Wii Nunchuk Controlled Dance Pleo! Dance! to Assist Children with Cerebral Palsy by Play Therapy

Jennifer Gregory[1], Ayanna Howard[2], and Chutima Boonthum-Denecke[1]
[1]Hampton University, Hampton, VA, 23668 USA
[2]Georgia Institute of Technology, Atlanta, GA 30332
jennifer.gregory1@my.hamptonu.edu, ayanna.howard@ece.gatech.edu, chutima.boonthum@gmail.com

Abstract

Children with cerebral palsy have difficulty moving their hands and muscles due to developmental issues. One way to assist these children is by having them participate in physical therapy. The best form of physical therapy for children is playing. Playing is a natural activity for children, and it also helps in furthering the developments of muscles. This form of therapy is perhaps a greater choice for children because it keeps the child engaged due to the interest the child holds in the activity. By integrating two projects done by previous students, a Pleo that is controlled by a Wii Nunchuk will be able to teach Pleo how to dance. The child will be engaged in this activity for long durations because there are many variations of dance that the Pleo can learn by moving many body parts. Children using this toy will have continuous movement in their arm muscles by moving the Nunchuk for the duration of the activity. This toy will not only help children with severe disabilities feeling equal to their non disabled peers by allowing them to use controllers found on many game consoles, but it will also enhance the child's self esteem and confidence by allowing them to control the outcome of the Pleo.

Introduction

The goal of this project during the summer of 2011 is to enable play for children with Cerebral Palsy (CP) that continuously entertains, which will allow extended play over long durations. This could be accomplished by integrating two previous projects. The first was created to teach Pleo to dance using its sensors. The second was created to control Pleo with the Wii Nunchuk. By integrating these two projects, children with severe disabilities will be able to teach Pleo to dance using the Wii Nunchuk.

Cerebral Palsy Overview

Cerebral palsy (CP), a disorder that affects muscle tone, movement, and motor skills, is one of the most common congenital childhood disorders. Nearly 500,000 people, both children and adults, in the United States have this condition (Bachrach, 2011). CP can be grouped into three different types. Spastic CP, the most common type, is the kind that causes stiffness and difficulty with movement. Athetoid CP causes uncontrolled and involuntary movements. The third type of CP is ataxic, and this causes a disturbed sense of balance and depth perception (Bachrach, 2011). There is no cure; however, there are treatments, therapy, special equipment, and even surgery to help children living with this disorder (Origins of Cerebral Palsy, 2011).

Physical therapy can help develop CP patients' muscles and movements. When it comes to children, the most natural form of physical therapy is playing. No matter what age a child is, playing is a valuable area of therapy, because not only does it help to release stress, but it can also assist their development and even speed it up (Origins of Cerebral Palsy, 2011). Playing involves hand-eye coordination and motor skills, which are the main effects of CP. Since children with CP have limited motor skills, all toys are not compatible and helpful in aiding them with developing their movements (Origins of Cerebral Palsy, 2011). The toy of choice has to be engaging, to keep the child's interest, and effective, in order to aid in the purpose of physical therapy.

Pleo: Autonomous Camarasaurus

Pleo is originally an autonomous robotic life form created by Ugobe in 2006 (see Figure 1). He is designed to mimic life and is modeled after a baby Camarasaurus dinosaur. He begins as an infant and grows to be a juvenile (Innvo

