Data Acquisition of XYZ Coordinate Positions of Human Joints Using Xbox Kinect Sensor and LabVIEW

Andrew Lascelle, Mohammad Habibur Rahman
Bio-Robotics Lab, Mechanical Engineering Department, College of Engineering and Applied Science

Abstract
With advancements in research with closed loop control systems dealing with rehabilitation robots, quick and precise gathering of data is necessary in order to fulfill this operation. With no real means of gathering joint positions as of now to calculate angles, locations, and rotations in certain appendages, this research was founded. New technology in the video game industry sparked awareness of a possible solution as to acquire this data. Using the Xbox Kinect, the video game system can sense movements of certain joints and appendages and assign them to actions in the program. The theory is that if we can tap into the data being obtained and processed by the Kinect, we could pull the XYZ coordinates for given joints in the human body and therefore know exactly where the joints are at any given time. Using LabVIEW, we connected to the Kinect and were able to in real time look at the XYZ coordinates of 21 different joints in the human body. Exporting this to a text file, we can then essentially have another program read that text file and use the data as the feedback needed to control the robot in closed loop. Using this breakthrough, we are able to provide real time accurate data and govern the rehabilitation robot so that it knows exactly how far it has moved the patients arm.

Introduction
There have been other devices that exist for the representation of data and manipulation of programs with movement. However generating real time data for multiple appendages’ joints in the arm has yet to be readily available to control external mechanisms with such accuracy. The Leap Motion controller does similar to what the Kinect can do, and can visualize the joints and appendages. Obtaining this raw data through LabVIEW was the goal, for LabVIEW has a large variety of applications and data transferring rates. In addition connecting the Kinect through LabVIEW, up to 9 bodies, and 21 joints per body can be obtained at one given time. This means we could record data for not only the patient but for where the physical therapists joints are as well.

Hardware and Software

Experimental Result and Discussion
In the images above, there is a clear representation of the output in LabVIEW displaying the joints making an animation of the current location of a body. In addition, we can see that two people are able to be in the display. One issue that arises however is that when a person's appendage passes in front of the other person’s, it starts to calculate joint positions on its own based on where other joints are and relative data of for instance how long their arm most likely is.

Modeling Motion
Precise data acquisition from the Kinect calls for a uniform coordinate system. In figure (5) the arm is going from relaxed to extended in front. This would yield data showing zero change in the X direction with changes in the Y (perpendicular to the floor) and Z direction coming towards the Kinect. In figure (6) we would see changes in both the X and Z direction but no change in the Y given that the arm stayed parallel to the ground. Collecting this data, we are able to calculate angles of extension and rotation based off of simple geometry.

How is This Data Useful?
There are certain limitations to what the brain perceives as movement. The brain is not able to see how it changes the limb, but instead how much of the limb moves. Using this data however, we are able to see how the limb moves through exercises, and how the brain changes the limb. The brain must correlate itself to certain aspects of the limb, and how the limb moves. This data can be used to show the physical therapist how well the patient is doing, and if they are able to perform certain movements.

Conclusion
The Kinect interface has proven to be a viable solution to obtaining accurate real time data. However further analysis and testing is needed to fully implement it for an accurate rehabilitation robot.

References

Contact Information
Bio-Robotics Lab, Bio-Medical Engineering Department, UWM
Andrew Lascelle, Undergraduate Student, lascell2@uwm.edu
Mohammad Habibur Rahman, mohammad.rahman@uwm.edu