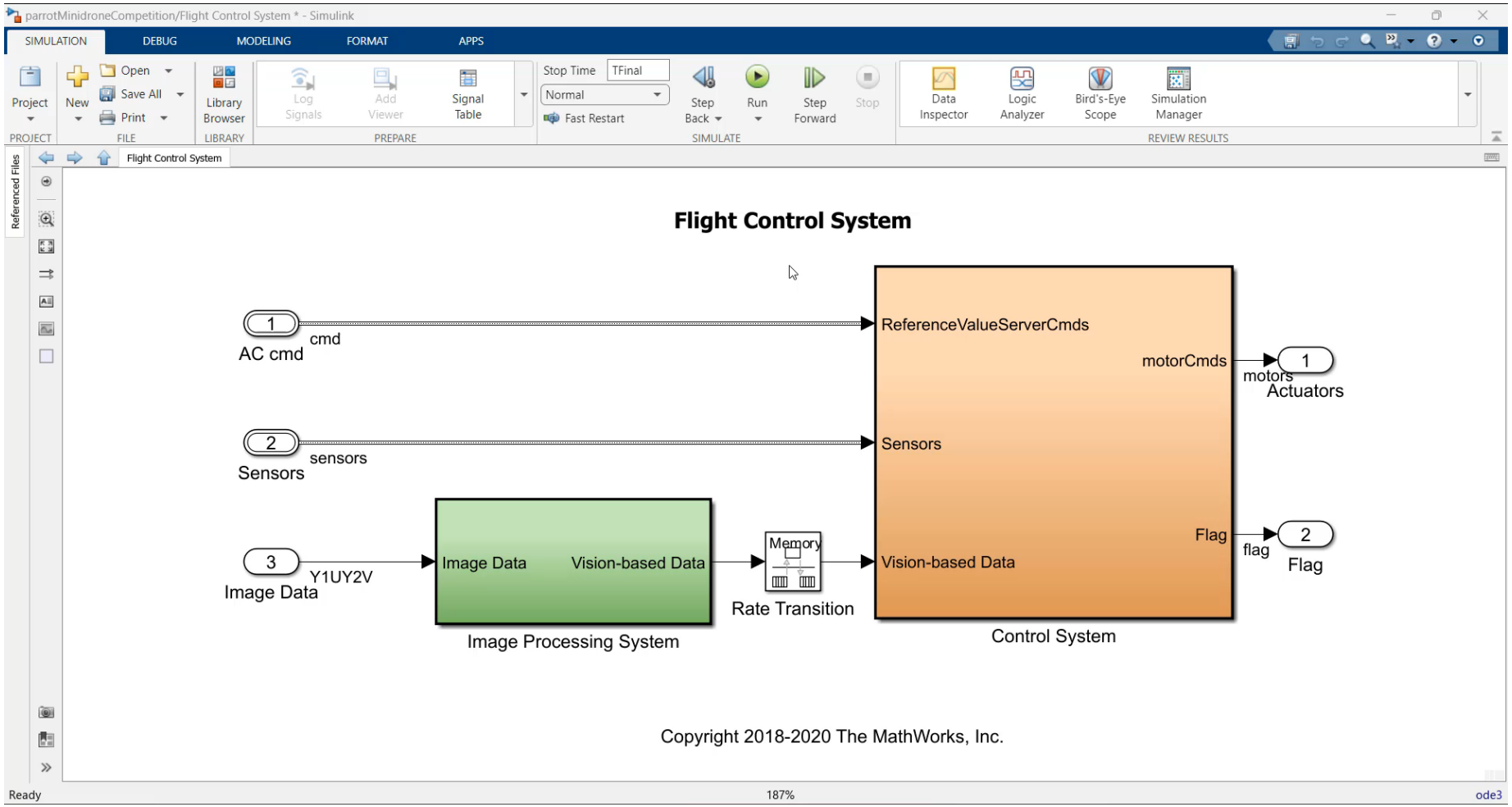


Image Processing Section



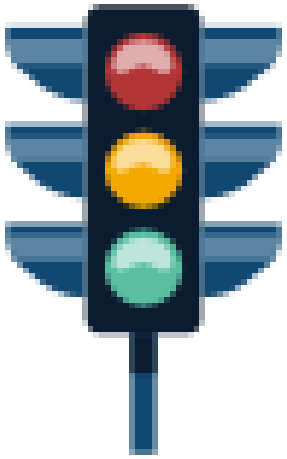
Path Planning



What is a State Machine?

