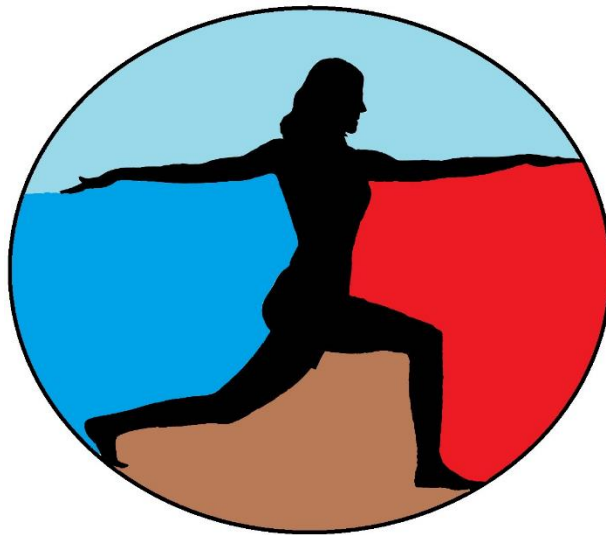# **E**lemental **K**inection

Requirements

Version 2.1

2 May 2016

Revision History

All revision history listed below.

Version	Change Summary	Date
1.0	• Initial Draft	10 November 2015
1.1	• Updated use cases • Fixed formatting • Updated references	17 November 2015
1.2	• Changed use cases and prototype order to better fit actual progression • Updated admin and therapist use cases to be more accurate • Fixed formatting	18 November 2015
2.0	• Made changes in content to more accurately reflect current projects functionality • Updated System Architecture • Updated Use Case Models to more accurately reflect current project functionality	22 April 2016
2.1	• Minor formatting	2 May 2016

Revision Sign Off

The following asserts that all team members have read the document and asserts that the information contained within this document is complete and correct.

Name	Signature	Date
Samuel Kent		
Jack Kempner		
Nathan Johnson		
Aakash Tyagi		

Table of Contents

1   Introduction

1.1 Purpose
This document contains the requirements of the Elemental Kinection Kinect desktop application, website and database.

1.2 Intended Audience
The intended audience of this requirement document includes the development team, the faculty advisor/client of the project and any other interested parties as they arise.

1.3 Scope and Objectives
This project's objective is to create a set of programs for physical therapists and their patients. Therapists will be able to conduct therapy sessions remotely with the use of the Kinect v2 and a website. Using these, therapists will be able to upload new exercises and assign exercises for a patient to complete in a session. The patients will have access to an engaging desktop application that automatically retrieves sessions for the patient to perform and sends the results of those sessions back to the therapist.

1.4 References
[1] https://dev.windows.com/en-us/kinect/hardware
[2] http://mobihealthnews.com/25281/eight-ways-the-microsoft-kinect-will-change-healthcare/
[3] http://mobihealthnews.com/22351/slideshow-7-startups-using-microsoft-kinect-for-online-physical-therapy/
[4] Roy, A.K.; Soni, Y.; Dubey, S., "Enhancing Effectiveness of Motor Rehabilitation Using Kinect Motion Sensing Technology," in *Global Humanitarian Technology Conference: South Asia Satellite (GHTC-SAS), 2013 IEEE,* pp.298-304, 23-24 Aug. 2013

1.5 Overview
Section 2 – Basic description of the project including its functions
Section 3 – System architecture is modeled
Section 4 – Details of external interfaces
Section 5 – List of functional requirements
Section 6 – List of nonfunctional requirements
Section 7 – Glossary of terms
Appendix A - Use Case Models
Appendix B - Prototype views

2 Overall Description

2.1 Product Perspective
Elemental Kinection offers a unique take on tele-rehabilitation using the Kinect. There already exist applications on the market that provide therapist with the ability to prescribe and monitor therapy sessions remotely. Elemental Kinection improves on this model by introducing the ability for therapists to dynamically add exercises to the application without the need for programmer assistance. It leverages the machine learning found in Microsoft Visual Gesture Builder to allow adding of new exercises in a way that is more intuitive and less technical than the traditional heuristic approach. Combining this feature with the standard features of tele-rehabilitation applications, such as remote assignment and monitoring, Elemental Kinection aims to introduce an application that is both engaging for patients and dynamic for therapists.

2.2 Product Functions
Elemental Kinection is made up of two distinct applications. The first is a desktop application that interfaces with the Kinect and is located in the patient's residence. This application receives the user's therapy session online, guides the user through the session and records the results to then be uploaded online. The user shall also receive feedback on their performance of the exercises in real-time. The second application is web-based and provides a portal for the therapist to upload new exercises and exercise assignments to a database as well as viewing session results from patients.

2.3 User Characteristics
Therapist - Elemental Kinection shall be usable by a therapist with minimal technical knowledge and access to the internet.

Patient - The patients using Elemental Kinection shall be able to navigate the desktop application easily and possibly be able to perform some simple file management.

2.4 Constraints
- Time Constraints:
  - Project deadline is April 2016
- Kinect Limitations:
  - Maximum capture rate of 30 fps and has a harder time detecting faster movement
  - Kinect range of detection is .4m to 4.5m
  - Exercises that occlude joints are not supported
- Data storage
  - Online database has limited amount of storage space
- Computer Constraints:
  - USB 3.0 port or higher
  - Screen with minimum of resolution of 1360x768
  - Computer must be running Windows 8, 8.1, or greater

