Team: May1304

Design Document

Project Name
Project Theia
Purpose
Develop an in-clinic software that allows patients to track and manage their therapy using the Microsoft Kinect to help guide their movements. (We will focus on parkinson's initially but will design the software to allow other exercises to be "plugged in".)

Prepared by Team May1304:

- Robert Romore
- Joseph Groenenboom
- Mitchell Ehlers
- Deven Starn
- Brian Kraus

Date of publication:

- 10/26/2012

Team: May1304

Revision History

Version	Date	Author(s)	Revision Notes
1.0	10/22/12	Robert Romore	Table of Contents
1.1	10/23/12	Mitchell Ehlers	Structured Document
1.2	10/23/12	Mitchell Ehlers	Intro and Design Overview
1.3	10/24/12	Robert Romore	Database Architecture
1.4	10/25/2012	Joseph Groenenboom	Assumptions and Constraints
1.5	10/25/12	Mitchell Ehlers	Application Architecture
1.6	10/26/12	Mitchell, Brian, Deven, Robert, Joseph	Added Standards Section
1.7	11/06/2012	Mitchell, Brian, Deven, Robert, Joseph	Added requirements section.
2.0	12/1/12	Mitchell Ehlers	Updated document title
2.1	12/1/12	Brian Kraus	Updated Application Architecture

Team: May1304

Table of Contents

Team: May1304

Design Document

Introduction

Purpose

The purpose of this document is to outline the different technologies and systems we will use to create a Parkinson's Therapeutic Game with the Microsoft Kinect. If you are reading this document hoping to learn the major goals of the project, refer to the project plan document as it will give you all the initial project definitions. This document is an expansion of the project plan.

Scope

In this design document we will highlight lower level detail on what technologies we will use to store user data, provide a web interface to therapy clinic, programming languages that will be used to develop the game and interface, and what the system flow will be like from a high level user point of view.

Document Organization

Audience

This document will be used by our team to help formulate a more exact process of implementing this project. It will also be used by next year's senior design team as they prepare to add more theory games to our interface or improve our parkinson game. Our advisor and professor will also be reviewing this document.

Team: May1304

Requirements

Our client has given the following functional requirements:

1. The system shall track moving objects to see if the patient hit them.
2. The cognitive load placed on the patient during an exercise must be low.
3. The system must provide performance based feedback to the patient.

The following are additional requirements that we believe will aid in the completion of the project:

1. The system will provide patient data to the client.
2. Exercise data will be transmitted to a database.
3. The system will include a web interface for data delivery to researchers.

Our non-functional requirements follow:

1. The patient data must be stored securely.
2. The system needs to remain stable throughout an exercise session.
3. The exercise system needs to be extensible.

Design Overview

This system will comprise of four main areas ….

1. The game
2. Client interface
3. Caregiver web interface
4. Data repository.

The game

The game will be programmed using the Microsoft Kinect to track patients movements. To do this we will be using the following.

- Microsoft Kinects for Windows SDK
    - Hardware requirements for PC:
        - 32 bit (x86) or 64 bit (x64) processor
        - Dual-core 2.66-GHz or faster processor
        - Dedicated USB 2.0 bus
        - 2 GB RAM
- XNA Game Studio 4.0
- Microsoft Visual Studio 2010
- Maybe adding to this as we begin development.

Team: May1304

This game's goal is to be used a therapeutic exercise of parkinson's patients. For it to be effective we will have users make quick movement to grab falling objects (this according to our client for the project Dr. Smiley-Oyen). The user will score points for grabbing or catching these falling objects. The falling objects will not fall randomly as this will allows researchers of parkinson's to easily observe if a patient's movements are improving by viewing that data for multiple attempts the patient had.

Patient interface

The client interface is where the game will be plugged into. It will also contain other options such as a planner in which a caregiver can plan what games the user is to play on certain days. The objective of the client interface is to make the system modular, so in the future other teams with this project can add more games easily. Creating a marketplace of therapeutic exercises. The client interface will communicate the game movement data to the 'Data repository' where it can be read back to the 'Client interface' or 'Therapy clinic web interface'.

