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Skyrise Explorer

Problem

Deep-sea exploration is dangerous and difficult, which has led to advancement in the field of marine robotics. To simulate the tasks that marine robots are expected to complete, students will traverse a field with miscellaneous obstacles and be able to gather various pieces back to their base for further study.

Abstract

Marine robotics has been an integral part of deep-sea and coastal research as well as in the sampling and monitoring of ocean environments for oil field surveys and military operations. This lesson starts with an introductory discussion on the engineering design process and how it is applied in different fields. The second part of the lesson is to act as a summative assessment for an advanced robotics course as small groups are asked to design, build, program, and test a robot to complete a variety of tasks. In addition, a sub-component of the lesson is for the group to design and 3D print a customized part for their robot.

Alignment with Standards

SCSh1. Students will evaluate the importance of curiosity, honesty, openness, and skepticism in science.

a. Exhibit the above traits in their own scientific activities.
b. Recognize that different explanations often can be given for the same evidence.
c. Explain that further understanding of scientific problems relies on the design and execution of new experiments which may reinforce or weaken opposing explanations.

SCSh3. Students will identify and investigate problems scientifically.

a. Suggest reasonable hypotheses for identified problems.
b. Develop procedures for solving scientific problems.
c. Collect, organize and record appropriate data.
d. Graphically compare and analyze data points and/or summary statistics.
e. Develop reasonable conclusions based on data collected.
f. Evaluate whether conclusions are reasonable by reviewing the process and checking against other available information.

SCSh4. Students will use tools and instruments for observing, measuring, and manipulating scientific equipment and materials.

a. Develop and use systematic procedures for recording and organizing information.
b. Use technology to produce tables and graphs.
c. Use technology to develop, test, and revise experimental or mathematical models.

Next Gen Science Standards

Engineering Design

HS-ETS1-1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.
HS-ETS1-4. Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

Common Core State Standards Connections:
ELA/Literacy -
RST.11-12.7
Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (HS-ETS1-1),(HS-ETS1-3)

RST.11-12.8
Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-ETS1-1),(HS-ETS1-3)

RST.11-12.9
Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. (HS-ETS1-1),(HS-ETS1-3)
Mathematics -
MP.2
Reason abstractly and quantitatively. (HS-ETS1-1),(HS-ETS1-3),(HS-ETS1-4)

Objectives

The objective of the lesson is to act as a summative assessment for the robotics course to display their progress in applying the engineering design process to build a mechanical robot that is able to perform a given task with parts that were designed and printed using CAD software.

Anticipated Learner Outcomes

Students should:

1.) Be inspired interest in the world of robotics research, particularly being exposed to marine robotics
2.) Understand the engineering design process and how it is applied to robotics
3.) Design and build a mechanical robot
4.) Program a robot to complete a given task, both autonomously and through remote control
5.) Design and 3D print a customized part for their robot

Assessment & Rubrics

A copy of the Powerpoint slides and the student handouts can be found in the Appendix of this document. A recommended rubric can be found for the competition.

Built in formative assessments can be done during the design and build process with the summative assessment being the robot's ability to perform in the competition. Further homework, in-class assignments or test questions relating to the design process with a focus on CAD can and should relate to the Anticipated Learner Outcomes.

Background

The background of this lesson plan is from research done for an omni-bot that was built for the purposes of measuring wind speed and direction to test various predictive algorithms that would be implemented in autonomous blimp movement. These blimps act as a cheap, but accurate model of the gliders that are currently in use to monitor ocean environments.

