

# Controlling a Robotic System with MATLAB and Simulink using a Desktop Computer

By Sergio Biagioni



# Agenda

- MathWorks Support for Student Competitions
- Advantage of MATLAB and Simulink for Robotics
- Demo: Ball Tracking with MATLAB and Simulink
- How to deploy MATLAB and Simulink to a Desktop Computer

# MathWorks Support of Student Competitions

MathWorks supports student competition teams by providing them with software and training. Student competitions inspire the next generation of innovators to put their classroom knowledge to practical use, solving real-world problems with software and hardware used by professional engineers.



# Robotics Student Competitions

- AUVSI Foundation
  - RoboBoat
  - RoboSub
  - RobotX
  - IGVC



- RoboCup



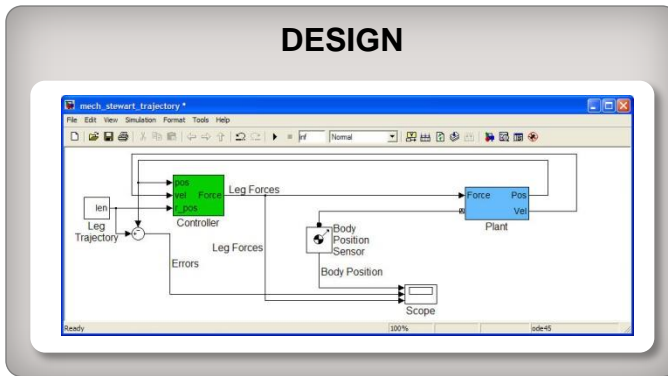
# Why use MATLAB and Simulink to deploy algorithms in competitions?

- Tools used by industry
- One design environment to design algorithms, model a vehicle and deploy algorithms to hardware.
- Model-Based Design

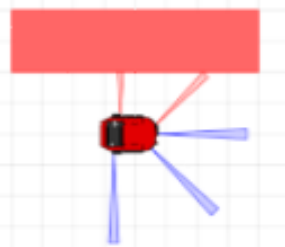
# Model-Based Design: Introduction

Model-Based Design uses block diagrams and simulations to mathematically model the system behavior.