Caregiver web interface

The mission of this web interface is to allow a caregiver of a patient to be able to log into the system from anywhere and look at game data for their patients. This web interface will pull the patient data back from the data repository. The caregiver will also be able to schedule game sessions on a patients calendar. We also assume that our users with parkinson's will be elderly and most likely won't have a electronic calendar so we will provide a feature to print that calendar out for the patient to take home with them. This interface will really be used as a tool for the therapy to track patient game information.

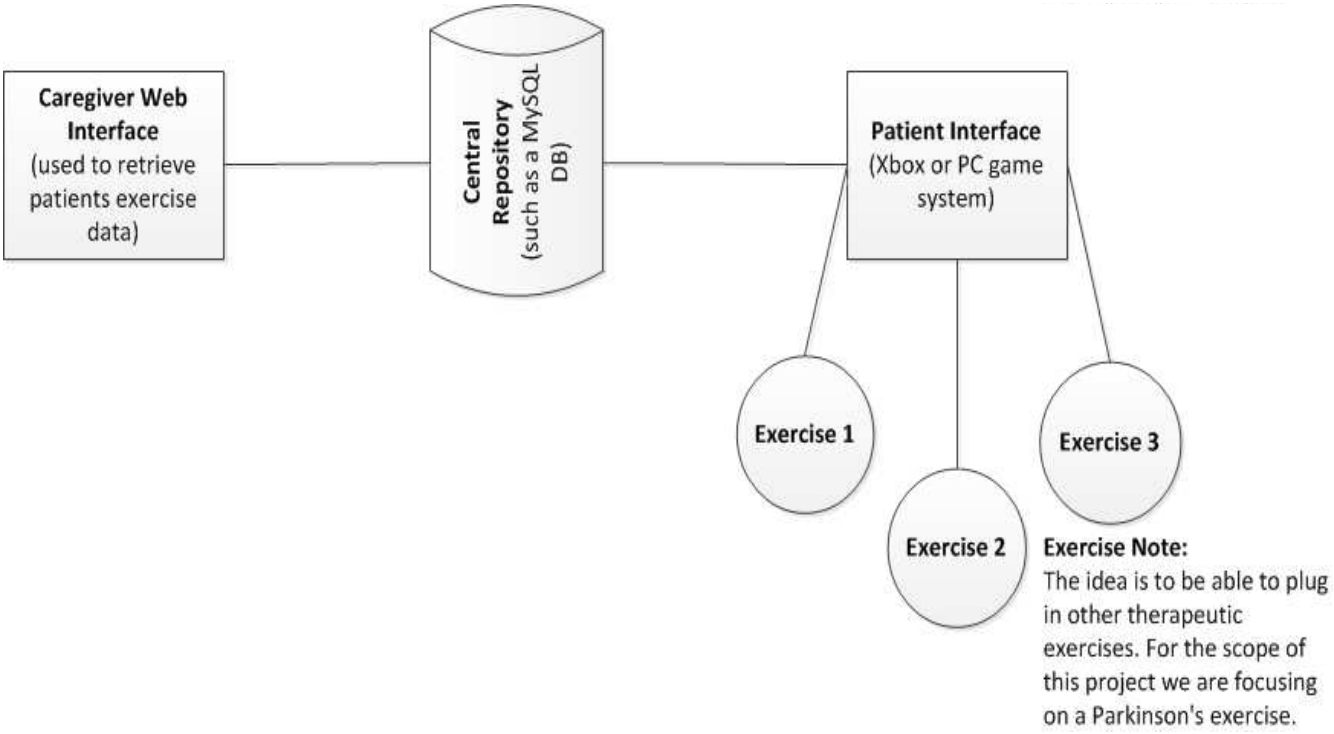
Data repository

The data repository will host all user data. This will include personal information, game tracking data from kinect, and other user account data. So the schema of this database will be very important in order to provide quick retrieval. The security of this database will also be a top priority as we cannot allow unauthorized people to view patients confidential data. So will have be following the Data Encryption Standard to ensure this.