Materials & Supplies

1. Download Autodesk Inventor here:

http://www.autodesk.com/education/free-software/inventor-professional

2. VEX EDR Robotic parts and curriculum guides:

http://curriculum.vexrobotics.com/home

3. RobotVirtualWorlds computer simulator:

http://www.robotvirtualworlds.com/

4. Recommended use of 12' x 12' field with game pieces as determined by teacher
5. 3D Printer (Statasys F170 was used for the purposes of this lesson)

Plan

During the first week of school (90 minute class periods):

1. Start with the opening question (3 minutes)
2. Introduce the idea engineering and design (5 minutes)
3. Discussion question: what makes a good design team? (3 minutes in groups, 5 minutes as a class depending on how many topics are brought up)
4. Discuss engineering design process and engineering fields (10 minutes as a class)
5. Engineering logbook explanation and journals entry (10 minutes)
6. Finish with engineering challenge (20 minutes)

The lesson is placed after the classes are already familiar with the robot components and programming and will be focused on the 3D CAD portion of the class. The project should take approximately 3 weeks on block schedule (90 minute class periods):

1. Start the lesson by introducing the premise of the game with background on marine robotics, followed by walking through the Skyrise Explorer game mechanics (including requirements for robot that include a customized part for the robot) (10 minutes)
2. Walk through setting up the workspace on Autodesk Inventor and show basic tools available through the making of a Lego piece (30 minutes)
3. Students spend the rest of the first class period practicing making various parts in Autodesk Inventor and brainstorming for robot design (45 minutes)

The remaining 2 weeks should be given for the students to finishing planning, building, programming and testing their robots. Integrate lessons as needed to focus on specific tools in Autodesk Inventor or to help troubleshoot issues that are arising with robot mechanics or programs.

The culmination of this lesson is a bracket-style tournament that the groups will compete against one another to determine the best robot design and execution.

Summary

To emphasize the importance of robotics and to introduce students to the world of computer aided-drafting (CAD) and 3D printing, this lesson plan seeks to put students in the shoes of an engineer design a robot for deep-sea exploration. In small groups, students are given the task of collecting objects and placing them in their zone for further study. To complete the task, students will design, build, program and test their own robot for a 2 week period and compete against the other teams robots in a bracket-style tournament to determine the best robot design and performance.

Appendix

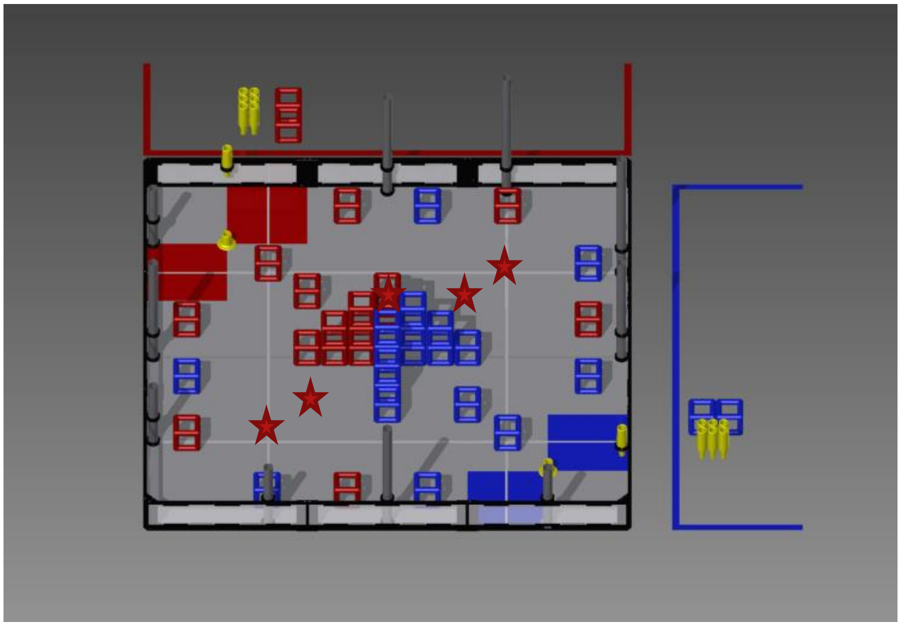

Figure 1. Overview of game field with various objects (represented by stars) placed in the field to represent "ocean artifacts" to be collected for study