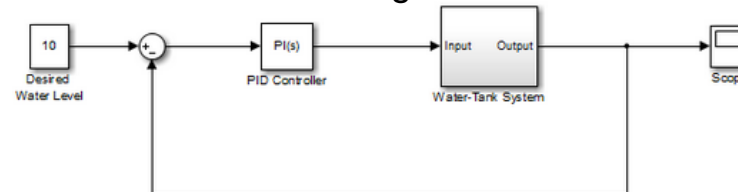
## DESIGN



## Sensor Models



## Control Algorithms

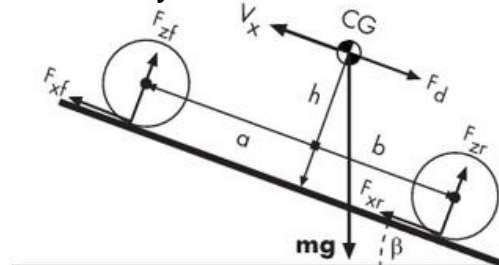


## Embedded Software

Command Window

```
fx >> codegen matlabAlgorithm
```

## Dynamic Models



# Model-Based Design: Mobile Robot Examples

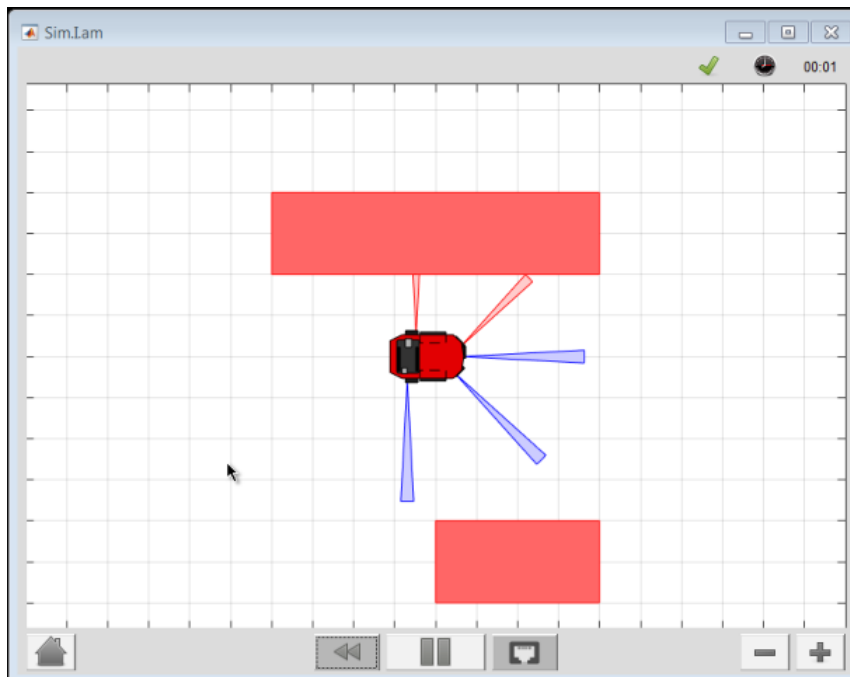
Sim.I.am

Mobile Robot Simulation with  
MATLAB

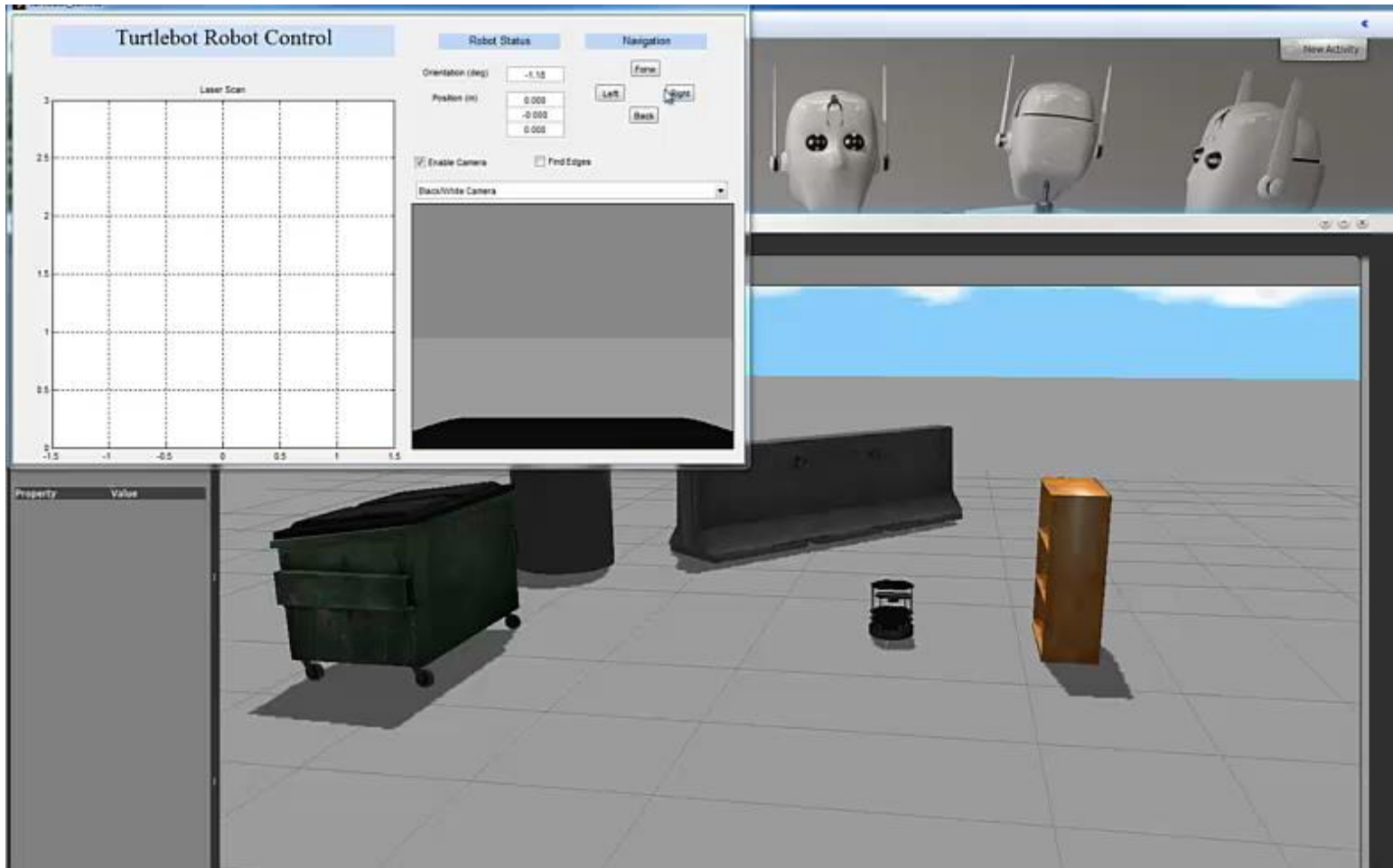
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Mobile Robot Simulation for  
Collision Avoidance with Simulink