Below summarize the above into a flowchart to show the design overview.

Figure 1

Team: May1304



Standards

When the software is finalized it will no doubt have the ability to produce a kind of portfolio for the patient's clinic. Because such sensitive information is at risk it is important to establish a standard for protecting that data between the recording (when the patient is active with the software) and accessing (when the patient's clinic needs to view the data).

Such standards involved in the protection of an individual's physical or mental health records (referred to as protected health information or PHI) are the HIPAA and HITECH standards. The records which get involved with the software could include anything from health progress to name and address or even social security numbers. It will be important to secure this information that follows a well known standard to not only keep the patients records safe, but help in supporting security claims for the software.

From the HIPAA and HITECH documentaiton provided by Amazon Web Services (http://d36cz9buwru1tt.cloudfront.net/AWS_HIPAA_Whitepaper_Final.pdf): "HIPAA's Privacy Rule restricts uses and disclosures of PHI, creates individual rights with respect to their PHI, and mandates administrative requirements. Among other requirements, the privacy rule requires a covered entity to reasonably safeguard PHI from any intentional or unintentional use or disclosure that is in violation of the requirements of HIPAA." Even if the software becomes

internal within the clinic it is designed for, there is still the importance of establishing rights between the client and patient. Who will be accessing this information and how the information will be accessed are also important topics. In short, while the software (the actual user interface, hardware used, etc) may not necessarily follow any standards, it is important to consider the data that will be generated from the software. The HIPAA and HITECH standards are such that can be followed to protect a patient's data.

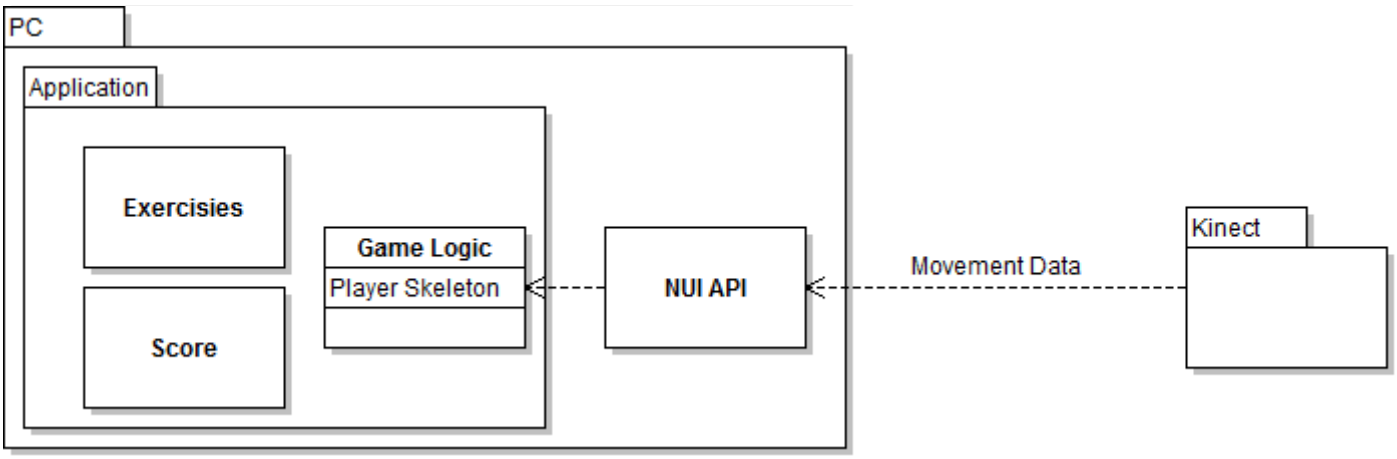
We will also be using “Standards for the Practice of Therapeutic Recreation” provided by The American Therapeutic Recreation Association. (http://atra-online.com/displaycommon.cfm?an=1&subarticlenbr=42) These standards are designed to deliver quality therapeutic recreation. Through processes such as assessments and treatment planning.