2.5 Operating Environment

The therapist shall be able to access the portal from any computer with internet access and an internet browser. The user should be able to set up the Kinect and application in their home.
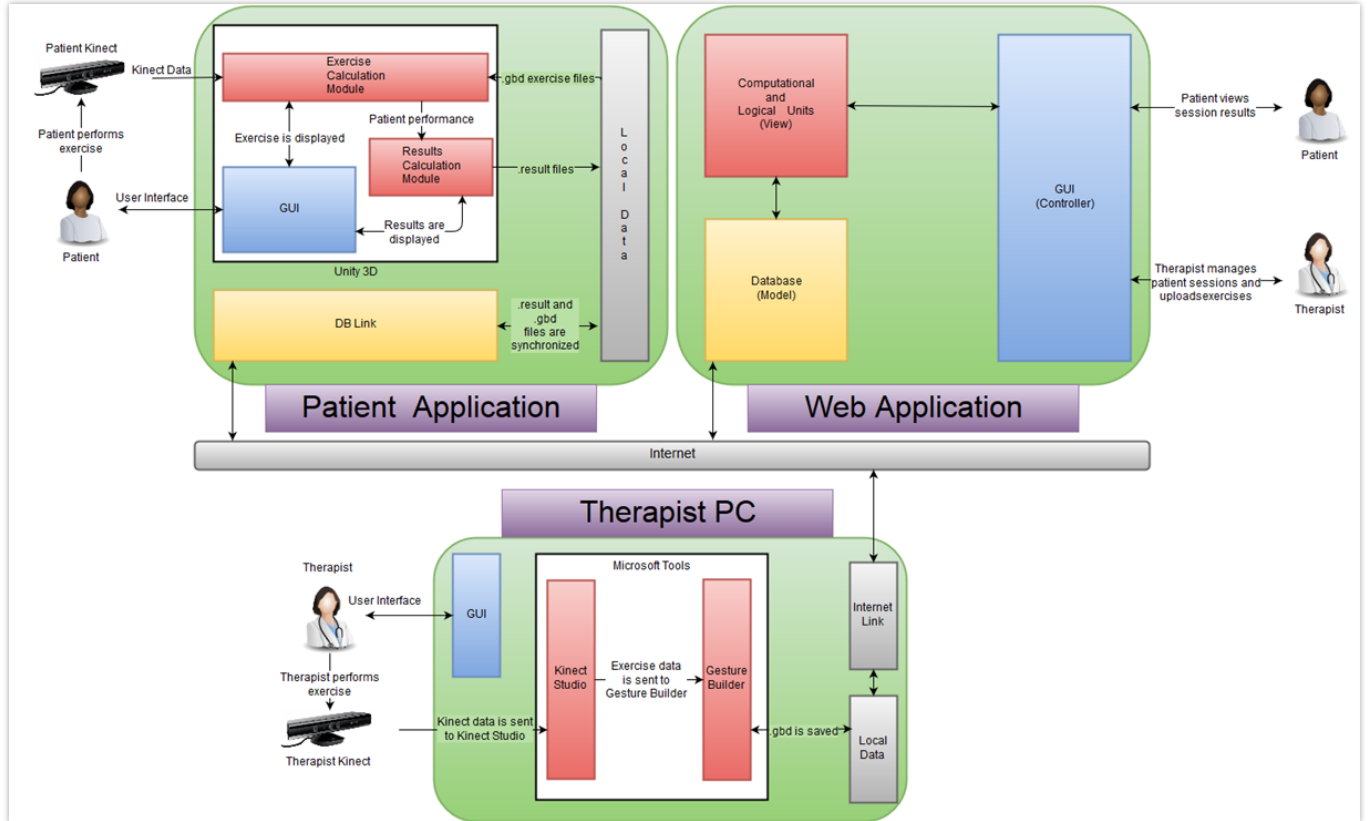
2.6 Assumption and Dependencies

It is assumed that the patient has a computer that is capable of running the Kinect v2 and is in communication with a therapist.
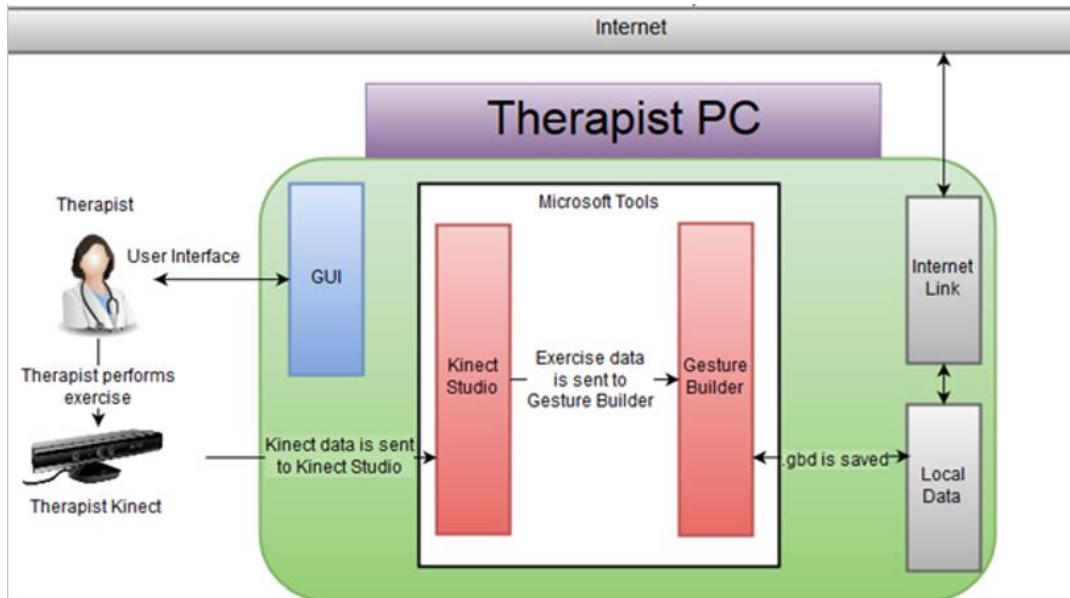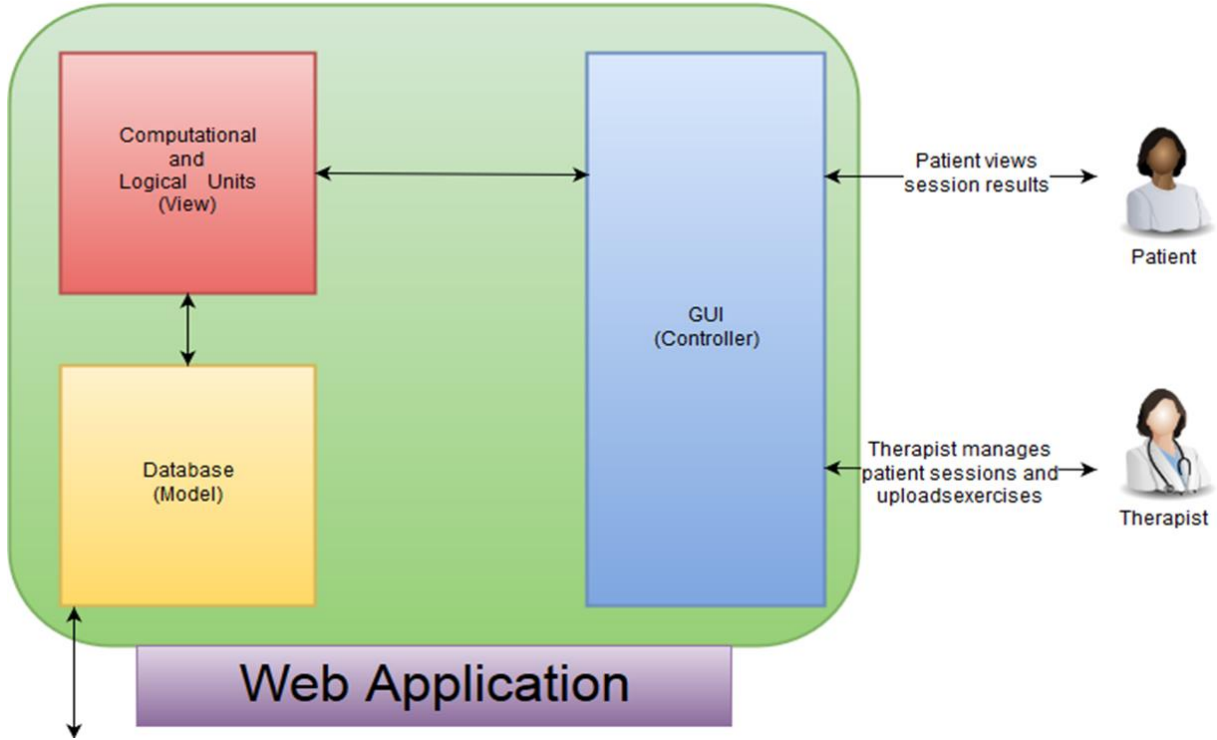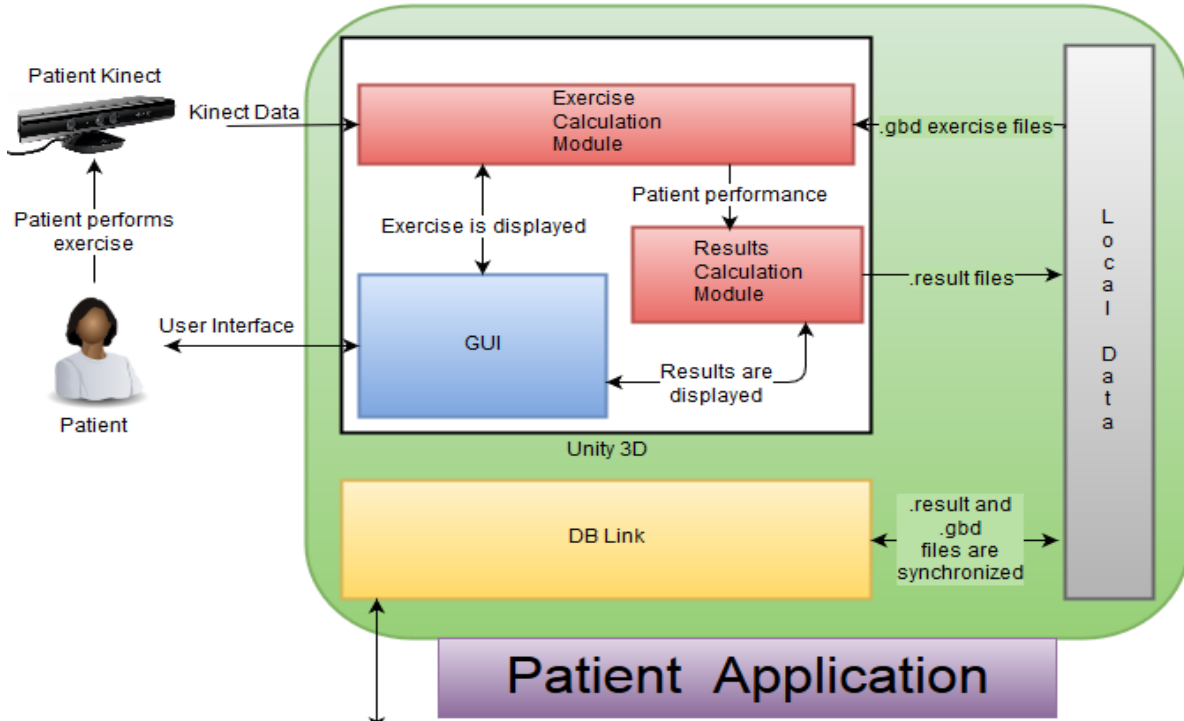
3   System Architecture

