

WiiLab Programming in MATLAB

A Research Experience for Teachers at Notre Dame

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Abstract - The first year engineering students at the University of Notre Dame are required to take an eight-week course: *Introduction to Engineering Systems 1- via MATLAB*. Students learn the fundamentals of computer programming using MATLAB. In continuing the effort to make *Introduction to Engineering Systems 1- via MATLAB* more relevant to students the Research Experience for Undergraduates (REU) students have created MATLAB in 2008 and WiiDorf in the summer of 2009. The scope of this paper is to look at the work and experiences of a local high school teacher during the summer of 2009 in the Research Experiences for Teachers at Notre Dame (RET@ND). The title of the RET program is, WiiLab: Bringing Together the Nintendo WiiMote and MATLAB under the guidance of Dr. Aaron Striegel professor of the Department of Computer Science and Engineering at the University of Notre Dame. There will also be a discussion on the use of the Wii Controller in the classroom. To conclude with the development of programs for the Wii Controller offered as shareware.

Introduction

In the summer of 2008, two students in the Research Experience for Undergraduates (REU), Jordan Brindza, and Jessica Szweda created WiiLab. WiiLab contains all the basic programs needed to create games in MATLAB using the Wii Controller. (Szweda, 2008) MATLAB® is a sophisticated computing language and advance computational program. MATLAB is a product of MathWorks. (MathWorks)

The first year engineering students at the University of Notre Dame are required to take an eight-week course: *Introduction to Engineering Systems 1- via MATLAB*. Students learn the fundamentals of computer programming using MATLAB. The textbook used for the RET program was *A concise Introduction to MATLAB* (Palm)

Introduction to Engineering Systems 1 can be a very challenging course for some first year freshmen. The premise of the WiiMote research is to continue to develop an instructional structure that would encourage self-efficacy among the students in *Introduction to Engineering Systems*. The motivational tool the research focused on was the Nintendo Wii Remote Controller

WiiMote

As of 2006 50 million Wii Consoles have been sold. Each Console comes with a Nintendo Wii Remote Controller that is equipped with Bluetooth capabilities. The Wii Controller also has an infrared camera that will respond to infrared light.

In the summer of 2009, two REU students Mark Overholt and Simon Zhang continued developing games that require the use of the Wii Controller. Mark and Simon created *The decision Recording Framework for Nintendo WiiMote Interactions* (WiiDORF). (Simon Zhang, 2009)

The WiiLab project had an additional member, a local high school teacher. Juanita Gerard joined Mark and Simon on WiiLab project to assist with suggestions on how the Wii Controller could be used in the classroom.

High Achievers

The Department of Education, for the State of Indiana, provides teachers with an online resource, *High Achievers*. (Education, High Achiever, 2008) The computer program, *High Achievers*, is designed to provide practice problems for Algebra Students taking the Core-40 End-of-Course Assessments. (Education, Core 40 End Of Course Assessment, 2008)

The Core-40 is a graduation qualifying requirement test. One concept given to students on the *High Achievers* test is unit cost. The concept of unit cost was coupled with the notion of creating an inequality given a story problem. I took the concepts of unit costs and inequalities and created mathematical computational problems and story problems. The thought process I use to communicate to Mark and Simon on what type of game I would like them to create is as follows:

Wii Game For high School Students
June 15, 2009

To help students solve a story problem where they will need to know the definitions of mathematical terms.

Create a game that will allow the students to practice making mathematical sentences and inequality sentences.

The game will need to include the definition of Unit Cost.

At the end of the game students will be able to create an inequality sentence from information given to them in a story problem.

Sentences are used in mathematics. An example of a sentence is:

Sue has ten music downloads and Mary has six music downloads and together they have sixteen music downloads they can share.

Expressions are use in mathematics. An example of an expression is:

seven multiplied by x

Expressions use mathematical operators which are, addition, + , subtraction, - , multiplication, • , and division, ÷ .

Expressions also use mathematical inequalities which are, less than, < , greater than, > , less than or equal to, ≤ , greater than or equal to, ≥ .