Application Architecture

This section will define the various components and their interactions within the context of the whole system. The components this section will outline are the game, patient application, caregiver web interface, and data repository.

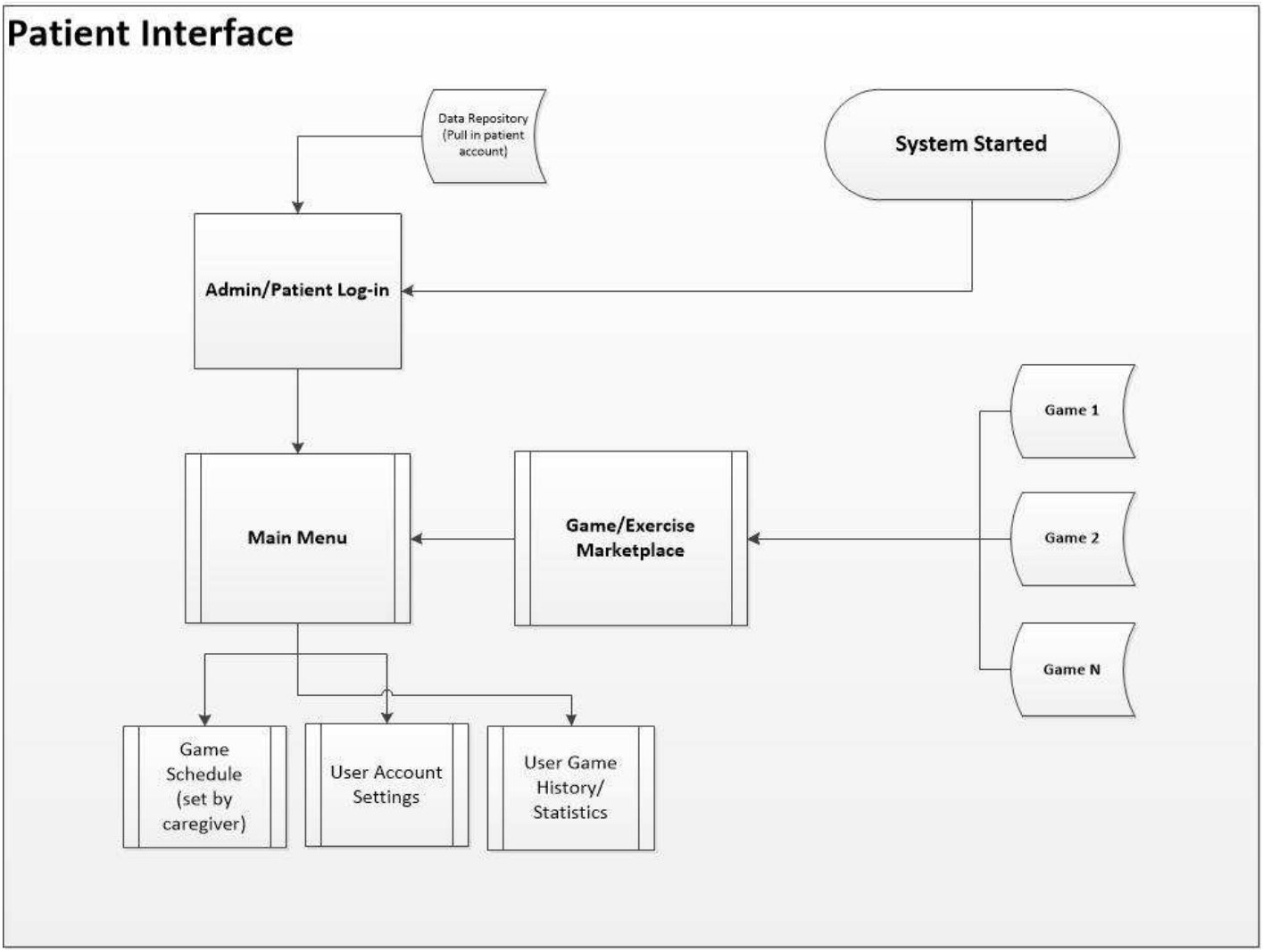
The Game (Figure 2)