3.1 Complete View

3.2 Therapist Close-up

3.3 Web Application Close-up

3.4 Patient Application Close-up

4 External Interface Requirements

4.1 User Interfaces

Patient – The patient shall have an interface that allows the user to load exercise programs from the web. The interface should then allow the patient to navigate the application with an intuitive UI.

Therapist – The therapist shall have a web interface for viewing results of patients, uploading exercises and assigning therapy sessions to patients.

4.2 Hardware Interfaces

A desktop PC is necessary for accessing the web interface and the database. The Kinect application shall run through a PC with a monitor of appropriate resolution. Finally the Kinect is an important hardware interface between the user and the application.

4.3 Software Interfaces

Microsoft Visual Gesture Builder is an interface that utilizes machine learning to generate new exercises in the form of gesture database files. Additionally a web browser shall be required to interface with the website. The Desktop application will provide the interface between the patient, the Kinect and the database.

4.4 Communication Interfaces

The Kinect API communicates between the Kinect and the patient application. The communication between the web interface and the database is constructed with Python. The Desktop application communicates with the web application through the internet.

5   Functional Requirements

5.1 General Requirements
- Therapists shall be able to create new exercises for the application
- Therapists shall be able to prescribe therapy sessions remotely
- Therapists shall be able to view results of therapy sessions remotely
- Patients shall be able to obtain therapy sessions remotely
- Patients shall be given instruction for exercises by the Kinect application
- Patients shall receive real-time assessments of their therapy

5.2 Kinect Application Requirements
- The patient shall be able to navigate the menus of the application with mouse and keyboard
- The application shall be able to receive an exercise from the web
- The patient shall be guided through a description of how to perform the exercise
- The patient shall receive real-time feedback on accuracy of exercise and number of repetitions
- The application shall be able to store the results of the exercise and upload them to the server

5.3 Database Requirements
- Each patient and therapist shall be assigned a unique ID.
- One-to-many relationship between therapist and their patients
- Database shall store therapy session results of each user
- Interactions with database shall be through the web application and the desktop application
- Database shall store and accept new exercise information

5.4 Web Application Requirements
- Each therapist and user shall have a unique login ID and password
- Therapist shall be able to upload therapy sessions
- Therapist shall to upload new gesture recognition files
- Therapist shall be able to view past result of patients
- Therapist shall have functionality to add new patients to the system
- Patients shall be prohibited from altering the database

6 Non-functional Requirements

6.1 Product Requirements
- Kinect application shall be able to track exercises based on a confidence interval of 0.75 to 1.0
- Results shall be displayed in a graphical representation of completed reps and exercises
- The web application and database shall have a response time of fewer than 5 seconds
- The Kinect application shall have a response time of fewer than 5 seconds
- Patients shall be able to use Kinect application with our provided instructions manual

6.2 Organizational Requirements
- The Kinect v2 is the compatible hardware version of the Kinect used in this application
- A therapist is required to set up an account for the user and prescribe sessions
- An Admin is required to set up new therapist accounts

6.3 External Requirements
- The database shall remove, when possible, personally identifying information
- Therapists shall be able to effectively learn gesture builder through online manuals and walkthrough videos

7   Glossary of Terms

Amazon Web Services – A secure cloud services platform for compute power, database storage and content delivery.

