Labs & Project Overview

There are roughly nine labs, followed by roughly 4 weeks for a semester project (depending on the semester. Each week has one lab exercise and one learning objective that supports a successful robotics project for a mobile robot.

Lab Topics & Learning

The labs include hardware, instruction, and hands-on tasks. Each team performs a lab exercise and submits results. Results may be a software, a set of measurements, or a working hardware result. For example, the students learn to power & control the motor driver in-lab, demonstrate forward/reverse control, and the instructor verifies the result for lab credit.

Week	Lab Topic	Learning Topic
1	Raspberry Pi, Linux	How to program in Linux
2	Python, Onboard Sensors, NodeRed	How to collect & display sensor data
3	Motor drivers, inverse kinematics	How to calculate movement & command motors
4	Encoders & Kinematics	How to plan movement & measure wheels
5	Compass & Calibration	How to calibrate a sensor
6	PID control	How to perform closed-loop control
7	Machine vision	How to use machine vision
8	Lidar, Obstacle Detection	How to detect obstacles
9	actuator integration	How to add actuators to my system

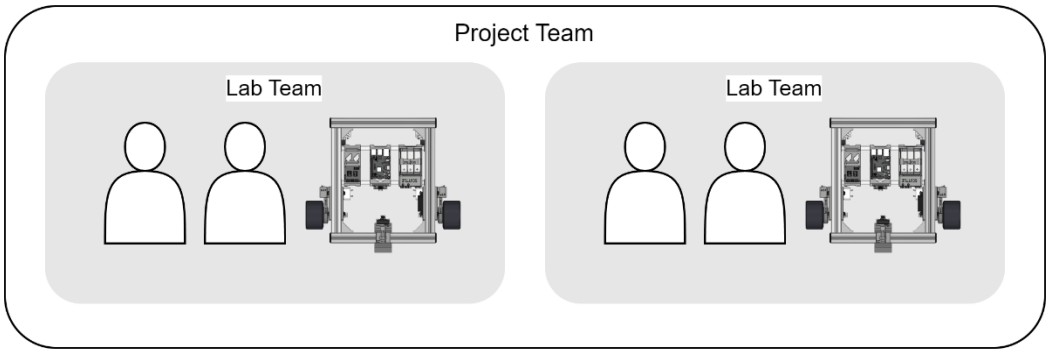
Project Actions & Learning

After lab exercises, weeks are dedicated to the teams project. The project selection is open-ended but the teams must take action to keep progress over four weeks.

Week	Project Action	Learning Topic
1	Raspberry Pi, Linux	Plan a robot function with sensors, actuators
2	Python, Onboard Sensors, NodeRed	Convert plans into computations
3	Motor drivers, inverse kinematics	Test & adjust a system for functionality
4	Encoders & Kinematics	Demonstrate outcomes & barriers.

Teams:

There are generally two students per robot, and two robots per team. For the labs, there are two teams combined together. Then, one robot is available for testing while the other robot is available for demonstration. Or, the teams may demonstrate both robots working together.



Resources

This is a resource-intensive lab. The following list describes resources and where the come from

Robot kits

kits include the SCUTTLE components and a few extra parts such as power supply and USB cables. They are checked out to students by the instructor and checked back in at the end of the course. Kit inventory is provided as a separate document. Students may bring kits home or to other lab spaces as instructed.

Laptops

Students use their personal computers to learn and perform lab exercises. The Laptop displays the robot software, by command-line-interface with the robot CPU. The students are directed to install some simple programs such as VSCode or PuTTy for performing lab exercises. Other academic software is also available for CAD modeling when it comes to building a project, or "slicer" software for designing a 3D print.

Technical Diagrams

Diagrams cover proper wiring configuration, coordinate frames for robot navigation, assembly of mechanical parts, etc. They are distributed in PDF documents found online, such as "Kinematics Guide" stored at scuttlerobot.org.

Datasheets

Datasheets are not needed for the labs directly, but they are necessary for adjusting sensors, changing the wiring of your robot, or discovering operating limits. For example, does my power adapter have sufficient power to add 3 servos? Datasheets are provided by links in the lab content or other technical guides.

Software

Template software is used for some labs. Usually, it is a python program. For example, one program may be downloaded by the student, added to the SCUTTLE CPU (raspberry pi or beaglebone) and perform a task. One such program commands the robot to drive in a straight line for a specified time. Software is made available to download from the web, or is included in the pre-existing image for the SCUTTLE CPU. The image is stored online, and students learn to download and install a fresh image on their CPU in case the software becomes broken.

Videos

Some learning material is provided in video format during the lab instruction. The instructor may use a pre-recorded video to explain a concept, such as "lithium battery safety." These videos are reused each semester and are noted in the lab content or simply shown during labs. Other videos may be offered for technical efforts such as wiring motors, or soldering a PCB. Videos are typically stored on YouTube and are openly accessible.

Tools

SCUTTLE is designed to require very few tools. Students may make modifications, repairs, or build additional circuitry. Hand tools are available in the lab (not to be checked out) such as soldering iron, crimpers, and screwdrivers. Your instructional lab offers these tools for use any times during your lab hours. Further work may be performed inside the lab during business hours or using the tools in your common labs. Students are encouraged to utilize engineering labs for 3D Printing, Electronics, and Fabrication as needed. There is a "tools guide" at scuttlerobot.org indicating necessary tools to support the mobile robotics lab.

Supplies

The instructional lab has consumable supplies such as solder, connectors, wires, and fasteners that are found on the robot. Students may use these supplies with permission, and are encouraged to build their projects by making designs with these components. This will save time in your design, improve repeatability, and increase the instructor's ability to help troubleshoot.

Project Resources

For project ideas, there is an Applications Guide on the scuttle website. There are also example projects made by previous students. The example projects are discoverable in the scuttle website videos, and sometimes further documented on Hackster.io, and with 3D printable models often shared on grabCAD.com. Students are encouraged to redesign past projects for improved results.