

Producing Real-Time Isotherms with the Boe-Bot

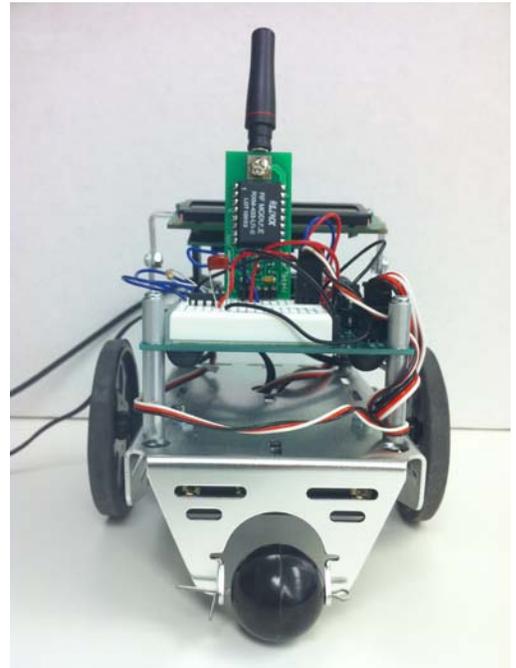
Image 1

ADA Description: BOE-Bot with DS1620 Temperature reading microchip

Caption: Image 1: none

Image file name: photo.jpg

Source/Rights: Copyright © 2010
Matthew Fisher. Used with
Permission



Subject Area(s):	Earth Science NYS Regents
Associated Unit:	Measuring Earth
Associated Lesson:	Iso lines (activity demonstrated via laboratory experiment and laboratory report)
Activity Title:	Producing Real-Time Isotherms with the BOE-Bot
Group Size:	4 students (6 groups)
Expendable Cost per Group:	Approximately \$150 per group
Grade Level:	9th
Time required:	164 minutes (4 lab periods)

Summary

The purpose of this lesson is to provide students a deeper understanding of isolines. Using the DS1620 digital thermometer and an LCD constructed from the BASIC Stamp 2 microcontroller (BS2), Parallax Board of Education Robot (Boe-Bot), smart sensors, and typical circuit elements, students take multiple temperature measurements in the classroom. The classroom will incorporate staged heating/cooling “devices,” ex. block of ice, to replicate heat sources/sinks. Students will plot the measurements on a worksheet (attached). Finally, students connect equal temperature readings to produce an isotherm map and calculate temperature gradient.

Engineering Connection

The collection of sensor information is used in the everyday life of science and engineering technology. Scientists use remote robots to collect data readings in environments that are too harsh or inadequate to support human life. For example, the Mars Rovers Spirit and Opportunity have been collecting data on the uninhabitable planet. The conjunction of the individual elements of this project (BS2, Boe-Bot navigation, and smart sensors) demonstrate first hand for students the importance of meshing scientific content with engineering capability.

Engineering Category

Category 1: Relates science concept to engineering

Category 3: Engineering analysis

Keywords

BASIC Stamp 2 microcontroller, circuits, DS1620 digital thermometer, gradient, heat sources, heat sinks, isolines, isotherms, smart sensors

Educational Standards

New York State Physical Setting/Earth Science Core Curriculum, 2010:

- STANDARD 1: Analysis, Inquiry, and Design
Mathematical Analysis – *Key Idea 1*: Abstraction and symbolic representation are used to communicate mathematically, for example: use gradient in context
Scientific Inquiry – *Key Idea 3*: The observations made while testing proposed explanations, when analyzed
- STANDARD 2: Information Systems
Key Idea 1: Information technology is used to retrieve, process, and communicate information as a tool to enhance learning.
- STANDARD 6: Interconnectedness – Common Themes
Models: *Key Idea 2*: Models are simplified representations of objects, structures, or systems used in analysis, explanation, interpretation, or design.