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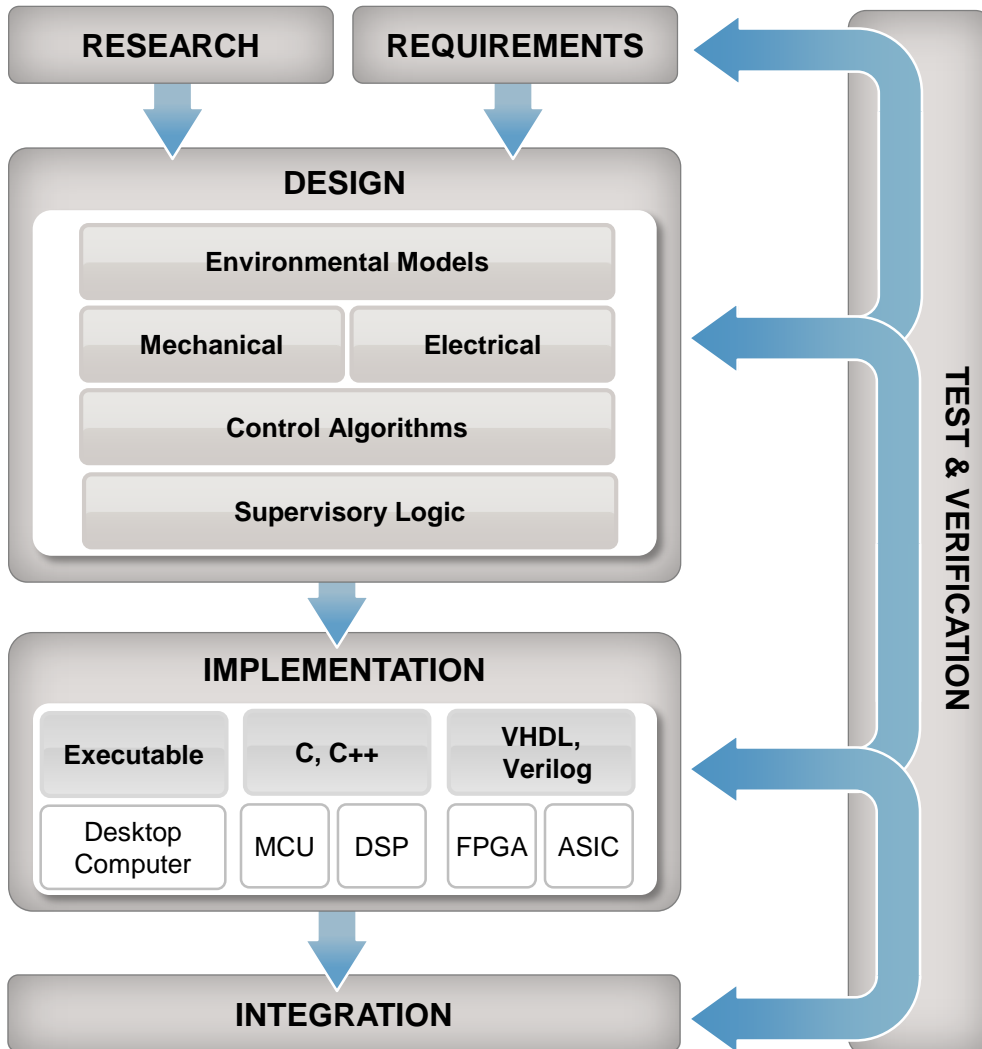


# Model-Based Design: Mobile Robot Examples





# Model-Based Design for Competitions



Start the design process early.

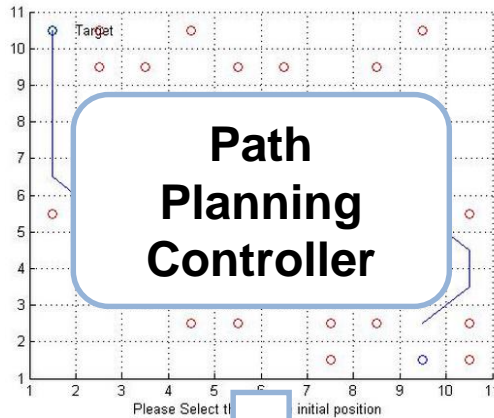
- Design without hardware
- Design without testing facilities



Automatically generate code from the simulation model for implementing directly on targets:

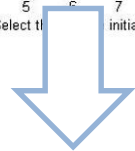
- **Desktop Computer**
- Microcontrollers
- FPGA's

# Model Based Design in Competitions



**Path  
Planning  
Controller**

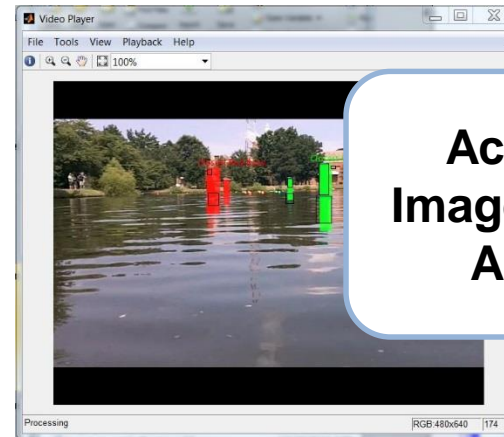
Please Select the initial position



**MATLAB  
Executable**



**Desktop  
Computer**



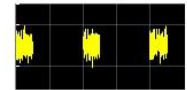
**Acoustic and  
Image Processing  
Algorithms**