Django - Django is a high-level Python Web framework that encourages rapid development and clean, pragmatic design.

Kinect Studio – Kinect Studio is a utility application that you can use to preview Kinect sensor array data, record and play eXtended Event File (XEF) files, control the timeline position, and select 2D or 3D views. Kinect Studio APIs enable you to develop custom tools, to record and play back body data using XEF files.

Kinect v2 - A motion sensing input devices by Microsoft for PCs. Based around a webcam-style add-on peripheral, it enables users to control and interact with their console/computer without the need for a game controller, through a natural user interface using gestures

Kinect for Windows SDK 2.0 – A set of developer tools, tutorials, and an API reference put out by Microsoft for the development of Kinect v2 on Windows 8, 8.1 and Windows 10.

MySQL – A popular Open Source SQL database management system, developed, distributed, and supported by Oracle Corporation

Nginx - A free, open-source, high-performance HTTP server and reverse proxy, as well as an IMAP/POP3 proxy server. It provides load-balancing, security controls and other monitoring tools.

Slack – A collaboration tool that allows for instant messaging, file sharing and other customizable plug-ins.
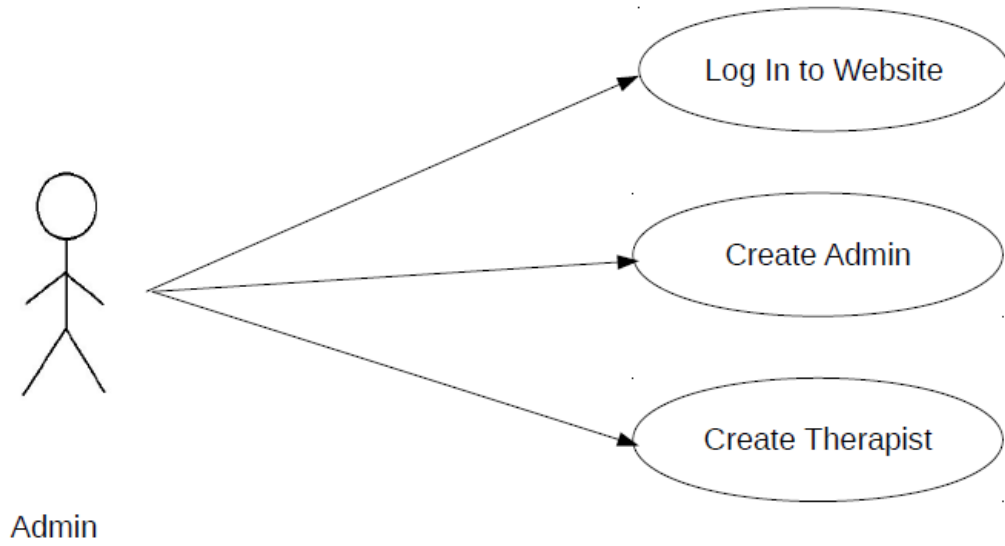
Telerehabilitation- the delivery of rehabilitation services over telecommunication networks and the internet.

Unity - a cross-platform game engine developed by Unity Technologies and used to develop video games for PC, consoles, mobile devices and websites.

USB 3.0 - The third major version of the <u>Universal Serial Bus</u> (USB) standard for interfacing computers and electronic devices. Among other improvements, USB 3.0 adds the new transfer rate referred to as *SuperSpeed USB* (SS) that can transfer data at up to 5 Gbit/s (625 MB/s), which is about ten times as fast as the <u>USB 2.0</u> standard.

Visual Gesture Builder - Visual Gesture Builder (VGB) generates data that applications use to perform gesture detection at run time. By using a data-driven model, VGB shifts the emphasis from writing code to building gesture detection that is testable, repeatable, configurable, and database-driven.
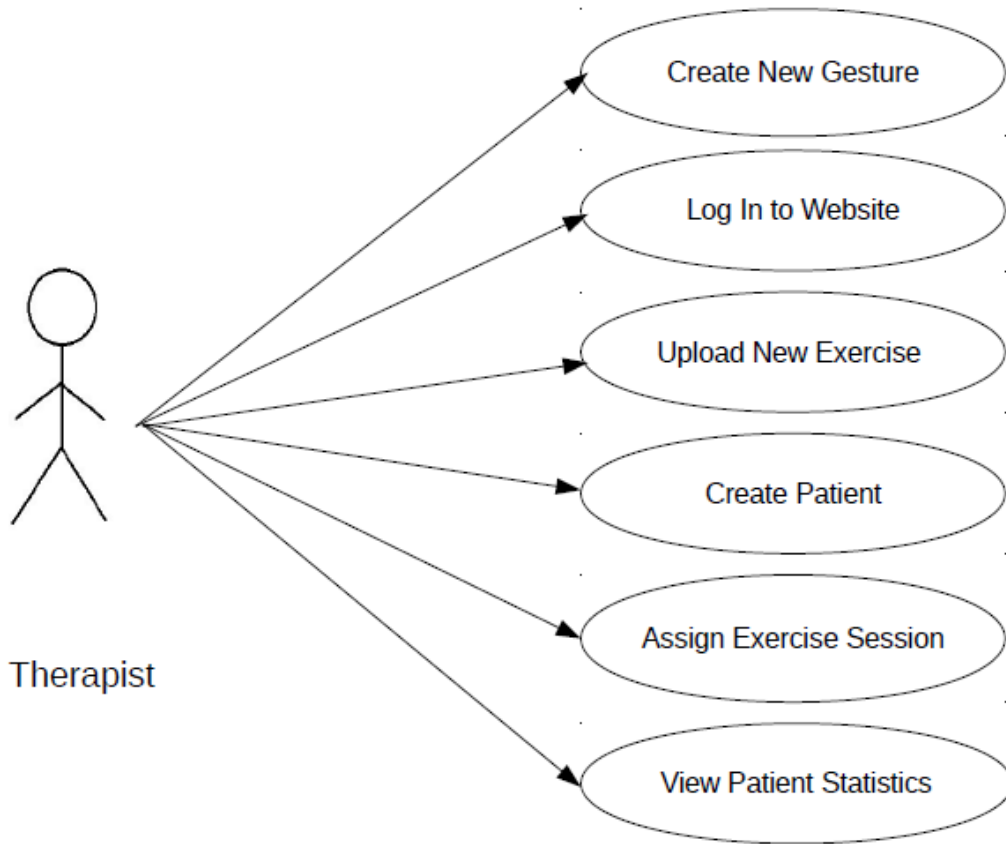
Appendix A: Use Case Models

