Workshop: Interfacing MATLAB with Sphero Robots for an Introduction to Programming Class

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This workshop is for engineering and technology educators who want to enhance their programming course with robotics. It focuses on interfacing MATLAB with wheeled robots to provide a fun and engaging introduction to programming, in the context of engineering concepts. Participants learn how to implement the workshop leaders' open source toolbox with raspberry pi controlled Sphero RVR robots, allowing instructors and students to program highly customizable robots with MATLAB.

The workshop leaders developed a toolbox that implements ROS as a bridge between Python running on a Sphero RVR's Raspberry Pi and MATLAB running on a student's computer. With this toolbox, the ROS and Python communications are hidden from the user/student, ensuring beginners in programming are not burdened by extraneous details and complications. This implementation of MATLAB controlled Sphero RVR's may be a good fit for other classrooms and institutions; the chassis is commercially available and relatively inexpensive, and the system is versatile and easily expandable for adding custom components and features.

This workshop shows participants how their students can use MATLAB to control a raspberry-pi controlled Sphero RVR for developing programming skills. In this workshop, we share ideas for how students can gain practical experience with key programming concepts such as flow control, inputs and outputs, and data analysis and manipulation. The vehicular robots simulate some basic autonomous car technology and use of neural networks. Students can learn about data collection and analysis using sensors and actuators, such as ultrasonic sensors, infrared sensors, digital cameras, and motors. We show how students can practice programming algorithms that process data from these sensors and control the movements of the robot, such as obstacle avoidance, following algorithms, and lane following. Additionally, we show how the toolbox can be used to connect concepts learned in their other introductory engineering courses such as calculus based physics, signal processing, and early introductions to machine learning. Example project presentation and assessment activities are discussed to demonstrate how the activities can develop teamwork, written and oral technical communication, and design skills.

To have the most impact and provide hands-on practice with the robots, this is a two part workshop. The first part of the workshop provides an overview of the system architecture and instruction on classroom implementation. Facilitators present example classroom activities demonstrating how the toolbox can aid in understanding programming and general engineering challenges. The second part of the workshop gives participants experience interacting with the robots in some basic hands-on activities with the robots that allow participants a higher appreciation and retention of covered material. A demonstration on how participants can extend the capabilities for their own unique usage is also provided. Part one is a prerequisite for part two, but participants can attend only part one.

Learning activity schedule:

Part One

1. System overview
2. Survey of workshop participants, background and goals
3. Robot Build - overview of standard Sphero and Raspberry Pi hardware
4. Software - overview of developed software components
5. Example introductory applications for learning programming skills and extension to other first year engineering topics.
6. Example learning outcome based assessment.

Part Two

1. Hands-on opportunity to use the robots with MATLAB and explore basic controls
2. Example introductory applications for learning programming skills and extension to other first year engineering topics
3. Participants work to develop their own classroom applications
4. Discussion of potential classroom applications and needs
5. Details of how to add features and expand the toolbox to facilitate unique goals
    a. Customizing hardware with additional Pi components and 3D printed parts
    b. How and where to modify code to integrate hardware updates

The workshop doesn't require prior knowledge of MATLAB, but some knowledge of MATLAB will be beneficial. Participants are encouraged to perform software setup prework in advance of the workshop so they can fully participate in the hands-on robotics activities. Prework information is provided to workshop registrants. Participants without the prework software will still have the opportunity to interact with the robots in small groups.