Understanding State Machines

Let's start with a simple example

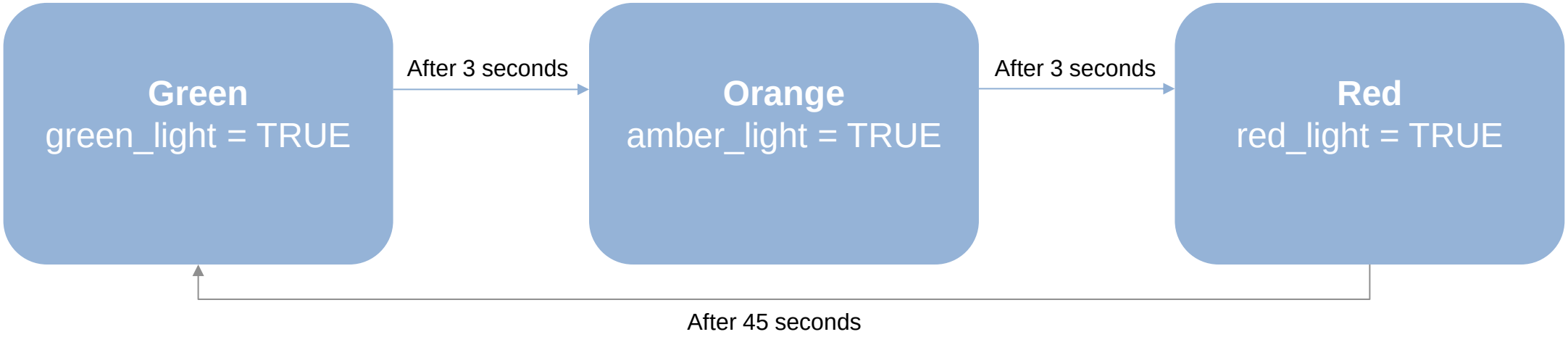


- Represent reactive systems that have states or modes
- States change based on defined conditions and events

