Using Wide-Spread Collaboration to Motivate Innovation and Creativity

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Center for Engineering Education and Outreach
Tufts University School of Engineering

http://www.cceo.tufts.edu
Why Engineering Education?

We NEED students…
• excited about math & science
• engaged in continuous learning
• capable of innovative problem solving
• aware of engineering’s importance to improving the future!

IF we want a future with…
• abundant clean energy
• the last of epidemics
• environmental stability
• food enough for all

Improving Education Through Engineering
Center for Engineering Education and Outreach

Outreach
- LEGO Engineering Conferences
- STOMP Network
- Workshops

Tools and Content Development
- Software
- Websites
- Print-based

Research
- Methodologies
- Curriculum
- Tools
The Briefcase

**Wiki data store**
- project files
- change tracking
- user permissions

**HTML**
- web services

**Web browser-based interface**
- Project Library
- Individual Profiles
- Online Collaboration
- Knowledge Base

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**One Button Publishing**

**Desktop authoring environment**
- SAM Animation
- SCRATCH
- Maya
- Alice
- ROBOLAB™
- Bundling
- Blogging
- Multimedia

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Web browser-based interface displays creations from the Briefcase (formatted server-side for viewing). Students edit a browser profiles and participate in online collaboration.

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Single authoring tool, allowing combinations of products from each of the software packages to be combined into one creative artifact. One button publishing uses web services to save data to the wiki data store.
Power of the Digital Briefcase

- Curriculum, content, technology and documentation all collected, organized and presented in one location

Curriculum Content:
- Activity description
- Procedural details
- Instructional text
- Educational pictures and movies

Project Development:
- Planning algorithms, schematics, and steps
- Experimentation
- Design choices and decisions
- Process feedback

Final Documentation:
- Program code
- Pictures/movies
- Text/audio descriptions
- Collected data
- Analyzed graphs
- Grades/comments
Distinct Advantages of Our Model

- Flexible data entry environment, encompassing multiple representations
- Varied teacher customization (to adapt for language, classroom, learning disabilities, etc)
- Third party and user defined plug-in inclusion
- Simultaneous inclusion of multiple software programming platforms
- Direct hardware connection with real-time interaction
Collaboration

In the classroom
- Curriculum
- Activities
- Concepts
- SOFTWARE
- HARDWARE

Across the globe...
- Curriculum
- Activities
- Concepts
- SOFTWARE
- HARDWARE
Problem 2

Part A. Show that a rocket, in free space (i.e., no external forces), of initial mass \( m_0 \) and speed \( v_0 \), attains speed \( v' \) by expelling mass, i.e., burning its fuel, where \( v' \) is given by:

\[
\frac{v'}{v_0} = 1 + \frac{\Delta m}{m_0}
\]

Here, \( \Delta m \) is the exhaust velocity and is assumed to be constant.

Part B. (Maier & Thornton 9-17) Assume that the rocket above starts at rest and accelerates uniformly with acceleration \( a \) until its final speed \( v' \). Show that the total amount of work done by the rocket engine is \( W = \frac{1}{2}m_0v'^2 \).

1. Show that for a single particle with constant mass the equation of motion implies the following differential equation for the kinetic energy:

\[
\frac{dT}{dt} = F \cdot s
\]

while if the mass varies with time the corresponding equation is

\[
\frac{d(mT)}{dt} = F \cdot \dot{p}
\]

2. Prove that the magnitude \( R \) of the position vector for the center of mass from an arbitrary origin is given by the equation

\[
M^2R^2 = M \sum m_i \rho_i^2 + \frac{1}{2} \sum m_i \rho_i \rho_j
\]

3. Suppose a system of two particles is known to obey the equations of motion, Eqs. (1.22) and (1.26). From the equations of the motion of the individual particles show that the internal forces between particles satisfy both the weak and the strong laws of action and reaction. The argument may be generalized to a system with arbitrary number of particles, thus proving the converse of the arguments leading to Eqs. (1.22) and (1.26).

\[
M \frac{d^2R}{dt^2} = \sum F_i = F^{(0)}
\]

\[
\frac{dL}{dt} = N^{(0)} \quad \text{(external torque)}
\]
Musical Instrument

Assignment Documentation

Fill in the areas with the requested information. The next page displays pictures of your creation.

Enter your instrument's name:

Describe your conceptual design of your instrument:

Enter your group members:

Give details of your technical solution (mechanical/programming)

Plays at least three notes? (yes, sort-of, no)

Recognizable tune? (yes, sort-of, no)
Here are two pictures of the final creation.

Video courtesy of Laurens200.
After viewing each experiment design from all the other groups, work as a class to design the final experiment.

Describe below the final process on which everyone agreed you will be using. Then take some pictures of the final set-up once you have created it.