Use Case	Log In to Website
Actors	Admin
Description	Admin provides authentication to the website.
Data	Admin user name and password
Precondition	• Admin has an account registered and is connected to the internet
Stimulus	Admin enters the EK URL
Response	• Enter username and password • Press "login" • Username and password are compared to what's in the database. • If valid, user is taken to the home page • If invalid, prompted for data again
Comments	

Use Case	Create admin
Actors	Admin
Description	Admin creates a new admin account.
Data	New account's information
Precondition	• The admin must be logged in
Stimulus	Admin selects "add an admin" on the admin homepage
Response	• Admin enters the information for the new admin account • The new account's username and password are saved to the database
Comments	

Use Case	Create therapist
Actors	Admin
Description	Administrator creates a therapist account, allowing them to create patient accounts, update/upload exercises, and assign sessions
Data	Therapist information
Precondition	• Admin must be logged in
Stimulus	Admin selects "add a therapist" on admin homepage
Response	• Admin inputs the necessary therapist information • Admin selects "create a therapist" • New therapist account information is saved to the database.
Comments	

Use Case	Create New Gesture
Actors	Therapist
Description	The therapists defines new exercises for storage in the database.
Data	.gdb (gesture build file)
Precondition	• Therapist has Visual Gesture Builder, Kinect SDK, and Microsoft Kinect
Stimulus	Therapist runs Visual Gesture Builder
Response	• The therapist performs the gesture in front of the Kinect • The therapist selects, in Visual Gesture Builder, which points in the recorded movements show the correct gesture • The therapist saves the clips builds the .gdb file • The .gdb file is saved to the therapist's computer
Comments	

Use Case	Log In to Website
Actors	Therapist
Description	Therapist provides authentication to the website.
Data	User name, Password
Precondition	• Therapist has an account registered and is connected to the internet
Stimulus	Therapist enters EK URL and navigates to the website
Response	• Enter username and password • Press "login" • Username and password are compared to what's in the database. • If valid, user is taken to the home page • If invalid, prompted for data again
Comments	

Use Case	Upload New Exercise
Actors	Therapist
Description	Therapist selects type of exercise to upload and selects .gdb file to upload
Data	.gdb file
Precondition	• Therapist is logged in • Therapist has created a gesture using gesture builder, and has the .gdb file stored locally on their computer • Therapist is on Exercise list screen
Stimulus	Therapist clicks on Add Exercise
Response	• Therapist enters exercise name, category and a short description • Therapist clicks on "choose file" and selects .gdb file • Therapist clicks "save exercise" • File is saved to the website
Comments	

Use Case	Create Patient
Actors	Therapist
Description	Therapist defines patient account parameters, enabling a patient to log in to their account from the application
Data	Patient username and password
Precondition	• Therapist is logged in and has a patient in contact.
Stimulus	Therapist navigates to Patient List screen and hits add patient button
Response	• Therapist enters username and password for patient. • Therapist shall enter the expected start and end date of the patient's therapy. • Patient account data is saved to the database
Comments	

Use Case	Assign Exercise Session
Actors	Therapist
Description	Therapist assigns a selection of exercises to be performed by patient. These are saved in the database and downloaded by the patients application
Data	Therapy sessions
Precondition	• Therapist has a patient • There is at least one exercise in the database • Therapist is on the View Session screen
Stimulus	Therapist clicks assign session
Response	• Therapist is brought to the Assign Session screen • Therapist enters information for each exercise and adds them to session • Therapist enters session due date • Therapist can link certain sequences of exercises together • Patient therapy session is saved to the database
Comments	

Use Case	View Patient Statistics
Actors	Therapist
Description	Therapist selects a patient from Patient List page and sees session stats. Patient's results file is pulled and graphs created from this data
Data	.txt results file
Precondition	- Therapist is logged in - Therapist is on the patient list page - Therapist has a patient who has completed at least one exercise
Stimulus	Therapist selects a patient on the Patient List page
Response	- View Patient page is opened - Webpage shows patients therapy results - Results can be sorted using dates and exercises - Results are shown according to reps completion and time taken to finish exercises
Comments	

Use Case	Log on
Actors	Patient
Description	The application authenticates the patient and proceeds to the main screen after synchronizing with the main database.
Data	User name, Password
Preconditions	- Kinect application installed on computer. - Patient has registered a username and password with therapist. - Patient has a computer capable of running the Kinect application. - Patient has a Kinect.
Stimulus	Patient starts the desktop application.
Response	- Patient inputs a username and password. - The application checks the internet connection. - If there is internet connection, the application checks the username and password against what's stored in the online database. - If the username and password is correct, according to the online database, the application syncs results and therapy sessions with the main database and directs the patient to the main page of the application. - Else, the patient is prompted to enter a correct username and password and the application remains on the logon page.
Comments	

Use Case	Complete Therapy Session
Actors	Patient
Description	Patient selects and performs exercises in the currently assigned therapy session.
Data	.gdb exercise files, online database session table
Preconditions	• Patient is successfully logged into the application and is present on the session select screen.
Stimulus	Patient logs in successfully.
Response	• Application displays a screen displaying the current, active session. • If this is either already completed or not available, the application will inform the patient that all current sessions are either complete or expired. • Application checks the local list of .gbd files against the current active session. If a .gbd file is found in the session that is not present in the local list, the application attempts to connect to the database of exercises and download the required .gbd file. • Patient selects an exercise from the current, active session. • Application displays the exercise screen. • Patient performs the exercise. • Application tracks each rep that the patient performs. • When the patient completes the exercise, how quickly the exercise was performed is recorded.
Comments	

Use Case	View Statistics
Actors	Patient
Description	Patient views overall progress by month in terms of repetitions completed and time take to complete exercises.
Data	Online database results table
Preconditions	• Patient is successfully logged into the application and is present on the session select screen. • Patient has completed at least one session on this computer. AND • Application has synced with the online database.
Stimulus	Patient clicks on the Stats button, selects month, type of result and exercise
Response	• Application selects all exercise results that match the selection for that month • Application displays the graph with the y-column being number of reps performed, or time taken for completion, and the x-column being the due dates of therapy sessions. • Application displays time taken in seconds or completed reps out of total reps over each point in the graph
Comments	