Example of problem:

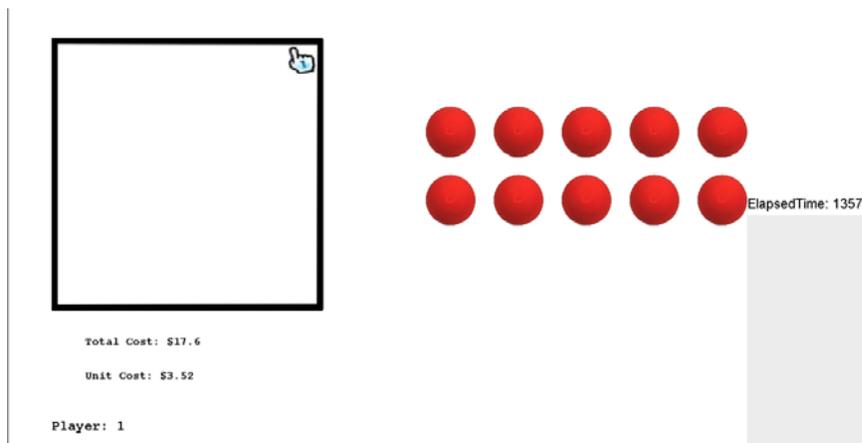
Megan bought 7 charms for \$ 31.50. Each charm costs the same amount of money. Write an inequality that can be used to find the maximum amount of charms (c), Megan can buy with \$75.00.

- A. What does the student need to know before they can start on this problem?
 - a. They need to know the unit costs of a charm.
 - i. Define the term 'Unit Cost'. The price of a single quantity of the whole.

- ii. To practice 'Unit Cost', have a game that will demonstrate the concept of 'Unit Cost'.
- b. They need to know the meaning of the term 'Inequality'.
 - i. A mathematical sentence built from expressions using one or more of the symbols $<$, $>$, \leq , or \geq .
- c. They need to know what symbols to use when you want to represent and inequality sentence.
 - i. $a < b$, means a is less than b
 - ii. $a > b$, means a is greater than b
 - iii. $a \leq b$, means a is less than or equal to b
 - iv. $a \geq b$, means a is greater than or equal to b
- B. How will the Student seam together the concepts of unit cost and inequalities to create an inequality sentence?
 - a. Create a game where the students will need to read a story problem which uses the terms 'Unit Cost' and 'Inequalities'.
 - i. Student will need to identify information from the story problem that will help them solve the problem
 - ii. Student will need to identify the proper inequality symbol needed to solve the problem
 - iii. Student will create an inequality sentence

Games

Prepared with my outline Mark created The Unit Cost Game, see figure 1. (Overholt, 2009)



The Unit Cost Game. Figure 1

Mark also created the Inequality Game (figure 2) and the Story Problem Game (figure 3). (Overholt, 2009)

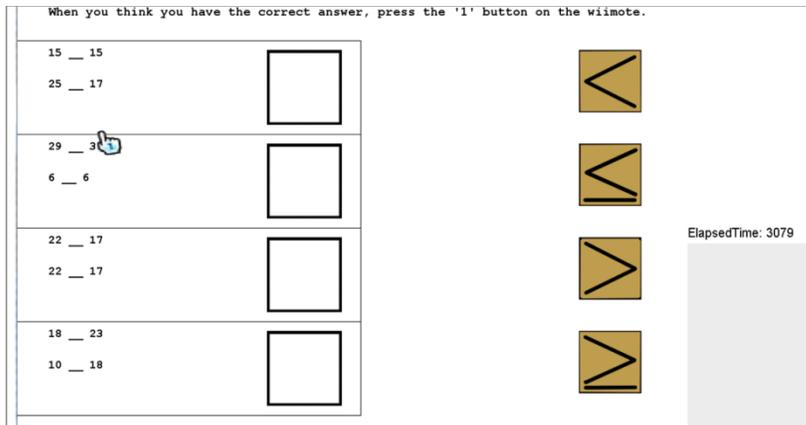


Figure 2, The inequality Game

Story Problem Game

The Story Problem Game combines the two concepts of unit cost and inequalities. The user is presented with a story problem. The user must then drag the correct symbols and numbers to make an inequality formula. For example: Megan buys 9 charms for \$156.32. How many charms can Megan buy for \$112.45. The user will then write an equation that looks like: $7.10 * X \leq 112.45$ where X is the number of charms. Like the previous two math games, if the first player gets the question wrong, then the next player gets a chance to answer that same question.