Team: May1304

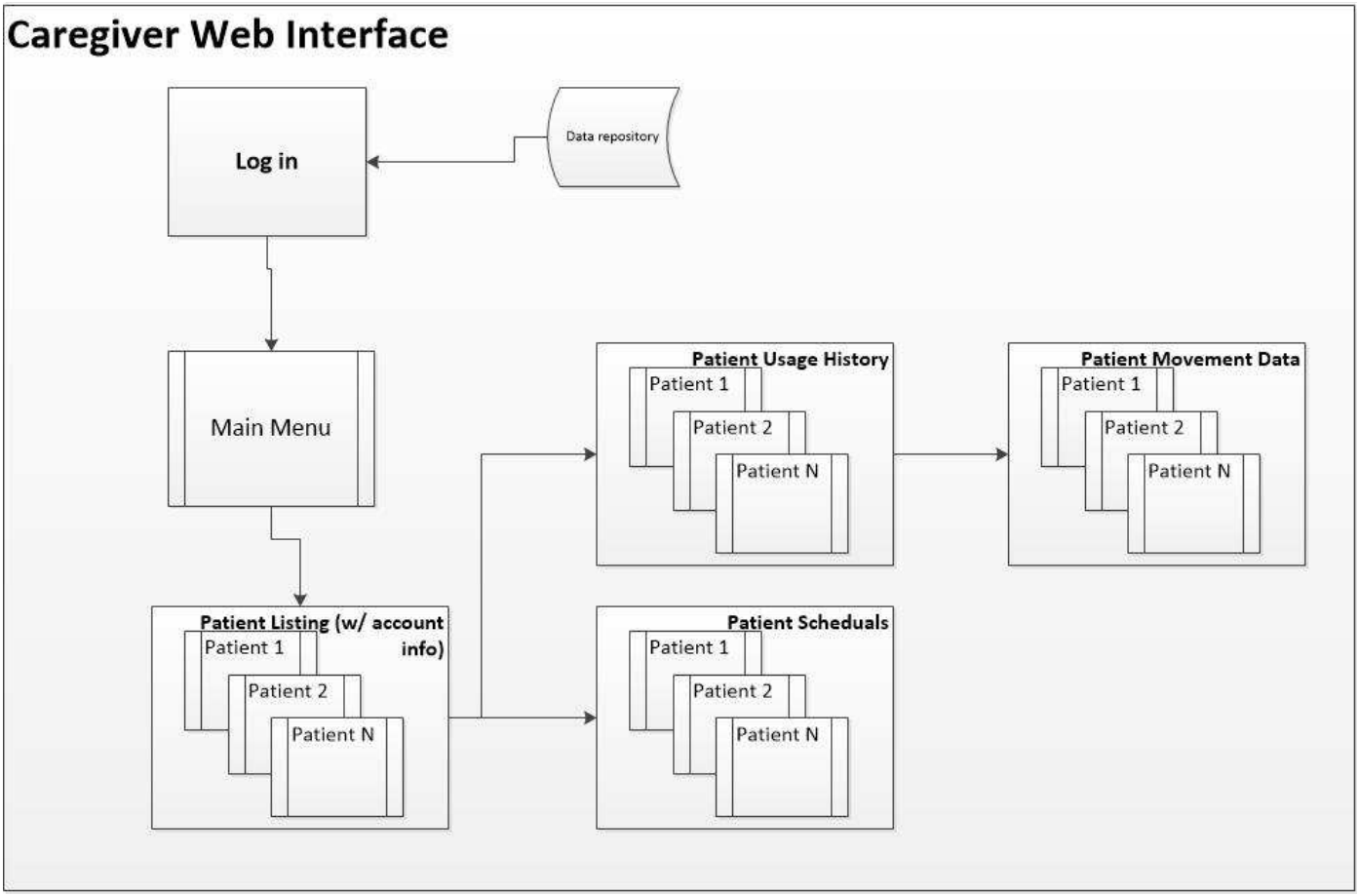


Patient Interface (Figure 3)

Team: May1304



Team: May1304



(Figure 3: Caregiver Web Interface above)

Data Repository

For detail on the data repository refer to the “Database Architecture” section.