Understanding State Machines

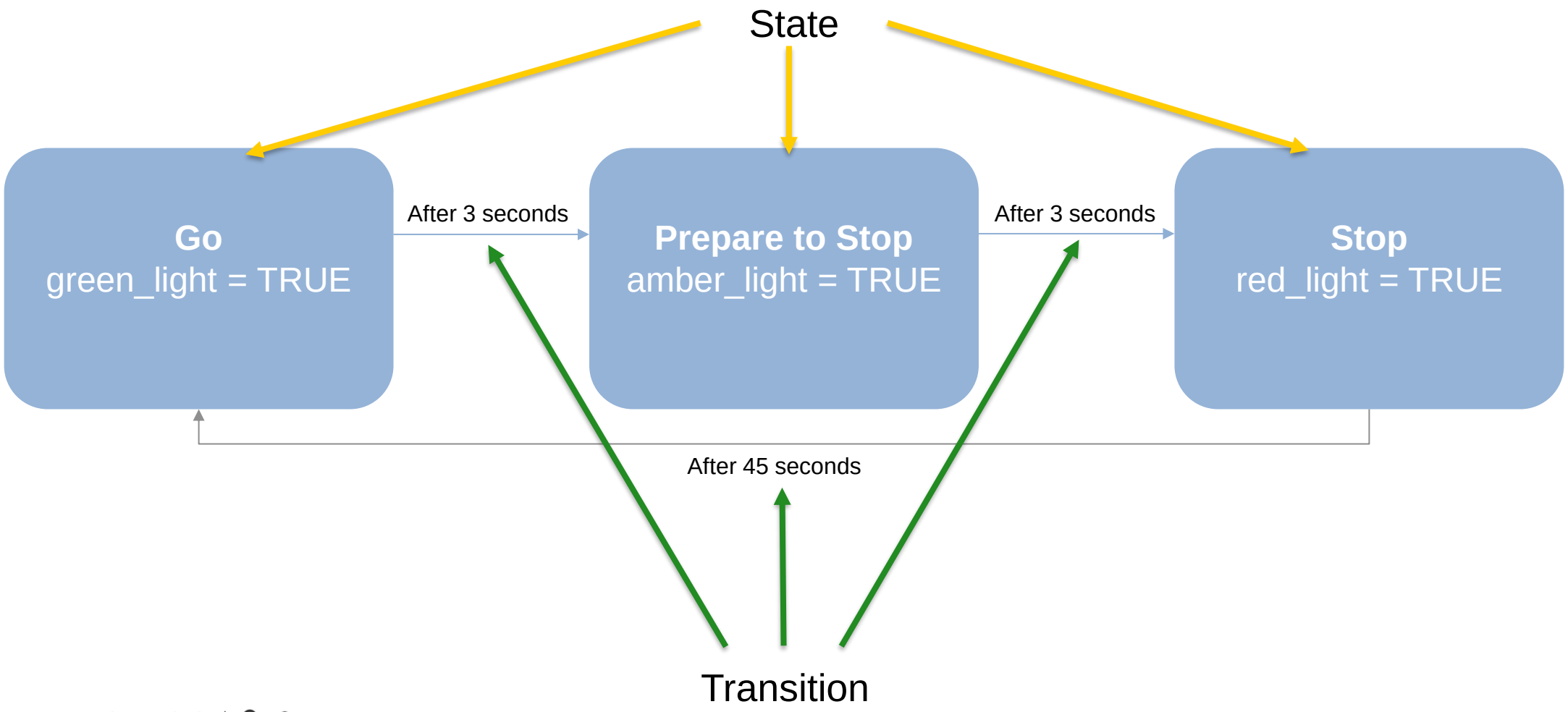
Modeling States and Transitions

- Rules to transition between states
- State transition diagram
- Current state depends on variables and previous state



Understanding State Machines

Modeling States and Transitions



Using State Machines in Simulink

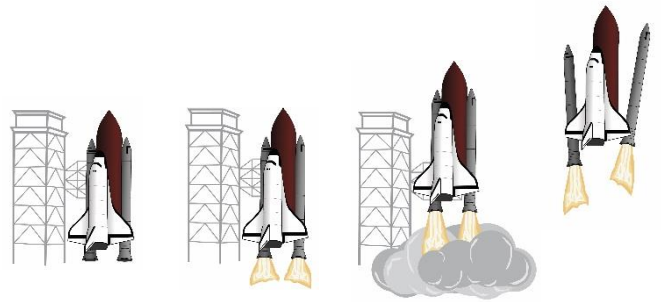
- **Simulink**

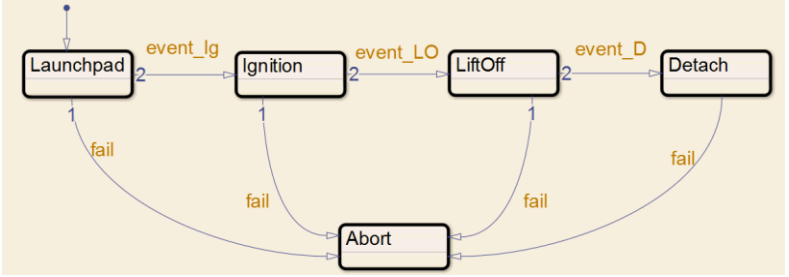
Simulink is used to respond to **continuous** changes in dynamic systems.