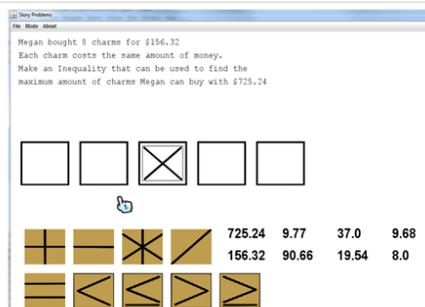


Figure 3, The Story Problem Game

Presentation of Games

Mark and Simon had the opportunity to demonstrate their games to a local high school. The objective of the demonstrate was two-fold, one, would the games work in the classroom, two, what would be the initial reactions of the students when presented with a game and a Wii Controller?

Except with some hiccups with recognizing the Bluetooth and Wii Controller, the games worked as expected. The initial reaction of the students was positive and the students wanted to work out the problems to achieve success in the game.

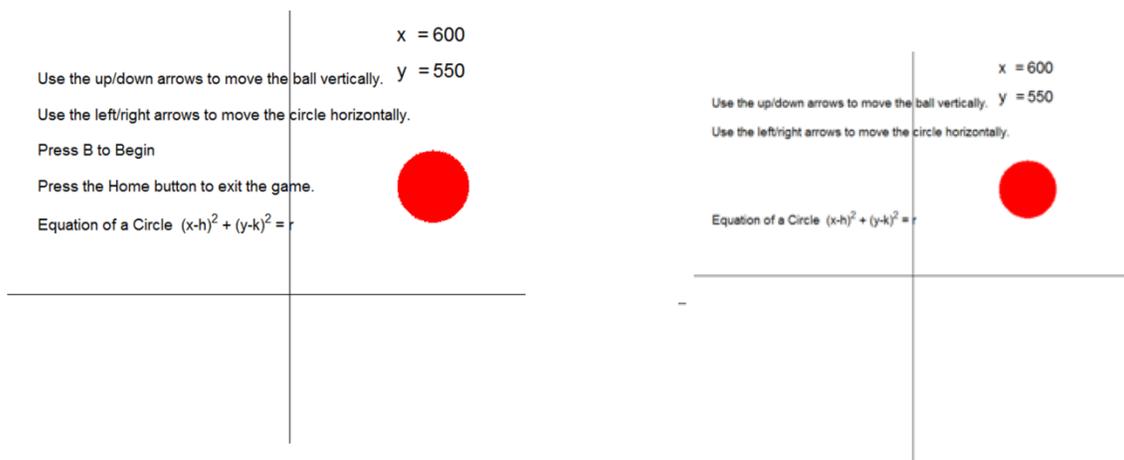
The positive reaction from the students makes the idea of using the WiiMote Controller in the classroom promising.

Game Circle-Draw-Project

My game is the *Circle-Draw-Project*. I used the WiiLab files and MATLAB to build the program. The game must be started using the WiiMote Controller. The object of the game was to have a circle on the screen where the player would be able to move the circle using the Wii Controller. The coordinates of the center of the circle would be present on the screen after the circle was moved. Students would then be asked if they could write the equation of the circle.

My program did not work. Dr. Striegel looked at my code and found that a file name was not a correct match to the function being called. After I changed the file name, the window appeared with the x and y grid, the filled circle and the text instructions. I was able to press B on the Wii controller and it removed the text I programmed to be removed. The key-pad on the Wii controller would not move the circle around the screen. Time did not allow me to correct the code.