Summary

If we put these four components together we see a overall flow that is shown in figure 1 in the design overview section.

Team: May1304

Application Implementation

Server

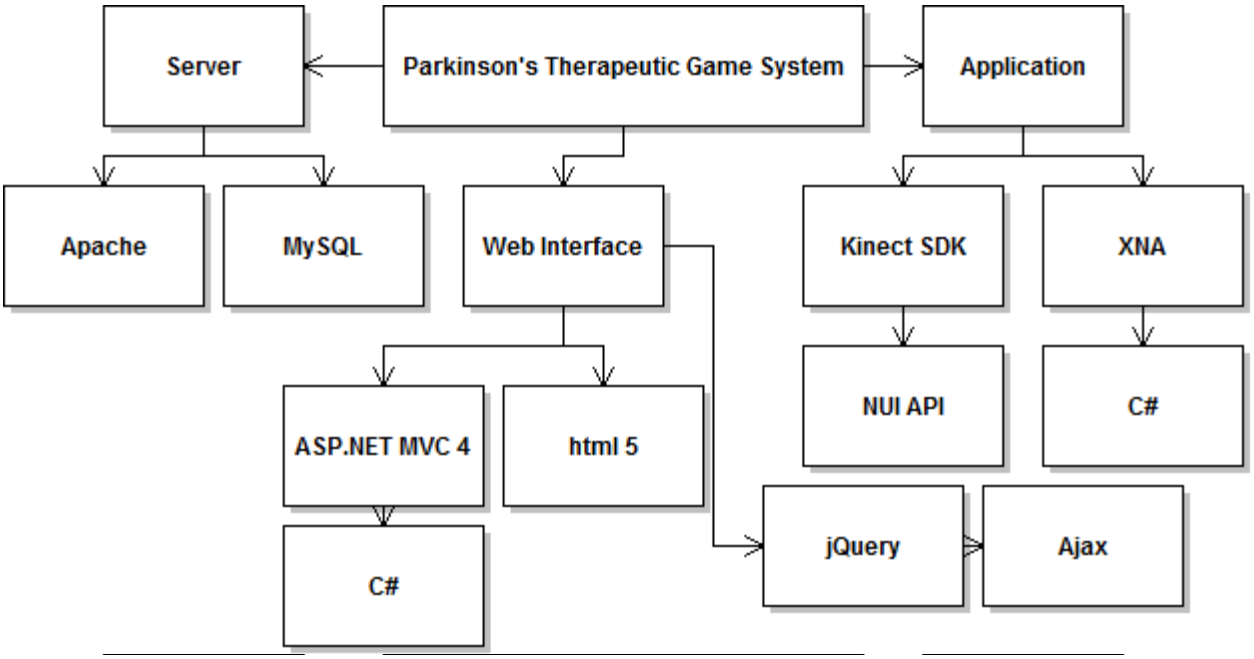
We will be using this server to host our web interface and central database. Our server will be running Apache. The server will also host our central database. The database will be using MySQL.

Web Interface

This is the portal for researchers to view the data we have collected. The site will be built using HTML5, jQuery, and Ajax. We will also be using the ASP.NET MVC 4 framework and C# to build the web applications. We will be using Visual Studio 2012 when building this.

Application:

The application itself will be built using the XNA game development framework. We will be getting input from the Kinect via the Natural User Interface (NUI) API that is provided with the Kinect SDK. We will be building the application using Visual Studio 2012 and C#.