- **State Machines**

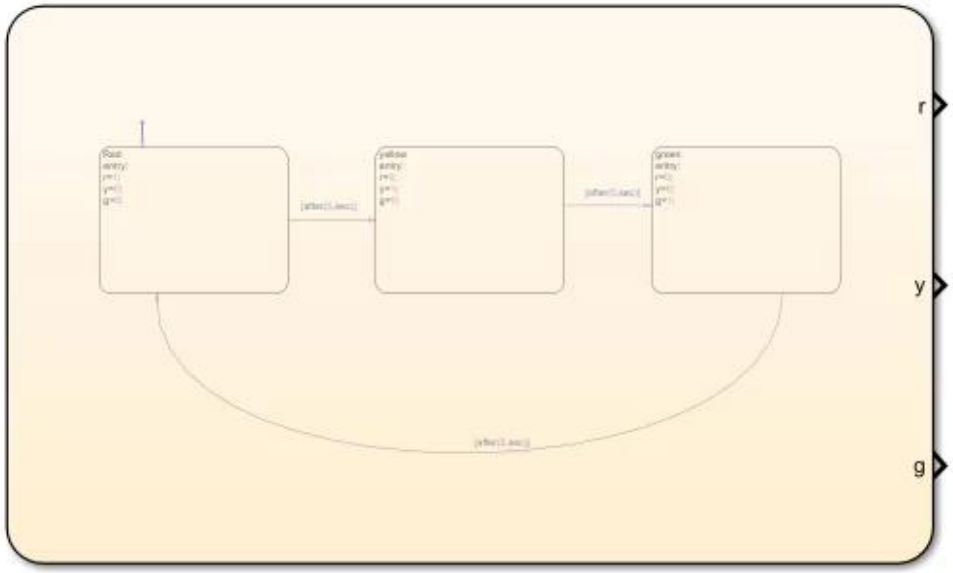
Stateflow is a tool used to respond to **instantaneous** changes in dynamic systems.

Real-world systems have to respond to both continuous and instantaneous changes.