Use Case	Online Login
Actors	Patient
Description	Patient accesses therapy results via the website.
Data	Username, Password
Preconditions	• Patient has registered a username and password with therapist. • Patient has internet access.
Stimulus	Patient navigates to the website URL.
Response	• Patient inputs username and password. • The website checks these against the online database. • If the username and password are correct, the patient is redirected to the patient page. • If the username and password are incorrect, the patient is prompted to input a valid username and password.
Comments	
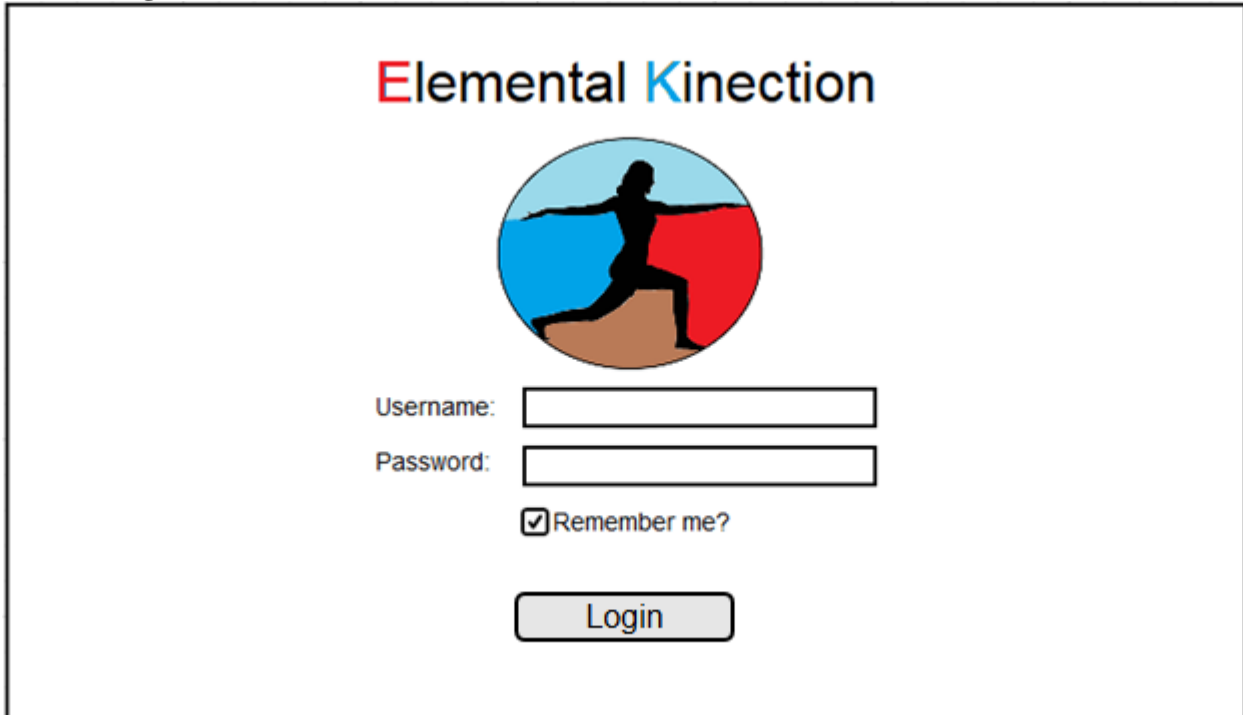
Use Case	View Results
Actors	Patient
Description	Patient views selected therapy results on the website.
Data	Online database
Preconditions	• Patient is successfully logged into the website.
Stimulus	Patient logs into the website.
Response	• Website selects all therapy session results stored in the database that is tagged with that patient's id and plots a graph. • If there are no sessions in the database, the website simply displays a blank graph and informs the patient that no sessions have been saved in the database. • Website displays the graph with the y-column being number of reps performed, time taken for completion and the x-column being the dates of therapy sessions completed. By default, the graph loads displaying reps. • Website highlights the specified month on the graph and highlights the number of reps performed, time, or score, depending on the setting the patient has chosen.
Comments	

Appendix B: Prototype views

Web Application Prototypes
Admin Login Screen

Login Button
        For admin → Admin Home Page

Admin Homepage

Welcome Admin XYZ

Add a Therapist   Add an Admin

Admin – Create a Therapist

Add a Therapist

Username: [username]

Password: [password]

First Name: [first name]

Last Name: [last name]

Workplace: [workplace]

[Create a Therapist]

Create a Therapist → Add therapist to database

Admin – Create an Admin

Add an Admin

Username: [username]

Password: [password]

First Name: [first name]

Last Name: [last name]

[Create an Admin]

Create an Admin → Add admin to database

Login Screen

Login Button

        For Patients   →   Patient Home Page

        For Therapists →   Therapist Home Page

Therapist Home Page

Patients:

▼ Username	▼ Start Date	▼ Completion Date
johnson	Nov. 03 2015	Mar. 03 2015

[Add a Patient]   [Manage Exercises]

Manage Exercises	→	Exercise List
Add a Patient	→	New Patient

Exercise List

All Exercises:

| Shoulder Touches |
| Reverse Flies |
| Left Arm Pendulum |
| Right Arm Pendulum |
| Left Hip Abduction |
| Right Hip Abduction |

Add a new Exercise

Name:

Category:
Arms ▼

Added By:

Date:

Description:

Add Exercise →   Go to New Exercise

New Exercise

Patient Home

Back

Exercise Name

Category

Description

Choose File

Save Exercise

Patient Home	→	Go to Patient List
Back	→	Go to Exercise List
Choose File	→	Upload .gdb file

Add New Patient

Back → Patient List
Create → Generate new patient account.