**MATLAB ROS  
Node**



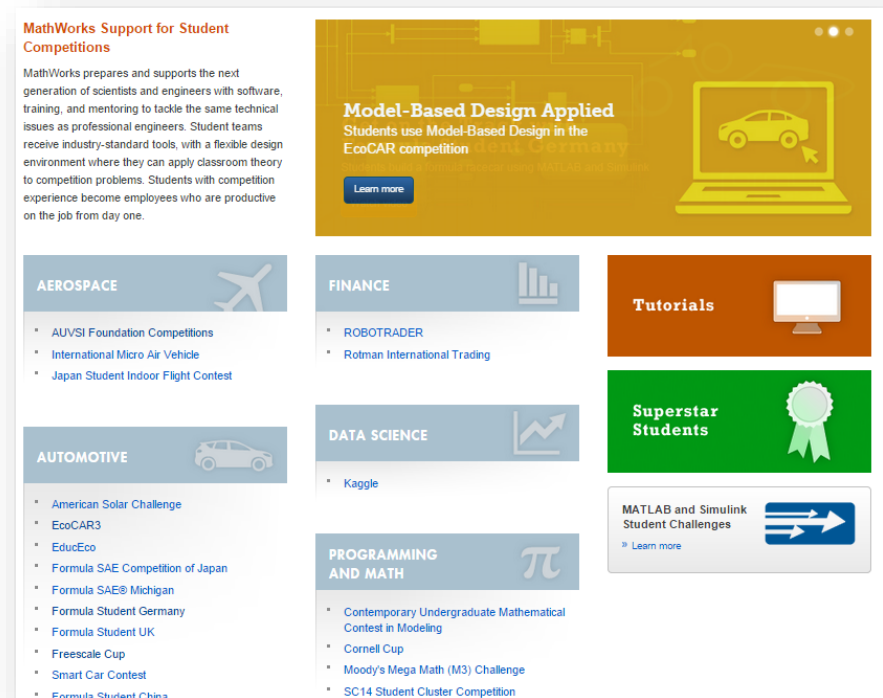
**Desktop  
Computer**



# Resources for MathWorks Support

- MathWorks Supported Student Competitions
- If your competition is not on the list of supported competitions, and you would like software support, send email to:

[academicsupport@mathworks.com](mailto:academicsupport@mathworks.com)



**MathWorks Support for Student Competitions**

MathWorks prepares and supports the next generation of scientists and engineers with software, training, and mentoring to tackle the same technical issues as professional engineers. Student teams receive industry-standard tools, with a flexible design environment where they can apply classroom theory to competition problems. Students with competition experience become employees who are productive on the job from day one.

**Model-Based Design Applied**  
Students use Model-Based Design in the EcoCAR competition

**AEROSPACE**

- AUVSI Foundation Competitions
- International Micro Air Vehicle
- Japan Student Indoor Flight Contest

**FINANCE**

- ROBOTRADER
- Rotman International Trading

**Tutorials**

**DATA SCIENCE**

- Kaggle

**Superstar Students**

**PROGRAMMING AND MATH**

- Contemporary Undergraduate Mathematical Contest in Modeling
- Cornell Cup
- Moody's Mega Math (M3) Challenge
- SC14 Student Cluster Competition

**MATLAB and Simulink Student Challenges**

Learn more

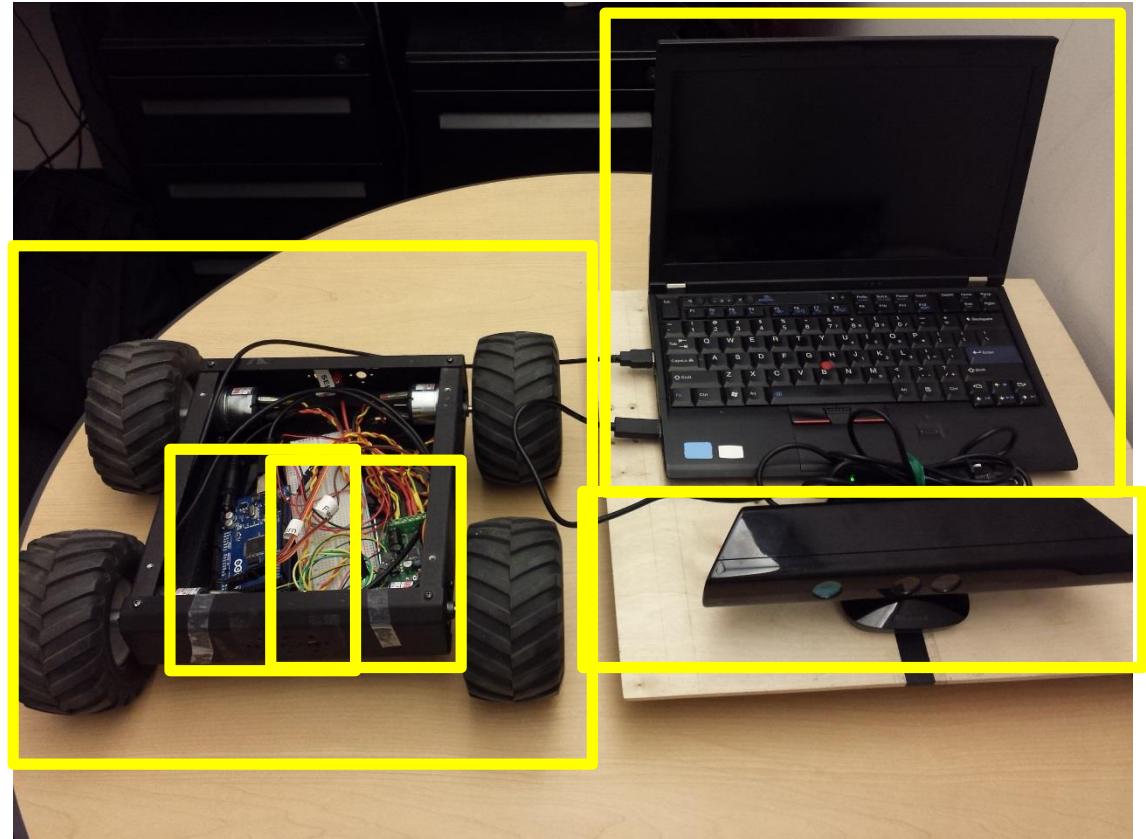
<http://www.mathworks.com/academia/student-competitions/>