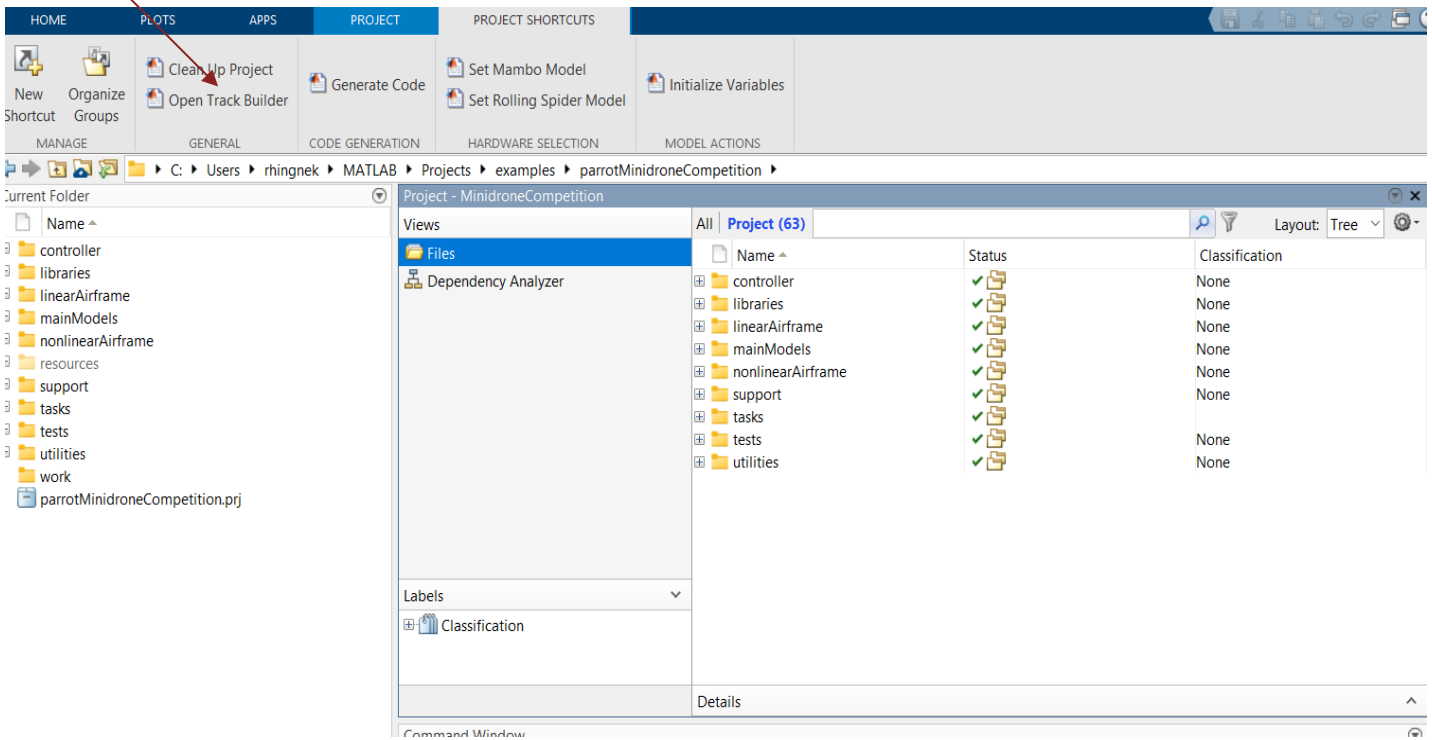


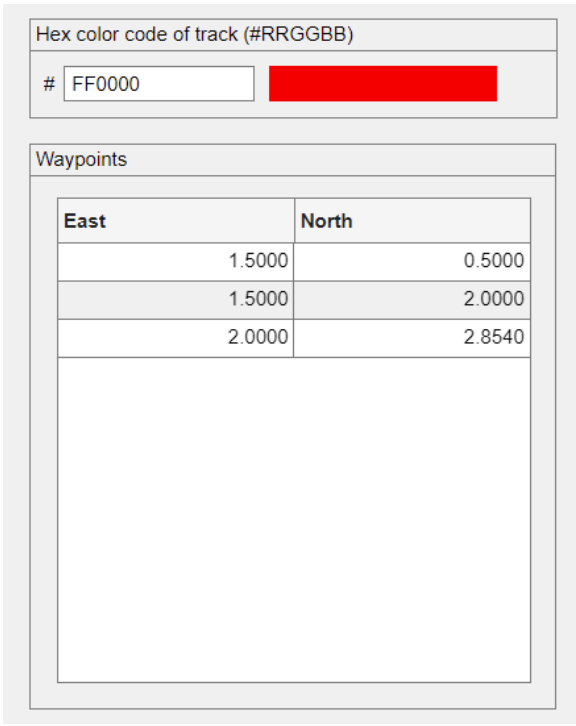
Let's have a look at the Stateflow model of the traffic light system



