

# Introduction to Mobile Robotics 6-Week Immersion Unit

Goal: Introduce students to:

- Programming mobile robots
- Applying measurement and geometry to calculate robot navigation
- Path planning using both geometry and multiple sensor feedback
- Interpreting sensor feedback/calculating threshold values/understanding conditional statements
- Systems and systems analysis
- Experimental process
- Documenting and explaining the results of their testing

# **Resources:**

1 NXT kit for every two students.

1 pre-built robot for each pair of students, preferably Taskbot, but the Robotic Educator model will work

1 USB cable to upload programs to the robot.

1 computer for every two students.

1 copy of the LEGO<sup>®</sup> MINDSTORMS<sup>®</sup> Edu NXT programming software.

1 copy of Introduction to Mobile Robotics curriculum installed on each computer.

Either the NXT battery pack or 6 AA batteries for each robot.

# Note to the Teacher

The six-week unit of study is designed to introduce the basics of the NXT as it teaches science, technology, engineering, and mathematics. In a six-week segment of time, students will learn how to use feedback from sensors, applied mathematics and measurement to program their robot to navigate in its environment. They will have the opportunity to complete multiple investigations involving partial inquiry and guided research, problem solve, work in teams, and document the what they've learned as they investigate how robots make decisions to navigate their environment. Typically each pair of lessons takes approximately one week to implement. As students become familiar with the programming environment, the NXT hardware, and the curriculum they may move a little faster based on ability and motivation. Do not allow the students to go through the lessons haphazardly. Require them to document their work and complete all exercises. Check for student understanding of both academic and technological concepts using the tests provided. It is important that students do not skip the applied mathematics in any of the lessons.

There are twelve major activities sequences in this unit, students will complete approximately two per week:

- 1. The *Full Speed Ahead Activity* guides students step-by-step through the process of setting up the programming environment, programming the robot, and running the basic moving forward program.
- 2. The *Wheels and Distance Investigation* involves students in an investigation of the relationship between wheel size and the distance the robot travels given a set number of wheel rotations.
- 3. The *Right Face Activity* which guides students step-by-step through the process of building two different programs each of which produces a different type of turn.
- 4. The *Measured Turns Investigation*, which involves students in an investigation of the relationship between robot geometry, motor degrees, and the amount the robot turns.

#### **TEACHER Notes**

- 5. The *Clap On, Clap Off Activity*, which introduces students to sensors, specifically the sound sensor. Students are led step-by-step through the process of finding a threshold, programming the robot, and running through several programs that rely on the sound sensor to control their robots behavior.
- 6. The *Frequency and Amplitude Exploration*, which involves students in an investigation of the properties of a sound wave, and which properties of the sound wave that the sound sensor is able to distinguish.
- 7. The *Follow the Guidelines Activity* guides students step-by-step through the process of programming the robot, and running the basic line following program.
- 8. The *Faster Line Tracking Exploration* involves students in a study of the factors involved in line tracking, and explains how to modify their robot to line track more efficiently.
- 9. The *Obstacle Detection Activity* guides students step-by-step through the process of programming the robot to respond to two different types of sensory stimuli.
- 10. The *Field of View Investigation* has students further explore the detection abilities of the Ultrasonic Sensor but laying out a field of view plot and then scaling it to fit on a sheet of paper.
- 11. The *Get in Gear Activity*, which guides students step-by-step through the process of changing the robot's gears, running the basic moving-forward program, and observing the differences created by the different gear ratios.
- 12. The *Gears and Speed Investigation*, which involves students in a quantitative investigation of the relationship between gear ratio and robot speed.

#### **Anytime Activities**

Over the course of the unit, some students will move faster than others, the "Anytime Activities" are designed to challenge advanced students while other student complete their work. The following anytime activities can be implemented:

- Hello! My Name Is... Not all robots work alone. Sometimes the have to interact with a human or human operator in order to perform their task. To make it easier and more pleasant for the human to understand what the robot needs, robot designers give their robots personalities using sounds and display options. Here, students will do the same with their Personal Assistant robots.
- *Full Stop* No matter how well you design your robot, sometimes things just don't go as planned. In this activity, students will design and program an emergency stop button for their robot, to make sure it can be controlled if it gets out of hand.
- *Ramp It Up* The robot won't be able to climb stairs, but it should be able to take advantage of a ramp if it can find one. In this Activity, students will explore the physical features of the robot that make it tip or be stable on a ramp. This includes a discussion of Center of Mass and support polygons.

#### **End of Project Activities**

The End of Project Activities provide excellent opportunities for students to sum up the lessons learned in the NXT curriculum. Each activity highlights different aspects of the engineering process, be sure to think critically about which End of Project Activity best fits the needs of your classroom.

• Research Report – For this assignment, students will reflect on their project, define key terms, and discuss and important discoveries. This activity is a good choice for classrooms that have the goals of understanding the engineering process and developing professional writing skills.

### **TEACHER Notes**

- Sales Presentation For this assignment, students will work in teams to identify a market for their robot, and then create an appropriate advertising scheme. This activity is a good choice for classrooms with and interest in the business aspect of product development.
- *Smart Housekeeping* This activity presents an open ended design challenge for students. Students are to build a robot that navigates a teacher designed game board.

#### **Teacher References**

In the Projects section of the Teacher CD you will find the following set of teacher tools to help you implement this lesson:

- Teacher Notes and Concepts PDF
  - A description of the Activity
  - What the students will do
  - A note to the teacher describing the rationale for the lesson
  - o What the student will be able to do by the end of the lesson
- A Lesson Starter Powerpoint, which is editable, that can be used as an anticipatory set that sets the stage for the lesson.
- Question & Answer Keys
  - o Student worksheet for the lesson
  - Worksheet answer key
  - o Student quiz
  - o Quiz answer key