

a-MAZE-ing Robotics

Science & Technology, Computer Science

Associated Unit

A-Maze-ing Robotics

Header Insert Image 1 here, left justified

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Yellow highlight = required component



Image 1

ADA Description: Photo of a robot in a maze.

Caption: An example of a robot navigating a maze.

Image file: robot in a maze.JPG

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Grade Level 8 (6-9)

Lesson # 1 of 1

Lesson Dependency

Time Required 20 minutes

Summary

Students learn about the roles of engineers in solving problems using the engineering design process. Through the use of math and science, students demonstrate the understanding of how sensors work and its application to problem solving.

Engineering Connection

Engineers work in a team environment to solve problems within given constraints. Engineers use the engineering design process to develop prototypes that lead to the completion of the actual product. Engineers often research and evaluate several approaches. Many times, the expertise from various disciplines are integrated in the project. One example may be electrical engineers, mechanical engineers and computer scientists working together to design a robotic arm.

Engineering Category = #3

Choose the category that best describes this lesson's amount/depth of engineering content:

1. Relating science and/or math concept(s) to engineering
2. Engineering analysis or partial design
3. Engineering design process

Keywords

Robotics, LEGO, sensors, engineering design process

Educational Standards

New York 2006, grades 6-12:

Standard 5: Technology

Students will apply technological knowledge and skills to design, construct, use, and evaluate product and systems to satisfy human and environmental needs.

Standard 6: Interconnectedness: Common Themes

Students will understand the relationships and common themes that connect mathematics, science, and technology and apply the themes to these and other areas of learning.

Standard 7: Interdisciplinary Problem Solving

Students will apply the knowledge and thinking skills of mathematics, science, and technology to address real-life problems and make informed decisions.

New York science/math/technology (NYSED, 2006, standards.pdf)

Pre-Requisite Knowledge

A basic understanding of what is an engineer and LEGO robotics building and programming techniques.

Learning Objectives

After this lesson, students should be able to:

- Build a robot to navigate through a maze
- Explain the advantages and limitations of different types of sensors (e.g. touch, rotation, ultrasonic, and light)
- Program a robot's movement based on sensor information

Introduction / Motivation

(Have ready to present to the class the PowerPoint presentation on What is an Engineer? The presentation contains information on the roles and misconceptions of engineers. It also explains and different types of engineers work together to go through the engineering design process. For example, many types of

engineers have collaborated to create the iPhone/iPad. These are chemical, electrical, mechanical, environmental, and computer engineers. The iPhone/iPad contain many sensors that are programmed as Apps. The NXT LEGO robotics system is a full robotics design and learning system. What must be considered in designing a robot to solve a problem? How can we program the sensors to obtain a desired result? Engineers work in teams to solve problems. Lets work in teams to create a robot that navigates through a maze.

Lesson Background & Concepts for Teachers

NXT Lego Robotics and the understanding of basic move blocks, wait state, sensor thresholds and loop states. Basic LEGO robot construction skills will be useful. Review Radius, Diameter, and Circumference. Prepare a maze layout using black electrical tape, foam board, PVC piping, PVC connectors and Zip ties.

Work through NXT Tutorials at http://www.ortop.org/NXT_Tutorial/

Lesson Outline

Instruct the class to build a robot. Have them add a light sensor, ultrasonic and touch sensor. Designs could be found on <http://www.nxtprograms.com> or the assembly booklets

Lead students through the basics of the programming software (NXT-G, RobotC, or Java).

Activity 1: Program the robot to navigate the maze using the Rotation Sensor. Math concept: Distance travelled = # of wheel rotations x circumference of the wheel. $C = 2\pi r$

Activity 2: Program the robot to navigate the maze using the Light Sensor with black electrical tape on marked areas. Math/Engineering concept: Threshold determination. To find a threshold, compute the average of the lowest sensor value (black tape) and the highest sensor value (light colored floor).

Activity 3: Program the robot to navigate the maze using the Ultrasonic Sensor. Science/Math concepts: The distance is determined by the following equation: The speed of the ultrasound wave multiplied by half the length of time it takes the wave to return. The sound travels at 331 m/s. The sound is transmitted at a frequency of approximately 44 Khz.

Challenge: Navigate the maze using a combination of the sensors.

Teams present their designs and solution

Vocabulary / Definitions

Word	Definition
robot	A programmed machine that senses it environment, makes a decision and performs an action.
engineering	The application of math and science to create a product or process to solve a problem amidst constraints.
ultrasound	A sound wave with a frequency that extends the range of the human ear. (above 20 Khz)
Circumference	The distance (perimeter) around a circle. $C = 2\pi r$
Diameter	The distance of a line through the center of a circle
Radius	The distance of a line from the center of the circle to the perimeter

Associated Activities

Participation in a First Lego League Competition. Visit <http://www.usfirst.org>

Lesson Closure

Teams will present their robots to the class. Each member of the team will discuss their role and how they contributed to the project. The class will discuss evaluate the performance of the robot. Did the robot perform as programmed? What variables may affect the way the robot senses its environment?

Assessment

Pre-Lesson Assessment

- Do you know what is an engineer?
- What is the difference between an engineer and a scientist?
- What is a robot?

Post-Introduction Assessment

Compare the functions of human senses to the LEGO robotic senses

Lesson Summary Assessment

- Robotic Design & Presentation
- Have students work in groups of 3-4 to design a robot to navigate a maze. Then have the teams present their designs to the class. Have the students consider a PowerPoint presentation that considers the following in their design and solution:
 - Why did you consider this particular design?
 - What was the function or expertise of each member in the group?
 - What type of sensors did you use and why?
 - Did the robot perform as intended?
 - What could you do to improve your design?

Lesson Extension Activities

Develop a smart robot that can navigate from any starting point in the maze to a specified goal.

Additional Multimedia Support

Refer to an excellent PBS video documentary, The Great Robot Race. This highlighted a DARPA sponsored competition to design an autonomous robot to navigate 130 miles in the Mojave desert.
<http://www.pbs.org/wgbh/nova/darpa/>

References

<http://mindstorms/lego.com>

Attachments

What is an Engineer.ppt, a-maze-ing activities.doc,

Other

None

Redirect URL

None

Contributors

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None

Supporting Program

The SMART Program at NYU Poly is hosted by Dr. Vikram Kapila in the Mechatronics Lab of the Department of Mechanical and Aerospace Engineering. Funding is provided by the National Science Foundation's Research Experience for Teachers initiative.

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