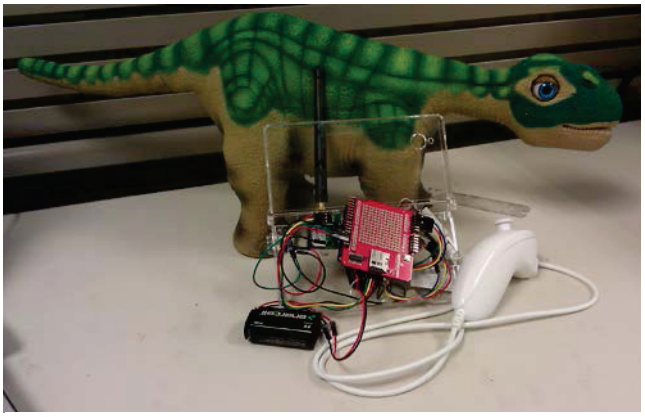

Figure 1. Pleo and Wii Nunchuk

Labs Corp, 2010). He interacts with the world by exploring, communicating, and playing with humans or other Pleo pets. He is able to develop his own personality through the use of his highly complex sensory system (Pleo, 2011). This includes 14 motors, eight touch sensors, an infrared transmitter/receiver, two microphones, a color camera, an infrared interrupter, tilt/shake sensors, ground sensors, and force feedback sensors. Pleo weighs 1.6 kg (3.5 lbs.) and measures 52.5 cm (20.7 in) in length, 15.2 cm (6 in) in width, 19.1 cm (7.5 in) in shoulder height, and 27.9 cm (11 in) in head height (Wilson, 2011).

Wii Nunchuk

The Wii Nunchuk was created by Nintendo. It is a device that has motion sensing technology, two buttons, and a control stick that allows for the controlling of characters on the Nintendo Wii console (Nintendo, 2011). A three-axis accelerometer allows for motion sensing and tilting. The Nunchuk is able to connect to any microcontroller capable of I2C, so that the data of the accelerometer, joystick, and buttons can be accessed (Wiki, 2011). The Nunchuk body measures 113 mm (4.45 in) in length, 38 mm (1.5 in) in width, and 37 mm (1.4 in) thick.

Dance Pleo! Dance!

In the Fall semester of 2010, four students developed a skit for Pleo that would enable Pleo to learn dance moves. Pleo is taught from a human teacher, and uses his senses to detect the movements he should learn. The human teacher taps a body part to select it for teaching. He uses his camera to see an object, and based on its track, moves the selected body part in conjunction with the object. The students were successful in getting Pleo to learn by demonstration and to learn by reinforcement (Curtis et al., 2011).

Wii Nunchuk Controlled Pleo

In April of 2011, a student named LaVonda N. Brown was able to turn the original, autonomous Pleo into a controlled robotic playmate using the Wii Nunchuk controller. This was done using an Arduino Pro microcontroller and XBee modems to allow for wireless communication between Pleo and the Wii Nunchuk (Mikhalchuk, 2009). By using the different combinations of the control stick and buttons on the Nunchuk, Pleo was able to perform different actions, including sound and movements (Brown, 2011).

Implementation

Methods

There were two main methods to choose from when implementing this project. The first method was to have the Arduino communicate with the SD card stored inside of Pleo. This would allow access to the scripts from the first project. With this method implemented, then Nunchuk data would determine the scripts called. The problem with this method was that the scripts that are loaded onto the SD card in Pleo are written in Pawn Scripting Language. This makes it difficult to communicate with the C based language that Arduino code is written in. Arduino would have to wirelessly access the SD card. This problem could not be solved in the given amount of time, so the following method was chose.

The chosen method of implementation was to simply write an Arduino code that would take the Nunchuk data input and store it on the Arduino to be recalled. The code is based off the original code used by the student in the second project, but there were some changes made in order to accommodate this project based on certain conditions. When the Nunchuk data is received by the Arduino, it is sent to the corresponding function and converted to angle data that is used to move Pleo's joints. The original Nunchuk data is stored in a multidimensional array. This array holds up to six inputs for each joint. When it is time for the data to be recalled, the array is traversed through so that each joint has the chance to move an angle in order to have each joint move simultaneously. This was in hopes of giving Pleo a life-like dance feature.

How to Use

In order to start Pleo, first the Arduino board must be turn on, and then Pleo is turned on. When Pleo is ready to play, he moves slightly. This takes about 15 seconds. The user can then choose which body part to teach Pleo. The body parts include the head, tail, hips, and each individual leg, and the body parts are chosen by moving the joystick to a given position. When a body part is selected, the user can then press and hold the "C" button and move the Nunchuk

in order to move Pleo. Only when the "C" button is pressed will the movements be stored to the Arduino. When the user is ready, they can move to the next body part and repeat, until he or she is finished. When the user is ready to see the dance that was taught to Pleo, first the joystick should be moved to the right position and held there until Pleo is back to his natural stance. Then the "Z" button is pressed and held. This calls a function on Arduino that traverses through the array and sends the data to the function that moves Pleo's related joints. If the user wants to restart from scratch, then the both "Z" and "C" buttons should be pressed and held at the same time until Pleo had returned to his natural stance.