Hands on: Track Builder

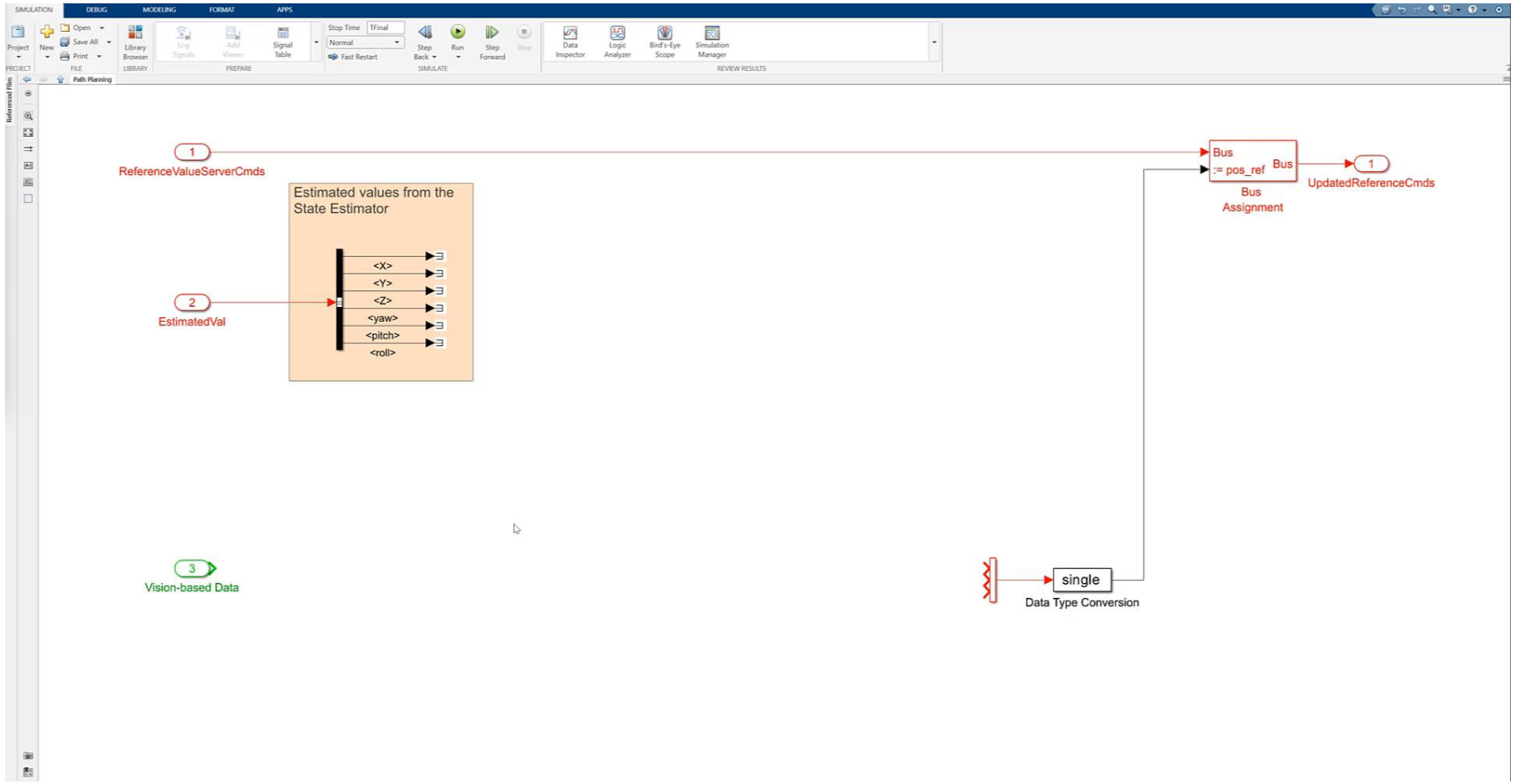
- Click on 'Open Track Builder' and generate waypoints in the app