View Patient

[Patient Name]'s Exercises

Shoulder Touches

Reverse Flies

Left Arm Pendulums

Month:
August ▼

[Patient Name]'s Results

Sessions
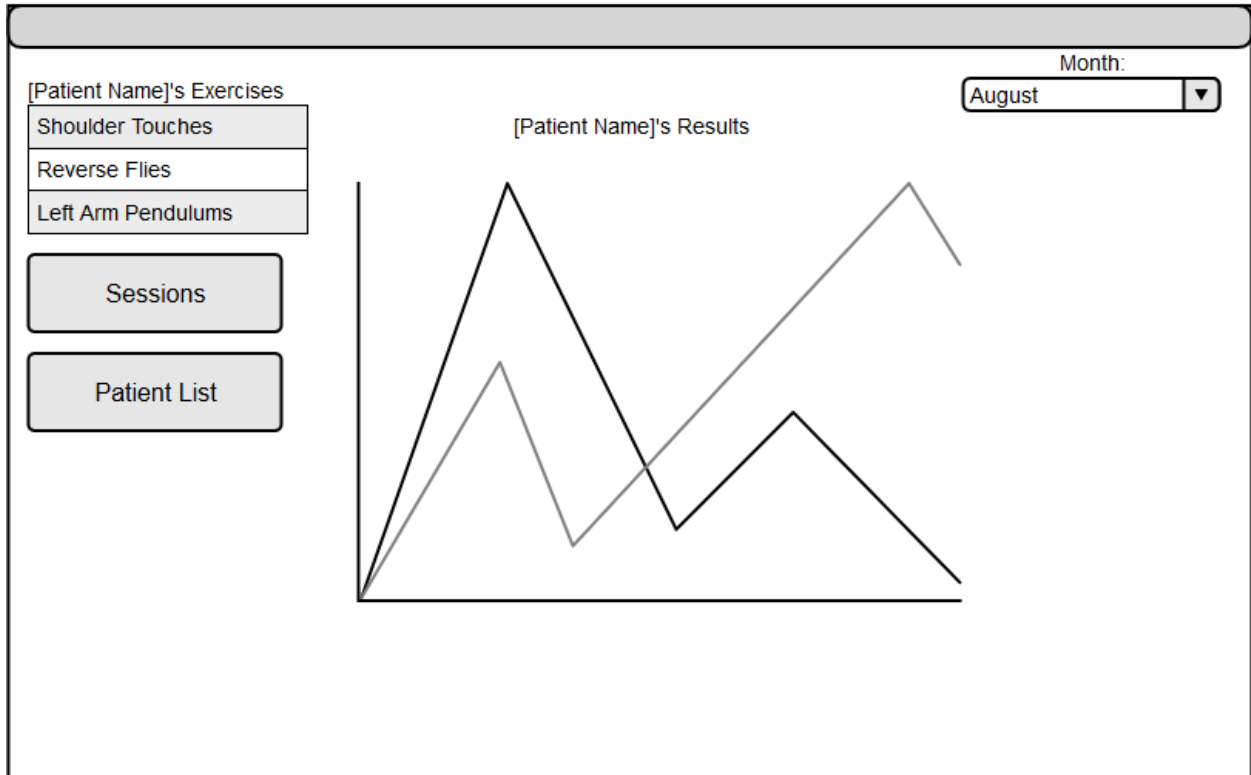
Patient List

Return   →   Patient List
Assign Session →   Assign Session

Assign Session

Welcome to Session Assignment

November 23, 2015

Shoulder Touches	10 reps	1:00
Reverse Flies	15 Reps	2:00

November 22, 2015

Shoulder Touches	15 reps	1:00
Reverse Flies	20 Reps	2:00
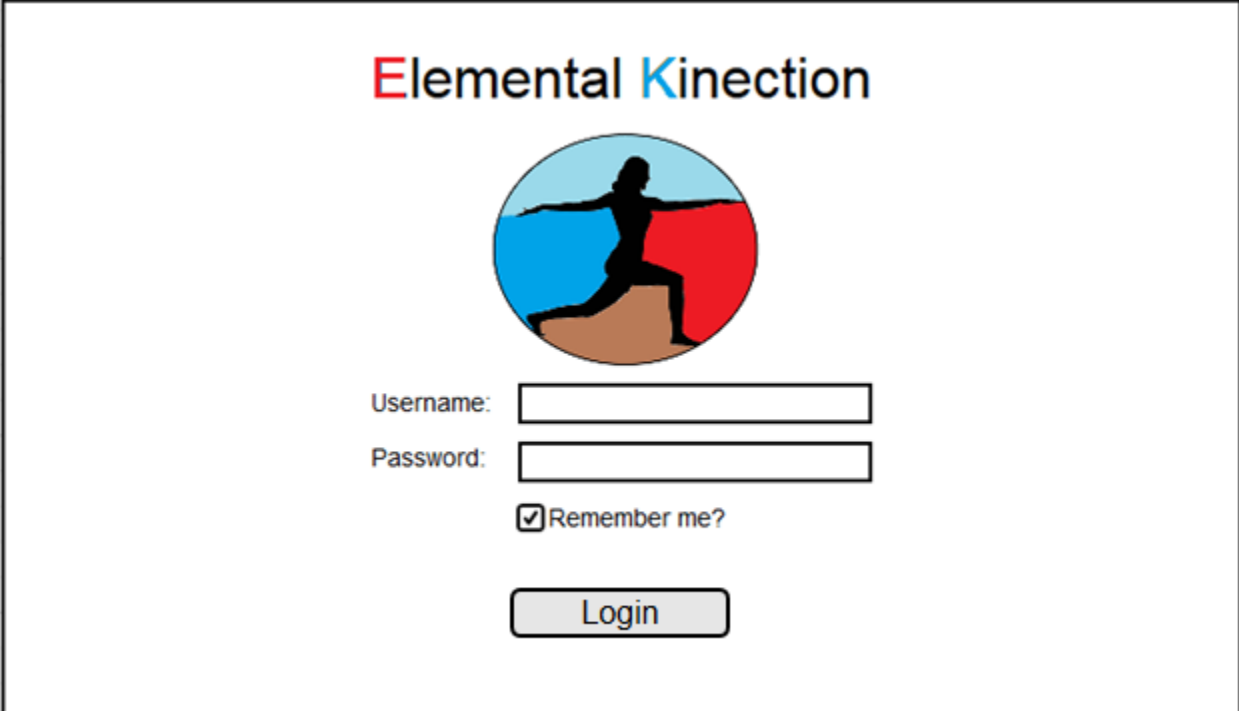
Create a Session   Back to Results