Pre-Requisite Knowledge

This lesson plan is an interdisciplinary venture with the Technology Education Department, specifically the Modern Technology class. Students will spend approximately 5 days to: learn about the electrical components needed, assemble Basic Boe-Bot, program the Boe-Bots DS1620 in order to measure heat, add LCD wiring, and program navigation of Boe-Bot.

Learning Objectives

After this activity, students should be able to:

- Define a field, in terms of a measurable value
- Explain how sensors take readings within a field
- Construct isotherms
- Demonstrate how heat sources/sinks affect field measurements
- Determine gradient

Lesson Background

Students are required to accurately connect isolines for the New York State Earth Science Regents. This is only one of many concepts that is intangible and difficult for students to grasp. Typically, teachers define the necessary concepts of a field, data values found in that field, purpose of isolines, and how they are connected. Then students are handed a sheet with a multitude of numbers and asked to accurately plot isolines. Unfortunately, there is an incredible disconnect in the students' minds regarding the fact that a classroom's temperature is not necessarily uniform throughout and by identifying where the temperature varies, isotherms can be created to show areas of equal value.

Motivation

Hand out a basic "connect the dots" worksheet and ask students to complete it. Then hand out a second worksheet that can be used to make isolines. Ask the students to connect all of the values. Students should be encouraged to be creative in completing the task. At this point, the teacher should not be instructing the students the proper method. Allow the students several minutes to work and then proceed with the isoline lesson. (If you do not already have your own lesson created, an excellent PowerPoint can be found at this link: <http://www.mrsciguy.com/resources.html>).

Lesson Procedure

Divide the students into groups and re-introduce the Boe-Bots that were fabricated during the Modern Technology class. Allow the students a few minutes to reacquaint themselves with the Boe-Bots. Students will then practice navigation, obtaining heat sensor readings, viewing the LCD screen that depicts the sensor readings, and recording the data. Remind students that isotherms are a distinct type of isoline that connects points of equal temperature. Next hand out the classroom schematic worksheet and explain that each group will navigate their Boe-Bot along the course to take sample temperature readings. At each "station," students will record the temperature reading in the designated place on the worksheet. Have the students work individually but with the support of their group to connect the isotherms. Introduce the heat sources and sinks and have the students collect new data. Teacher should be checking for accuracy. Once the groups are done, have the students calculate gradient from various stations (each group should be assigned different calculations).

(Remember, this lesson will be completed over several class periods. Each teacher will have to plan accordingly based on their specific number of minutes per period and end the lesson where appropriate).

Lesson Closure

Have each group share their observations and findings. Students should explain what other sensors could be used to collect data and how the isolines would be affected.

Assessment

Students will write an explanation on the connection between any field and the measurable values in that field. They will go on to clarify how isolines are created. They will accurately complete an isoline worksheet. Finally, they will describe the role of the Boe-Bot in this activity.

Classroom Extension

Students can connect the Ping Ultrasonic Distance Sensor and develop contour maps.

References

“What’s a Microcontroller?”

<http://www.parallax.com/Portals/0/Downloads/docs/prod/edu/28123-WAM-v3.0.pdf>

“Smart Sensors and Applications”

<http://www.parallax.com/Portals/0/Downloads/docs/prod/sic/3rdPrintSmartSensors-v1.0.pdf>

“BASIC Analog and Digital”

<http://www.parallax.com/Portals/0/Downloads/docs/books/edu/Web-BasicAnalogDigital-v1.4.pdf>

Acknowledgements

This research is supported by the National Science Foundation under NSF Grant #: EEC-0807286 (Science and Mechatronics Aided Research for Teachers (SMART)).

The author is thankful to Professor Vikram Kapila, Jared Alan Frank, David Lopez, and Parth Kumar for their guidance, helpful comments and suggestions, and support.

This work was conducted in summer 2010 in the Mechatronics Laboratory at the Polytechnic Institute of New York University.

INCLUDE:

1. Attach “Classroom Schematic” worksheet
2. Attach PBASIC program (our original full program)