# A Smartphone Application For Home-based Hand Rehabilitation

Kody Fitch, Brandon Shepard, Martin Soto, Joseph Yang
Supervisor: Professor Rahman

CS595 Spring 2019

## 1 Abstract

Our goal is to design and prototype a smartphone based, hand rehabilitation application. Deliverable at the end of the project will be a fully functional smartphone application that guides and measures rehabilitation through the use of a wearable robotic glove.

## 2 Functionality

The smartphone application will communicate wirelessly with the robotic glove. The robotic glove will receive exercise direction from the application while communicating glove positional data back to the application. The application will process, display and communicate this glove data to the patient while simultaneously uploading hand data to the cloud. With the data stored in the cloud, the rehab professional can login to the application, access patient data and prescribe exercises remotely. The long-term goals of the project is to have multiple physical augmentations so that different body parts can be rehabilitated through this application. In addition, in order to reduce workload from physicians and doctors, machine learning can be implemented to analyze the data generated in order to give advice to patients.

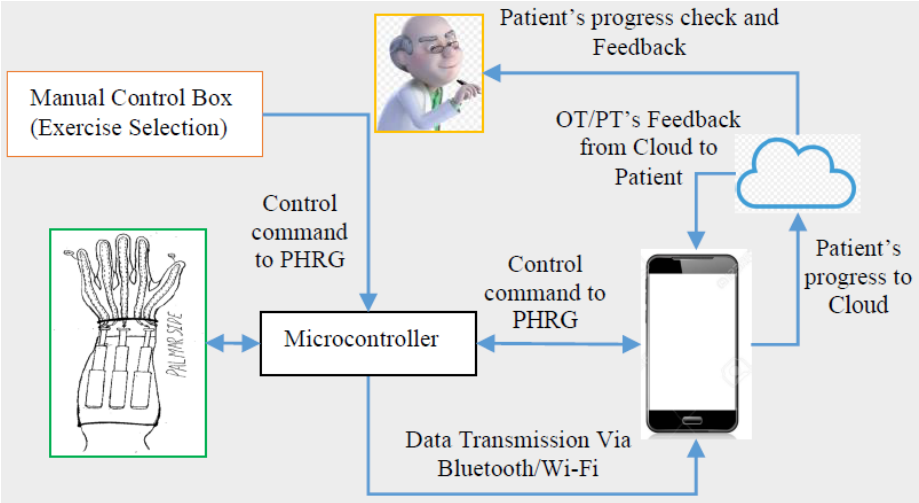


Figure 1: Rehabilitation System Schematic

# 3 Semester Scope

Given the time and resource constraints for the capstone, the scope of the project has been scaled down as shown in figure 2. The main change is the removal of

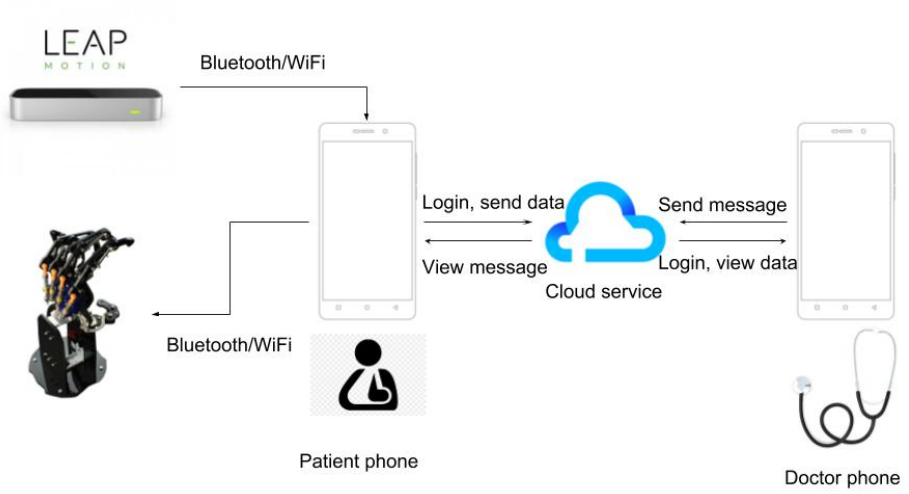


Figure 2: Updated Project Scope

the robotic glove. The glove has not been produced yet, so the project will use a Leap Motion device and robotic hand in its place. The Leap Motion device will reflect the motion tracking functionality of the glove and the robotic hand will reflect the assistive motion of the glove. By doind this, an API and communication protocol can be developed in lieu of the robotic glove. The glove can then be produced with the protocol and API in mind, allowing for straightforward replacement of the Leap Motion device and robotic hand when completed.

# 4 Technologies

## 4.1 Smartphone platform

We have chosen to use Ionic. Ionic is a framework based off the popular Angular platform created by Google. Ionic allows for the creation of platform agnosic, hybrid applications. A hybrid application supports both web applications and native applications, making it a strong choice for this project. Additionally, the ionic website appears to be well documentated and the platform comes with the majority of the components needed to complete the project.

## 4.2 Robotic glove simulation

A robotic glove prototype is being developed by Prof. Rahman's team at the UWM Biorobotics lab. In the mean time we will be simulating the glove with the use of Leap Motion sensor and a bionic robotic hand. Both items are being provided by the UWM Biorobtics lab.

Figure 3: Bionic Robotic Hand

### 4.3 Cloud service

Amazon AWS will be used for our cloud service. The Ionic team and the Amazon AWS team seem to have a good relationship with each other and have collaborated in the past to make ionic applications easier to integrate with Amazon AWS. Furthermore since Amazon AWS is one of the most popular cloud platforms there is a lot of good documentation for it.

### 4.4 Justification for & alternative technologies

Project requirements and resource restrictions influence the platform to develop the phone application on. Native apps have better performance and more direct API to the phone's hardware, but require a seperate codebase for iOS and Android. Hybrid apps are great for rapid app development, but come with slower performance. The requirements do not require high performance such as 3D rendering and the app needd to be completed in a short amount of time, so the team has decided to use a hybrid platform.

As with most web dev projects, there are countless alternatives. Some popular alternatives to Ionic include React Native (React), Kendo UI (JQuery) or Quasar (Vue). The platform decision was based on three criterion:

- group skillset
- quality of documentation
- platform coverage

With quality of documentation and platform coverage being sufficient across the various platforms, the differentiator was group skillset. Overall, our group had the most experience with Angular platforms. As such, Ionic was decided upon.

The robotic glove is currently in development, and there does not appear to be a marketed alternative. There appear to be alternatives to leap motion sensors, but since Prof. Rahman has provided and recommended the simulation hardware. As a result, we did not extensively search for alternatives.

In regards to the bionic hand. Generally speaking, as robotic hand precision increases so does cost. The main purpose of the hand is to confirm communication and sending locomotion instructions. It is a temporary device to be used until the glove is ready to replace it, so high precision is not required. Again, Prof. Rahman has lead the decision process for robotic hand selection as he balances budgetary constraints with precision constraints. The product that was ordered is a $219 hand from robotshop.com that is compatible with Arduino.