Patient Home Page

Month:
August ▼

[Patient Name]'s Exercises

Shoulder Touches

Reverse Flies

Left Arm Pendulums

Sessions

Patient List

[Patient Name]'s Results
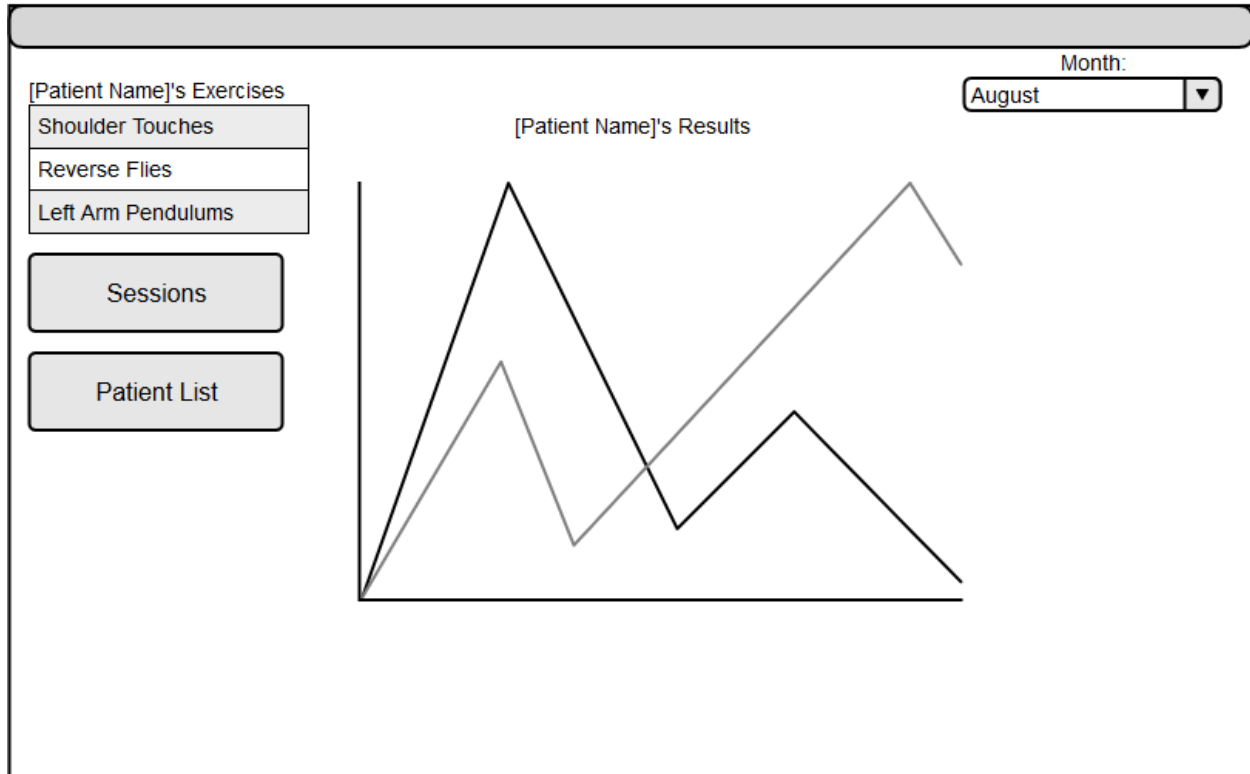
Reps   →   Show reps performed over time.
Time   →   Show time for exercises to be performed over time.
Score   →   Show score over time.

Kinect Application Prototypes
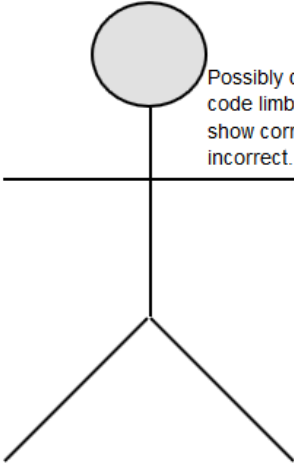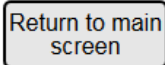**Login Screen**
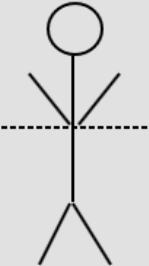
If connected to internet, goto main screen.

Kinect Main Screen
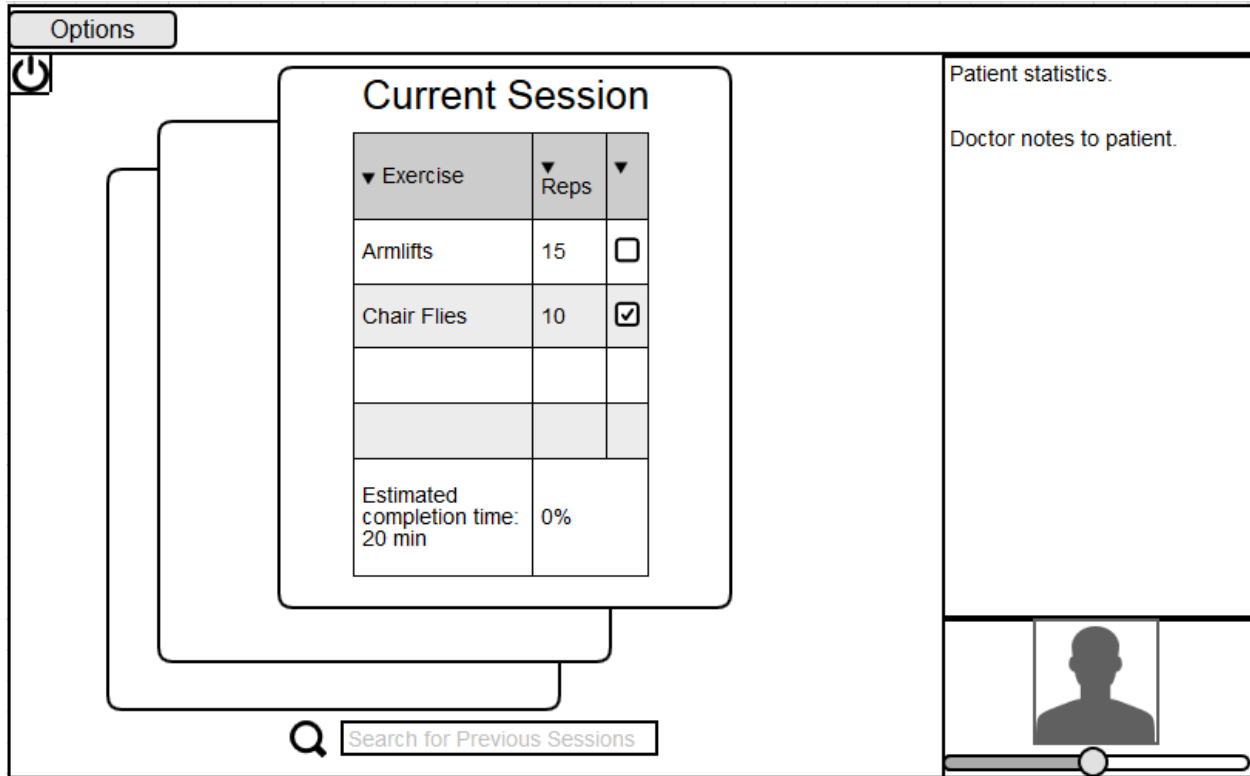
Options   →   Go to View Settings
Clicking on a previous card goes to view statistics.

Kinect Exercise Screen

Reps
remaining: 1

Possibly color
code limbs to
show correct or
incorrect.

Total Reps: 15

Time Elapsed: 14:12

Directions for the
exercise.

Return to main
screen

View Statistics

[Patient Name]'s Exercises

| Shoulder Touches |
| Reverse Flies |
| Left Arm Pendulums |

Sessions

Patient List

[Patient Name]'s Results

Month:
August ▼