CS 2310 Software Engineering Final Project Report

Arm Motion Assessment for Remote Physical Therapy Using Kinect

I. Introduction & Motivation

Kinect based remote physical therapy systems are becoming increasingly popular and a number of start-ups have emerged in recent years to tackle the problem of effective remote physical therapy using Kinect. Remote physical therapy aims to alleviate the inconvenience of in-person physical therapy as it is inconvenient for elderly people to commute to clinics for physical therapy. Not only this but rural areas or small towns may not have access to experienced physical therapists. In addition, remote physical therapy systems can greatly improve the efficiency of therapists as it enables them to attend multiple patients at the same time.

In this project, I implement a use case of remote physical therapy systems by focusing on real-time arm motion assessment for therapy using Kinect. Arm motion is assessed by using the left arm and right arm joint information obtained from Kinect tracking of the skeletal stream. Details of algorithm and implementation are given in Section 4 of the report. Section 2 discusses the system description and components, followed by message exchange between the components of my system in Section 3 of the report.

2. System description & Components

The system has the following main components,

- **GUI**: a control panel to display and adjust component parameters
- **Kinect Reader**: The Kinect sensor will take three dimensional camera input to capture movement of skeletal points on the patient while the patient performs the exercise and computes arm motion angles (rightElbow angle and leftElbow angle) sent out as reading messages to Kinect monitor.
- Kinect Monitor: This component is meant to evaluate the patient arm motion of the patient and see if the movements lie within the threshold parameters specified by the instructor. If the movement exceeds the thresholds, count of the number of mistakes will be updated and an alert message with mistake count will be sent out.

- Uploader: Sends out an email to the therapist when alert message is received

- SIS Server: The SIS server is the center of all interactions and all components will interact with each other through communication via the SIS server. All components are registered to the SIS server and all messages are sent through the server.

**Message Communication**

Given below is the sequence of snapshots showing message exchange between the components of the system.

1. All components are first initialized and registered to the SIS server.

![Snapshot 1](image1.png)

2. Each component connects to the SIS server

![Snapshot 2](image2.png)

![Snapshot 3](image3.png)
GUI launches the components after they are connected. The minimum and maximum thresholds are set on the GUI.

3. After activation, Kinect interface shows up and real-time left and right angle messages are sent from KinectReader to KinectComponent.
Given below is the format of the reading message sent by the KinectReader.

The Kinect monitor receives the reading message, checks if it is outside the provided thresholds, updates the mistake counts and sends an alert message shown in the KinectMonitor component on GUI above in (3)

**Kinect Sensor Angle Implementation**

The Kinect Sensor component runs in C# and the KinectReader component in Java communicates with the sensor via sockets. As the KinectReader component needs angles only, I do not transfer all 20 skeletal joints information from the sensor but instead compute the angles in the C# program and send them as messages to the Java KinectReader component. Below is the snippet of the code that computes angles. Other than this input processing has been done in the C# program to obtain the skeleton figure and draw it on the interface from SkeletonStream of Kinect data.
Demo

The demo of the project can be viewed at the link provided below,

http://screencast.com/t/YkjAYnZ6nJJ

Gems

The gems implemented are,

1.) Using Kinect Sensor
2.) Getting realtime reading from KinectSensor program rather than just an alert message
3.) Demo video