CS 6235 Real-Time Embedded Systems
Project Proposal

Cost-Effective Physiotheraphy Alternative using Wii Balance Board

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Goal

Our goal is to develop an application that encapsulates a balanced-based physiotherapy regiment and fitness tracking using data received from a Nintendo Wii Balance Board. In combination with the Nintendo Wii Console System and the Wii Fit video game, many health centers have already devised rehabilitation programs for patients of all ages, and especially in stroke victims. By creating a series of testing games that are similar to the counterparts in Wii Fit, we could offer a rehabilitation program at a fraction of the price. Currently, it requires the console system, balance board, and Wii Fit video game for this form of physical rehabilitation, but with our design all you would need is the balance board, assuming there is availability to a computer with a Bluetooth connection. This could provide the service to medical facilities and patients at a fraction of the cost, and also encourage designs of new Bluetooth compatible balance boards at cheaper prices.

Motivation

The Wii Balance Board is a unique piece of hardware using four weight sensors that is used to add another dimension of interactivity to Wii video games. In particular, the balance board brings the ability to test balance and fitness in the context of a video

game atmosphere. Due to this, many rehabilitation centers use the Wii Fit video game in combination with the balance board to improve coordination and general fitness in many patients. Stroke victims have especially benefited from this, because the games help rewire the damage to the brain by repeating motions, maintaining balance, and developing lost coordination.

With this in mind, we want to offer many of the same benefits that the Wii Fit video game creates, but without relying on the Wii Console System and video game. Some previous work has been done connecting the Wii remote control and balance board to a Linux system through Bluetooth and our design builds upon this base. The application will provide a few tests that allow users to track their balance and fitness performance over time.

Studies have shown that this is an effective form of physiotherapy, because patients can interact with their training, rather than just perform it. Tracking results over time to see improvement and continually attempting to outperform personal records help provide motivation to continue in therapy. In addition, the game aspect adds entertainment value to an activity that normally consists of effort and strain.

**Proposed Tests in Program**

- **Center of Balance**: Patients are asked to stand straight and still for a period of time while their center of balance is tested. Variance from center is deducted points from a standard starting amount.

- **Single Leg Balance**: Patients attempt to stay balanced on one leg for a period of time. After a trial period to center balance on one leg initially, a timer tracks how long balance is maintained. Score is based on variance from center and amount of times "reset" to two legs to maintain balance during a period of time. This test is repeated for the other leg as well.

- **Dynamic Balance**: Patients try to keep their center of balance "dot" within a bounding box that moves around a grid. The box stays in an area for a certain amount of time and then moves to a new random location. The patient must adjust their weight so that the center of balance moves to the new location. Points are awarded for time spent within the box and fluidity of switching locations. Shrinking box dimensions and adjusting the time between location switching adjust the difficulty.

- **Stop & Go**: Patients simulate walking by taking steps in place or shifting weight back and forth from left and right feet when told to "Go". When told to "Stop", the patient would try to stand as still as possible until being told to "Go" again. This would go back and forth randomly until a certain time or distance is met and scored accordingly. Movement during stopping periods would be penalized.

- **Maze Navigation**: Patients move their "dot" through a randomized maze using the balance board. Score is based on the time it takes to move through the maze to the finish.

- **Labyrinth**: Patients move their "dot" to a hole on the screen. Boundary zones that return you to the start are randomized on the board and other obstacles can be placed along the way. This is a step up in difficulty from the maze since it requires constant balance control.

- **Weight/BMI Tracking**: Although not a balance test, weight and body mass index (BMI) of the patient will also be tracked to store in their profile for general fitness purposes.

Implementation
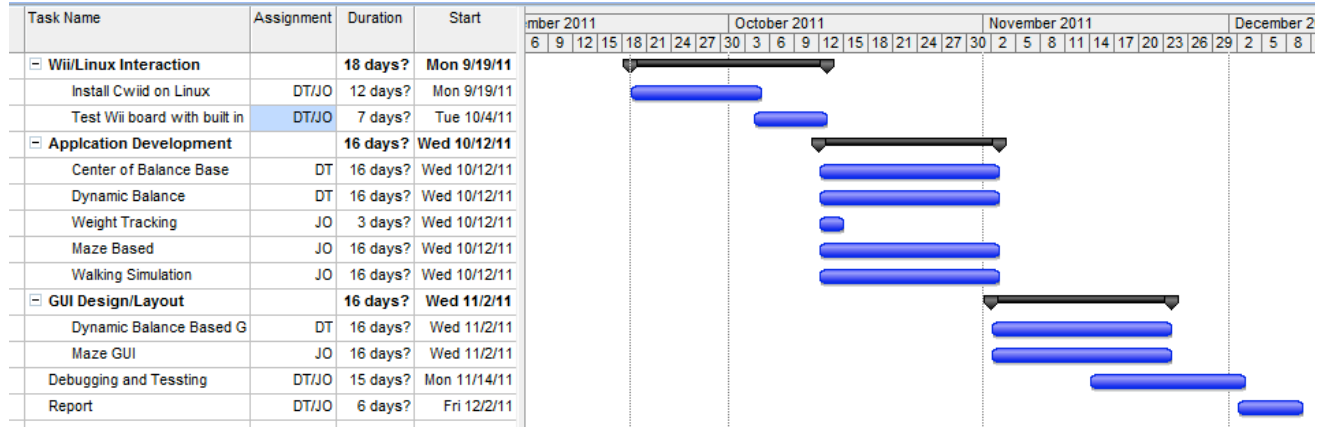
System Architecture

The code library that already exists for the Wii balance board is an open source project called CWiid. The CWiid project uses a combination of C and Python code to interface with the balance board connected through Bluetooth. The C code interacts with the Bluetooth stack and supports modules that can be used in conjunction with the Python code. Although the programming can be done solely through the C code base, using Python simplifies the coding at the application level, especially in GUI development. The overall hardware layout of the system is shown below in Figure 1.