Table 1 shows the body parts that are controlled by the joystick positions and the functions controlled by the button combinations on the Wii Nunchuk Controller.

Table 1. Wii Controlled Dance Pleo! Dance! Functions

Button Joystick Position	Z NOR C (select body part)	Z ONLY	C ONLY	Z AND C
TOP	Head (joints 11 & 12)			
TOP RIGHT	Front Right Leg (joint 0)			
RIGHT	Natural Stance			
BOTTOM RIGHT	Back Right Leg (joint 6)			
BOTTOM	TAIL (joints 9 & 10)			
BOTTOM LEFT	Back Left Leg (joints 4)			
LEFT	Torso/Hips (joint 8)			
TOP LEFT	Front Right Leg (joint 2)			
CENTER		Dance	Teach/Learn (Selected body part)	Reset Pleo

Challenges

When developing the code for Arduino, there were a few challenges. It was noticed that using an array to store the data would only allow for limited storage of movements, since the array is a static structure. Unfortunately, Arduino does not allow the use of dynamic structures, or else a vector could have been used to replace the array. This would have been ideal since it is unknown what amount of movements the user would like to teach Pleo. Another alternative was to store the movements to an SD card. For this, a micro SD shield was purchased from sparkfun.com. This was attached to the Arduino by soldering the pins and connecting them to the headers. When first trying to test a simple read and write code for the SD shield, the SD card could not be initialized. Looking further into this problem, it was noticed that the SD card was not even being recognized by Arduino. After multiple attempts to fix this problem, there was no success in time to complete this project. After these failed attempts, the original idea, to use an array, was used.

Another issue that came up is the hardware packaging. The wires make it difficult to fit into the case that was being used to hold the necessary components. This could be improved in the future by shortening the wires as much as possible. Also, since there is now an SD shield attached to the Arduino, which along with the wires and the battery makes it a crowded fit into the case.

Results

The results that were received were not completely what were expected, but very close. When uploading the program to the Arduino Pro and testing out the project, there was partial success. Pleo was able to learn moves that were taught to him by the user using the Wii Nunchuk, and then replay them. When it comes to the playback, however, there are some slight issues. Sometimes there is a delay in Pleo's movements, and often Pleo's movements are not exactly the same as the given movements. The latter is partially due to the data that is stored. When the user moves the Nunchuk and holds the "C" button down, data is stored, so this can allow for some mistakes. For example, the most common is when the user holds the Nunchuk a certain way for longer than intended, and the same data is stored. Another possible reason is that when the array is traversed through, it may move one angle at a time, and two of Pleo's body parts, the head and tail, have two joints that move them. This causes the body part to move either vertically or horizontally.

Conclusion & Future Work

This project that was developed by integrating two previous projects was for the purpose of allowing entertaining play for children with severe disabilities to provide them with a long period of engaging and fun physical therapy. Using the Pleo robot and controlling it with a Wii Nunchuk gives the child a chance to play with a toy that they find entertaining. The child can also feel just as normal as their non-disabled peers by using the same controllers that are used on gaming consoles. By giving the child the goal to teach Pleo a dance, the child is absorbed even more into the playing physical therapy because it has

a purpose. More than likely, the child will want to try several different dances out on Pleo, which means more movement and development of muscles.

There is plenty of room for improving this Wii Nunchuk controlled dancing Pleo. The code could be further enhanced so that there is less delay and mishap when Pleo recalls the dance that was taught to him. Another option would be to discover a way to have Arduino wirelessly communicate with the SD card inside of Pleo so that the scripts from the first Pleo project can be used. Also in the future, it would be ideal to incorporate the beat detection feature that Pleo has to have Pleo move to either a standard beat or a given beat when music is playing. A final enhancement would be to load music to the SD card that is connected to the Arduino. This gives the user an option of selecting the music of his or her choice to have Pleo dance to, which will be more entertaining.

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