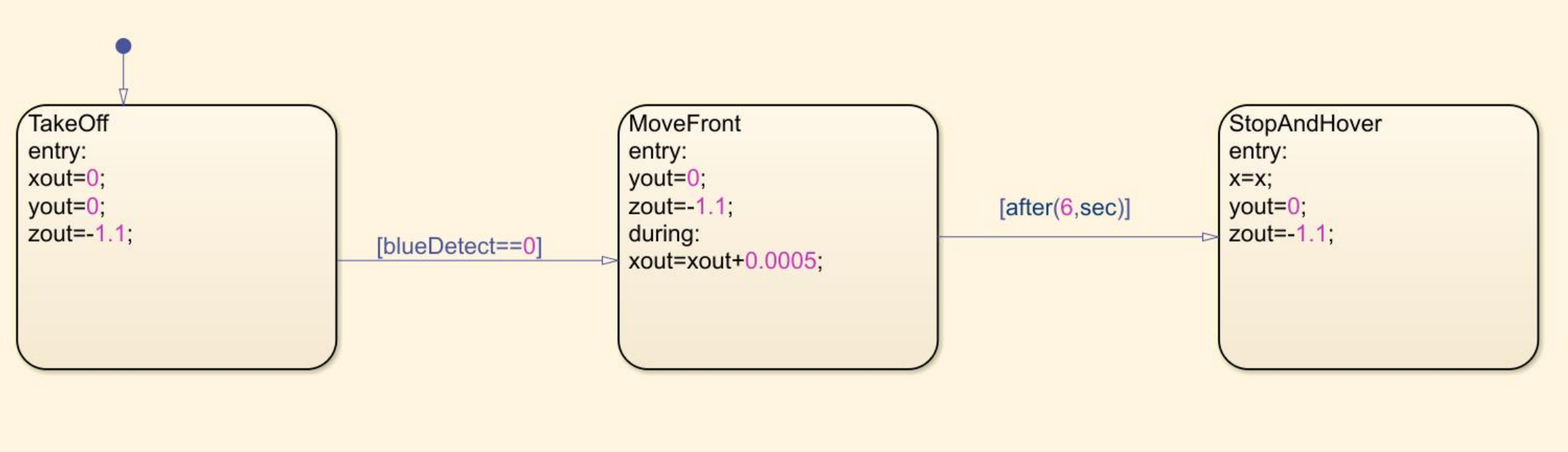


Hands on: Add Stateflow chart and states

Stateflow

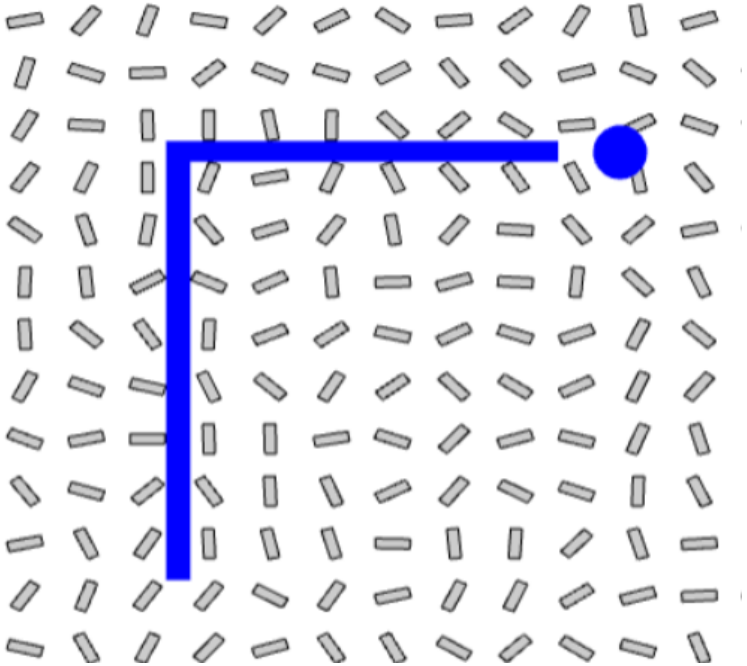


Hands on: Tracking the first line segment
Stateflow



Time to design your own autonomous line follower !

Track 1

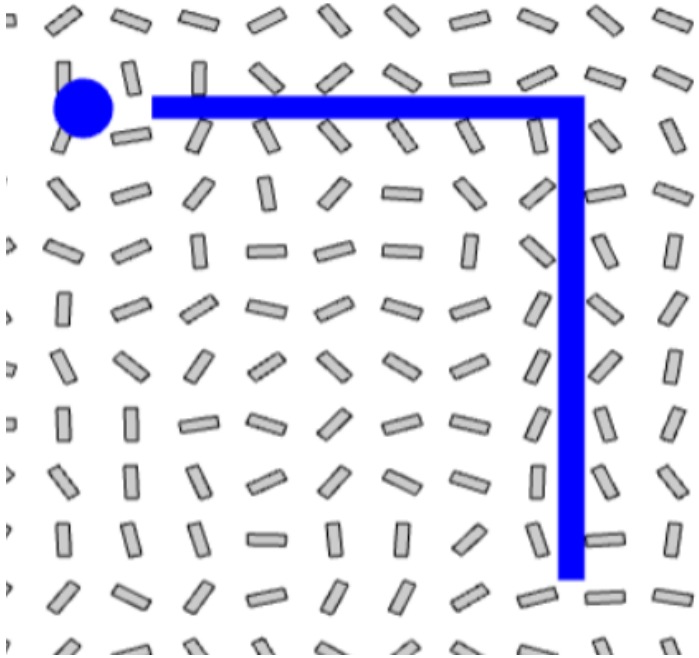


30 mins

Straight & Right

Track Coordinates: (1,1),(1,3),(3,3)

Track 2



30 mins

Straight & Left

Track Coordinates: (3,1),(3,3),(1,3)

Results (optional: use this slide if you want to showcase any completed/good submissions)