Our group tested the values of 16,000, 17,000, 18,000, 19,000 and 20,000 and recorded the average values. The class compared everyone's values and picked and tested those that didn't make sense. We tested the sounds at full volume on the computer and volume of 5 on the program.
What can you tell about the NXT microphone based on this graph? What values constitute the acceptable range of the NXT microphone?

What sources of error exist within your experiment? How could these have affected the final results collected?

Background noise, speaker and microphone malfunction, breathing/gum chewing, and limitations of the technology skewed our results. They all would affect what the computer heard and the output of the computer.
Test the Sensor

Use the graph below to collect real-time light data from your rover. Make sure the robot is turned on and connected to the computer. Also, double check that the light sensor is plugged into input 3.
Add/Delete Page Experimentation

This book experiment...

At the beginning, when a new page is added, you have...

There are some known issues:
- The page number is not unique.
- You can't up-down.
- Text boxes are not the same size, even if they are not the same text.
- Finally, anything can be fixed.

Add Page: Select Template

[OK] [Cancel]
Sharing via One Button Publishing

Examining Mars Soil

Turn in your Assignment

1. Export your book to a single file and email it to your teacher.
2. Print your book.

Select the method below:

- Export and Email
- Print

Folders

- Physics
- Chemistry
- Math
- EN 10
- EN 10 Zoo Animals
- EN 10 Orienteering
- Binary Morphology
- Examining Mars

Books

- Introduction to LabVIEW
- Introduction to Programming
- Introduction to Robotics

Description

Title: Introduction to LabVIEW
Author: Chris R
Date Created: 3/24/08
Last Edited: 6/29/08
Version: 4

Description:
This book teaches some introductory material about how to use LabVIEW. It discusses VIs, the tools palette, loops, events, and errors. It is a good way to be introduced to the graphical programming language.
Thank You

For more information about our Center or this project specifically, please contact:

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Supplemental Slides
The LEGO Robotics Platform
ME 184 RoboBooks

Description:

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Author: Chris R
Date Created: 3/24/08
Last Edited: 9/12/08
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Why This Works: Classroom Management

- Step 1 + Step 2 + Step 3 and “wait, what was Step 2???”
- Activity can troubleshoot itself
- Teachers more satisfied with curriculum
- Students more motivated and engaged
Why This Works: Increased Interactivity

- Between student and technology
- Between student and work
- Between student and student
- Between student and teacher
- Between teacher and teacher
Why This Works: Simple Customization

• Teachers easily customizing activities
  – Ability to change look/appearance and content based on personal preferences, classroom specifics, local standards, languages spoken, etc

• Student authoring activities themselves
  – Recording progress, generating reports, combining real-world/real time data with multimedia elements
Light Sensor Task

In this task, you are going to try out the light sensor with the LEGO NXT robot. You will specify how long the NXT will take light measurements and then try to duplicate the graph to the right with the sensor.

The code above will allow the NXT to collect data with the light sensor. Change the times the sensor is collecting data to match the graph to the right. The light sensor will click when it is collecting data and then beep to tell you to switch lighting conditions. Collect data and try to match the graph by clicking the arrow button and running the program on the NXT.

Attach the light sensor to your NXT in port 1. Then, upload a picture of your NXT by clicking on the picture to the left.

Now that you have collected data with your NXT, let’s see if your graph matched the one above. Upload your data by clicking on the graph below and selecting Add Data.
Analyze the Data

Based on the data you collected, find the darkest and lightest soil locations. At what time did the rover reach these spots? How far away from the start are those areas?

Darkest spot:
- Time: 
- Distance: 

Lightest spot:
- Time: 
- Distance: 

[Graphs showing light value and distance over time]
**Introduction to LabVIEW**

**Bad wires**

Bad wires occur any time you have a wiring error and can be fixed by deleting the bad wire and rewiring the connection. You can either use the select tool and the delete key or "Remove Broken Wires" in the Edit menu. Try identifying the error in the program below and then fixing it.

In this case the error is due to the fact that the wires are in space, rather than in an icon. Try linking them to again or deleting and re-wiring.

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**Loops and Structures**

LabVIEW has many different structures you can use in a program. They include for loops, while loops, case statements and event structures and each one has a lot of different attributes so I will only give a general overview here. For more help, go to the web pages at the end of this book.

So the for loop and while loop below both generate (and plot) an array of 100 members. The left loop (for loop) automatically indexes the array, with each iteration of the loop adding a new element onto the array. The while loop, on the other hand, does not and you have to right button click where the wire crosses the while loop and select "Enable Indexing." Try modifying the code a little. First, change the number of points in each case to 500. Then try plotting the sin(πi/180).

Finally, try playing more with shift registers. Run the program to the right with the execution highlighting on (the light bulb next to the Run button). What does the program do?

Type Your Answer Here