It is shown below:



```
% a WiiMote game written in MatLab 7.6.0 language which creates a circle. It
will also draw vertical and
% horizontal lines. The WiiMote must be connected and there are files
% needed for the program to work properly
%This program will not run as a standalone program.
%Author Juanita Gerard and Mark Overholt
global x;
global y;
global cir;
global liX;
global liY;
global xValue;
```

```

    global yValue;
    global xT;
    global yT;
    global yMove;
    global xMove;
    global wiimote;
    global gCurrentKeyPress;

initializeWiiMote();
    disp('Welcome to the Circle Game!')
    init();
%cir is for the drawing of a filled circle with a radius of 10
%this is the circle which the user will move around the screen

inst1 = text(50,700,'Use the up/down arrows to move the ball
vertically.','FontSize',14);
inst2 = text(50,650,'Use the left/right arrows to move the circle
horizontally.','FontSize',14);
inst3 = text(50,600,'Press B to Begin','FontSize',14);
inst4 = text (50,550, 'Press the Home button to exit the game.','FontSize',
14);
til = text(50, 500,'Equation of a Circle (x-h)^2 +(y-k)^2 = r','FontSize',
14);
%Wait for user to press B on the WiiMote Controller
waitForButtonPress('B');
hide(inst3);
hide(inst4);
done = 0;

    wiimote.GetButtonsState();
while(true)
    while (done == 0 && ~isButtonPressed('HOME'))
        %check if the player wants to end the game

        % For use of the WiiMote pad

        if (isKeyPressed('upArrow') == 1)

            yMove(cir,30);
            text(50,300,'Up Arrow');

        end

        if (isKeyPressed('downArrow') == 1)

            yMove(cir,-10);

        end

        %checkKeyPress('leftArrow');
        if (isKeyPressed('leftArrow') == 1)
            xMove(cir,-10);

        end
end

```

```

        %checkKeyPress('rightArrow');
        if (isKeyPressed('rightArrow') == 1)
            xMove(cir,20);

            end
        redraw();

        pause(.1);

    end
end
%prompt at ending
set(tx,'String','Press A to play again, Press Home to exit');
while (~isButtonPressed('Home') && ~isButtonPressed('A'))
    pause(0.01);
end
if(isButtonPressed('Home'))
    quit= true;
    return;
elseif(isButtonPressed('A'))
    quit= false;
    return;
end
end

```

Unexpected Findings

While searching the internet for information on the Wii Controller, I discovered that there are many educators using the Wii Controller in the classroom. Not with programmed games but as an electronic whiteboard. Johnny Chung Lee has developed many applications that use the Wii Controller and has also created an infrared pen needed to communicate with the Wii Controller. (Johnny Chung Lee > Projects > Wii)

Working with the REU students was amazing! They were so passionate about their work! For the most part it would be quiet and they preferred the lights off. It was not until the last day when they were done and had completed their paper and poster did they come back to the room to talk and offer me some suggestions on real-world-application I would be able to use in the classroom. It was unfortunate that there was not time to talk to the REU students further.

The poster project was also, for me, incredible. Here the REU students and I were able to talk about the REU projects they worked on. It would be well worth your time to visit this site where the posters are on the web:

<http://snoopy.cse.nd.edu:8080/Plone/reu-projects/summer-2009> .

In Conclusion

Working with MATLAB was very challenging and frustrating. I remember how maddening it was not to be able to figure out a problem when I was in college. But this feeling of frustration also reminds me of what my students must feel when they try to understand and still cannot grasp the concepts. I need to be fully aware of how my students are feeling and listen to their concerns and validate to my students that their concerns are my concerns.

As much as MATLAB was taxing to me it was exhilarating to be in a learning environment once again. The RET program at Notre Dame was a wonderful gift to me. Meeting Mark and Simon and watching their intense passion for programming was a rare treat for a high school teacher.

Thanks

I want to thank Dr. Aaron Striegel for the opportunity to work with such a fine group of undergraduates. Thank You! Mark for all your help on my code when my programs would not work and for showing me how to build a Sensor Bar and an infrared pen. You are a very patience teacher and would be a great asset to the learning community. Finally, a special Thank You! To Simon. Our talks on how students need to own their mathematical problems and to teach them about radians even though it is not on the standards has me planning how I will teach and approach my classes in the fall.

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