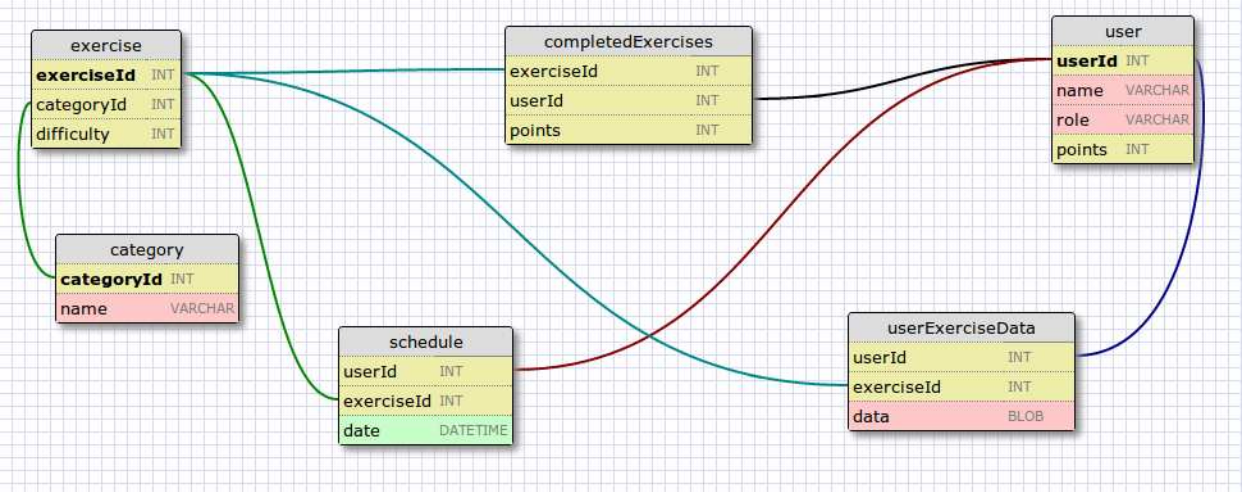
Team: May1304

Database Architecture

The project will use a database to store patient information, exercise data tracking information, a schedule of exercises as determined by the physician, and exercise results for future review by physical therapists. Other information that needs to be stored will be discussed with the client(s) at a later date. As such, this database architecture design is not final.

For the database backend, the project will use MySQL.

Data Model



Data Model Explained

Exercises will be stored in the “exercise” table, each with a unique identifier. Exercises will be associated with a category, stored in the “category” table, which identifies which exercise category each exercise will belong to.

Users will be stored in the “user” table, each with a unique identifier, a name, a role (either a patient or a caregiver), and the amount of points they have collected. A user’s exercise data for each exercise will be stored in the “userExerciseData” table, each with a userId associated with the user, an exerciseId associated with the exercise, and the data representing a set of points the user generated throughout the exercise. This set of points will allow caregivers to resimulate the patient’s movements throughout the exercise in order to more effectively study and draw conclusions concerning the patient.

Caregivers will also have the ability to schedule exercises for their patients, stored in the “schedule” table. Each scheduled exercise is identified by a unique user and exercise identifier, as well as a date on which the exercise needs to be completed.

Assumptions and Constraints

In the construction of this project we have made the following assumptions:

- Both Kinect for XBox and Kinect for PC will work with the code base.
- Kinect technology will be commonplace for the lifetime of the project.
- The Kinect will give accurate enough data to be useful in research.

These assumptions will impact the feasibility and longevity of the project. The ability of clients to use the project depends on the availability of the Kinect. Additionally, the Kinect comes in two varieties. The Kinect for XBox is much more common as of this point. The most critical assumption is the last one. One of the focuses of the client is gathering research data. The system has yet to be tested in a clinic and we assume that the system will function in the intended installation setting.

Additionally we have to operate under the following constraints:

- The software must have a low learning curve.
- The software must be able to be installed in a variety of locations.
- The cost must be kept low relative to standard therapeutic supplies.
- Data gathering requires an internet connection.

As stipulated by the client, the software must be able to be used by people experiencing different stages of Parkinson’s disease. As such, the exercises must have a low level of complexity and must not require remembering large amounts of information. The goal of this project is to increase the availability of therapy for Parkinson’s disease and provide more data for researchers to use. For this to happen the project must be able to be installed in a variety of locations for wide distribution. Also related to distribution the cost must be kept low so it is more accessible to clinics and possibly individuals (at some point in the future). Lastly any user of the project must have an internet connection for automated data gathering.