Figure 1. System Layout.
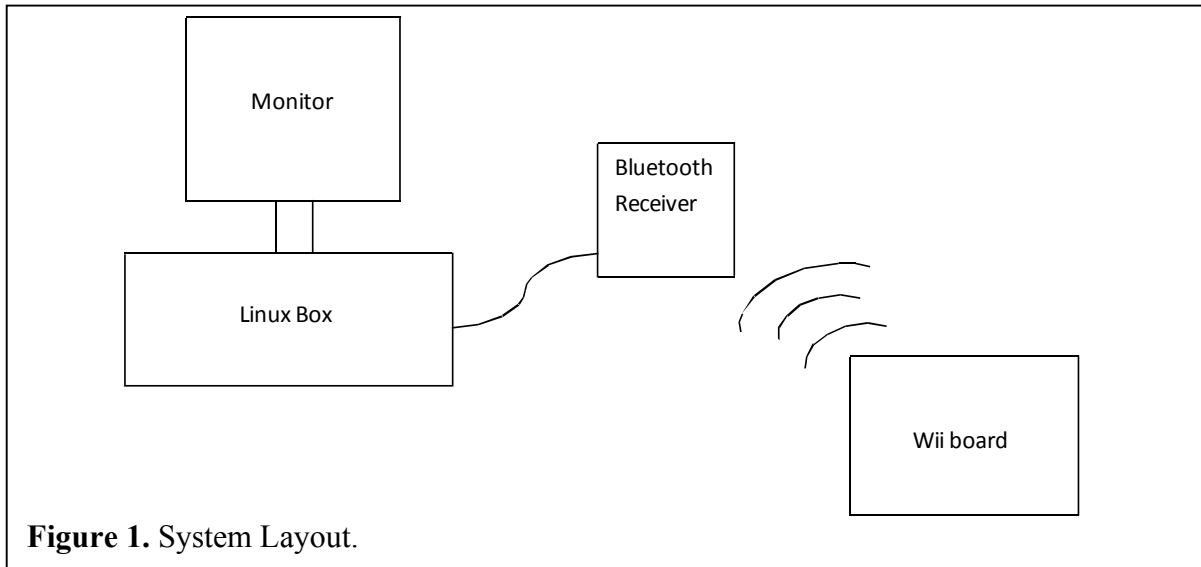
Resources

  The three main hardware resources of the project are the Wii balance board, a Bluetooth receiver, and a computer running Ubuntu Linux. The software resources used will be CWiid and Pygame. CWiid contains the drivers in C that interact with the Bluetooth connection of the balance board, while Pygame handles the GUI framework. The C code supplies the data coming from the balance board to a module, which can be manipulated to be read from Python. The main area of development will be in coding and designing the application and testing programs, which will use the real-time data supplied by the balance board.

Schedule

Task Name	Assignment	Duration	Start
⊟ Wii/Linux Interaction		18 days?	Mon 9/19/11
Install Cwiid on Linux	DT/JO	12 days?	Mon 9/19/11
Test Wii board with built in	DT/JO	7 days?	Tue 10/4/11
⊟ Applcation Development		16 days?	Wed 10/12/11
Center of Balance Base	DT	16 days?	Wed 10/12/11
Dynamic Balance	DT	16 days?	Wed 10/12/11
Weight Tracking	JO	3 days?	Wed 10/12/11
Maze Based	JO	16 days?	Wed 10/12/11
Walking Simulation	JO	16 days?	Wed 10/12/11
⊟ GUI Design/Layout		16 days?	Wed 11/2/11
Dynamic Balance Based G	DT	16 days?	Wed 11/2/11
Maze GUI	JO	16 days?	Wed 11/2/11
Debugging and Tessting	DT/JO	15 days?	Mon 11/14/11
Report	DT/JO	6 days?	Fri 12/2/11

References

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<http://www.wellsphere.com/general-medicine-article/nintendo-wii-fit-for-physiotherapy/460917>

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<http://wiibrew.org/wiki/Wii_Balance_Board>

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<http://www.nintendo.com/consumer/downloads/wiiBalanceBoard.pdf>

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<http://news.bbc.co.uk/cbbcnews/hi/newsid_7870000/newsid_7877800/7877879.stm>

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<http://www.dailynewstranscript.com/lifestyle/health_and_environment/x390643827/Gentle-Wii-Fit-exercise-works-for-nursing-home-s-residents#axzz1YM7dWnGf>

[10] *Physical rehabilitation with Wii*
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[11] *Vestibular rehabilitation using Wii*
<http://vestibular.org/images/pdf/Using%20Wii%20for%20Vestibular%20Rehab_VEDA pubC7.pdf>

[12] *Information on the CWiid project*
<http://abstrakraft.org/cwiid/>