# Demo: Ball Tracking with MATLAB and Simulink

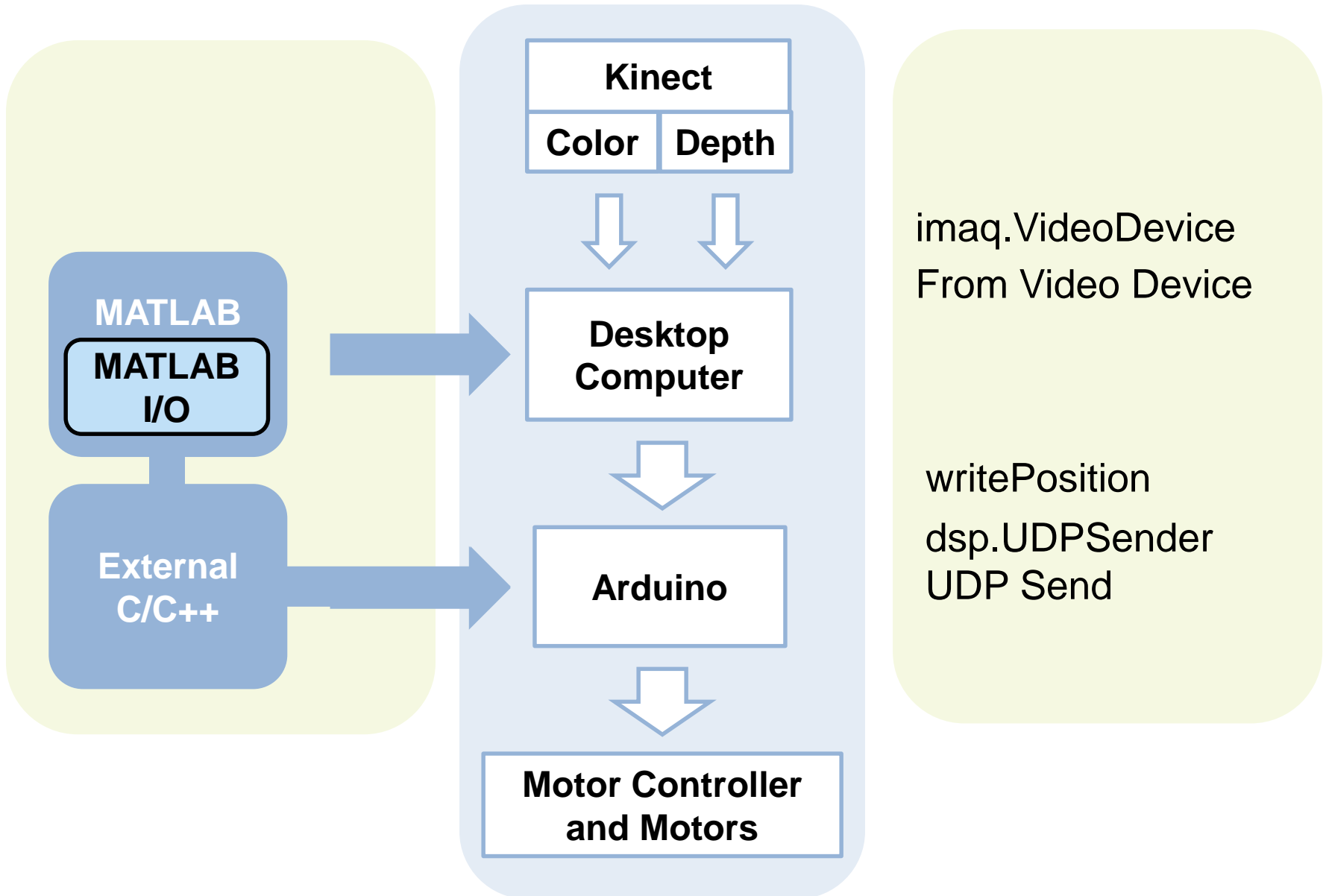


# Hardware Layout

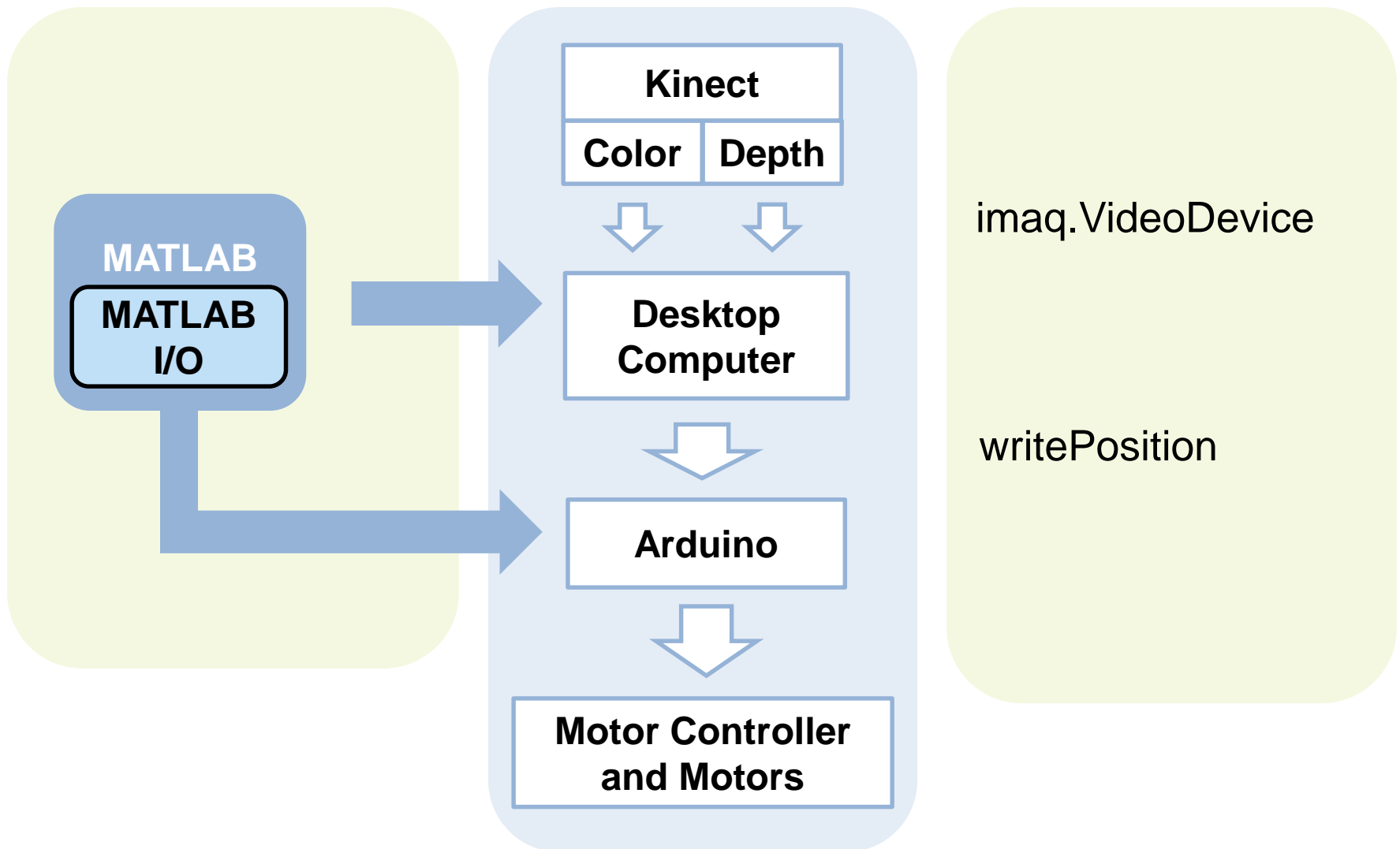
- Microsoft Kinect for Windows
- Standard Laptop
- Lynxmotion Rover with DC Motors and Encoders
- Arduino Mega 2560
- Arduino Ethernet Shield
- Sabertooth Motor Controller



# Hardware and Software Layout



# Demo 1: MATLAB with MATLAB Support Package for Arduino



# Hardware Support

Overview Search Hardware Support Request Hardware Support

### Refine by Vendor

- 3S-Smart Software Solutions 1
- Adimec 3
- ADLINK 2
- Advantech 3
- Agilent 4
- Aldebaran 2
- Allied Vision Technologies 7
- Altera 6

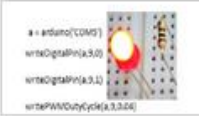
### Refine by Application

- Communications Systems 11
- Control Systems 35
- Digital Signal Processing 40
- Embedded Systems 58
- FPGA Design 17
- Image and Video Processing 53
- Internet of Things 5

Q

Results 1 - 25 of 163

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#### Arduino Support from MATLAB

**MATLAB** Support Package for Arduino hardware enables you to use **MATLAB**® to communicate with the Arduino® board over a USB cable. This package is based on a server program running on ...

Vendors: [Arduino](#)

Tags: [Project-Based Learning](#), [Support Package Installer Enabled](#)




#### USB Webcam Support with MATLAB

Using UVC compliant webcams with **MATLAB**®, you can explore and develop live image processing and computer vision applications on PCs. **MATLAB** provides webcam support through a Hardware...

Vendors: [Apple](#), [Creative](#), [Logitech](#), [Microsoft](#), [Philips](#)

Tags: [MathWorks Supported](#), [Project-Based Learning](#), [Support Package Installer Enabled](#)




#### Audio Support from MATLAB

**MATLAB**® audio support provides the ability to : Read and write audio files in common formats such as WAV, AVI, FLAC, MP3, and MPEG-4 AAC Playback and record audio files using the PC sound...

Vendors: [Apple](#), [Microsoft](#)

Tags: [MathWorks Supported](#)



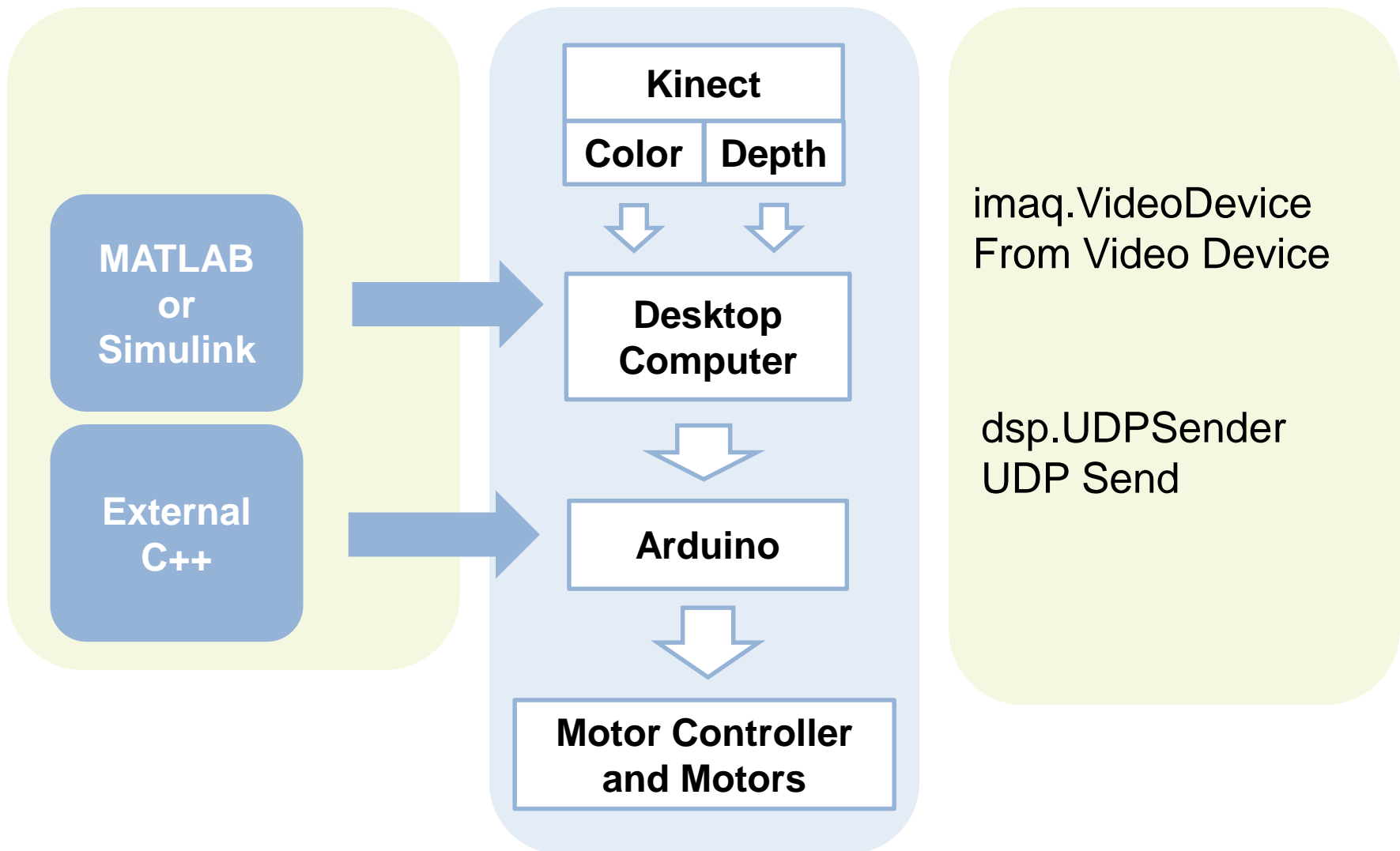
#### Raspberry Pi Support from MATLAB

Core IV GPU. Support for Raspberry Pi 2 New Use **MATLAB** Release 2015a with your Raspberry Pi 2. Download support by clicking the "Get Support Package Now" button above. With the **MATLAB**®

<http://www.mathworks.com/hardware-support/>



# Demo 2: MATLAB or Simulink with Executable Deployment



# Deployment Options

- Both MATLAB and Simulink can be used to deploy algorithms to a Desktop Computer
- The three deployment options are:

|                           | MATLAB  | Simulink  |
|---------------------------|---|---|
| Run in MATLAB or Simulink | Run code in MATLAB                                  | Run code in Simulink                                |
| Generate Executable       | buildExecutable using codegen and PackNGo           | buildExecutable using slbuild and PackNGo           |
| Algorithm Export          | Generate C/C++ code only, use external IDE to build | Generate C/C++ code only, use external IDE to build |

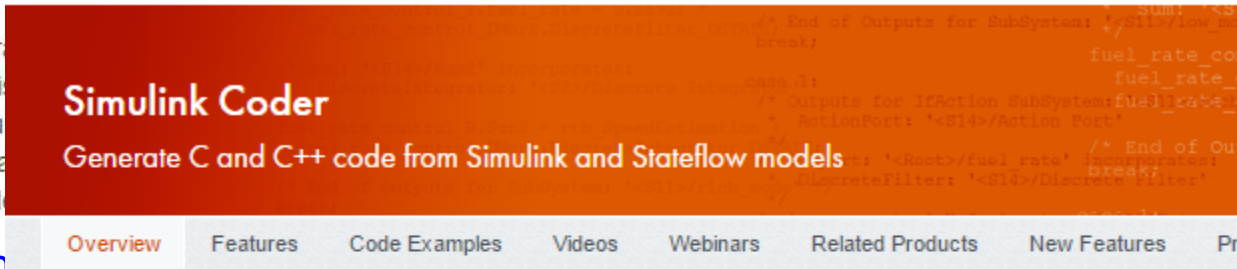
# Algorithm Export



**MATLAB Coder**  
Generate C and C++ code from MATLAB code

Overview Features Code Examples Videos Webinars Related Products New Features

MATLAB Coder™ generates source code from MATLAB language features and operations. It can generate portions of MATLAB code



**Simulink Coder**  
Generate C and C++ code from Simulink and Stateflow models

Overview Features Code Examples Videos Webinars Related Products New Features

<http://www.mathworks.com/products/matlab-coder/>

Simulink Coder™ (formerly Real-Time Workshop®) generates and executes C and C++ code from Simulink® diagrams, Stateflow® charts, and MATLAB® functions. The generated source code can be used for real-time and nonreal-time applications, including simulation acceleration, rapid prototyping, and hardware-in-the-loop testing. You can tune and monitor the generated code using Simulink or run and interact with the code outside MATLAB and Simulink.

<http://www.mathworks.com/products/simulink-coder/>

# Getting Started Guide for AUVSI Foundation Competitions

- Contains examples showing how to deploy MATLAB and Simulink to a Desktop Computer

File Exchange



MATLAB App 

## Getting Started AUVSI

by [MathWorks Student Competitions Team](#)  
04 Sep 2014 (Updated 02 Feb 2015)

Learn how to use MATLAB and Simulink to control and design algorithms for an Unmanned Vehicle System

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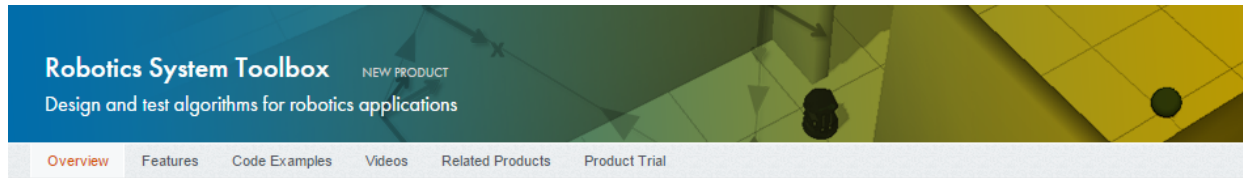
 [Download Zip](#)

Code covered by the [BSD License](#) 

# Overview of Getting Started Guide

- Included topics
  - Video Acquisition
  - Communication i.e. udp
  - MATLAB Acceleration
  - Deployment to Executable
- Included functionality
  - buildExecutable - converts MATLAB and Simulink to deployable executable with one function call
  - Simulink Soft Real-Time block
  - dec2ascii - decimal to ascii function
  - Others...

# MathWorks Robotics

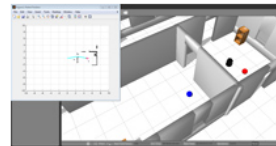




Robotics System Toolbox™ provides algorithms and hardware connectivity for developing autonomous mobile robotics applications. Toolbox algorithms include map representation, path planning, and path following for differential drive robots. You can design and prototype [motor control](#), [computer vision](#), and [state machine](#) applications in MATLAB® or Simulink® and integrate them with core algorithms in Robotics System Toolbox.

The system toolbox provides an interface between MATLAB and Simulink and the Robot Operating System (ROS) that enables you to test and verify applications on ROS-enabled robots and robot simulators such as Gazebo. It supports C++ code generation, enabling you to generate a ROS node from a Simulink model and deploy it to a ROS network.

Robotics System Toolbox includes examples showing how to work with virtual robots in Gazebo and actual ROS-enabled robots.

- ▶ [Key Features](#)
- ▶ [Interactive Data Exploration](#)
- ▶ [Algorithm Design and Testing on a Robot Simulator](#)
- ▶ [Algorithm Testing on a Physical Robot](#)
- ▶ [Log File Import and Analysis](#)
- ▶ [Code Generation and Deployment](#)
- ▶ [Multiplatform and Multimaster Support for ROS](#)



 [Documentation](#)  [Functions](#)  [Data Sheet](#)

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### What's New



From Yanliang Zhang, Robotics System Toolbox Technical Expert

- [Hands-on Tutorial on Robotics System Toolbox at ICRA 2015](#)
- » [Email Yanliang](#)

### Technical Resources

- [Support](#)
- [Technical Articles](#)
- [System Requirements](#)

### User Community

- [Answers](#)
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<http://www.mathworks.com/products/robotics/>