ECE1778: Creative Applications for Mobile Devices

Final Report

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We give permission to allow the video presentation and our report to be posted on the course website. We also give permission to have our source code be made open source.

1. INTRODUCTION

1.1 Background

A hip fracture is a defining moment for an older adult. Patients who leave rehabilitation after their hip fracture with substantial functional impairment have a poor prognosis, including a 20% risk of death in the first year. Maximizing participation and gains in rehabilitation is thus an important clinical goal. There are many barriers to effective participation in rehabilitation. Issues such as anxiety, demoralization, dysfunctional beliefs about exercise, poor self-efficacy, sleep disturbance and fear of falling can result in disengagement from rehabilitiation. OnMyFeet is an app which applies theories of behavioural engagement to the issue of improving participation by older adults in rehab. The app is modeled on Enhanced Medical Rehabilitation (EMR), an evidence-based behavioural intervention[1].

1.2 Motivation & Goal

OnMyFeet is an app designed to help therapists and patients to work together on goals, track progress, and identify barriers to therapy participation in a format that is user-friendly for seniors. This allows therapists to tailor their care by collecting patient feedback and monitoring patient status.

The primary aim of OnMyFeet is to improve patient engagement and outcomes in rehabilitation.

1.3 Specialist Projects: Specialist Context

The OnMyFeet app is an important step towards use of health technology to apply a behaviour change intervention within a particular population receiving a time-limited intervention. The use of behavior change interventions (such as EMR) in healthcare is constrained by burden on providers, limited ability to measure and intervene upon behavior in real time, variable adherence by patients, and low rates of implementation of behavioral techniques in clinical practice.

[1] Lenze EJ, Host HH, Hildebrand MW, Morrow-Howell N, Carpenter B, Freedland KE, Baum CA, Dixon D, Doré P, Wendleton L, Binder EF. Enhanced medical rehabilitation increases therapy intensity and engagement and improves functional outcomes in postacute rehabilitation of older adults: a randomized-controlled trial. J Am Med Dir Assoc. 2012 Oct;13(8):708-12

OnMyFeet helps to address this by using technology to deliver the behavioural intervention and measure its benefits in real time. It is not designed to replace the interaction with the physical therapist, but to enhance the patient's engagement with that interaction, and thus improve their motivation and effort. It does this through techniques, such as goal-setting, feedback on performance, barrier identification, and action planning, which have been shown to be effective in behavioural sciences.

OnMyFeet also provides a starting point for studying how older adults interact with technology such as wearables. We aimed to simplify the presentation of the Fitbit data, and future research will evaluate the usability of this interface for older adults in rehab. OnMyFeet has the potential to be used as a research tool in tracking performance outcomes in rehab in relation to activity levels, rehab participation, and rehab barriers. Future studies will also need to validate the Fitbit algorithms against gold standards to ensure they are able to accurately capture these measures in older adults.

2. OVERALL DESIGN

2.1 Block Diagram

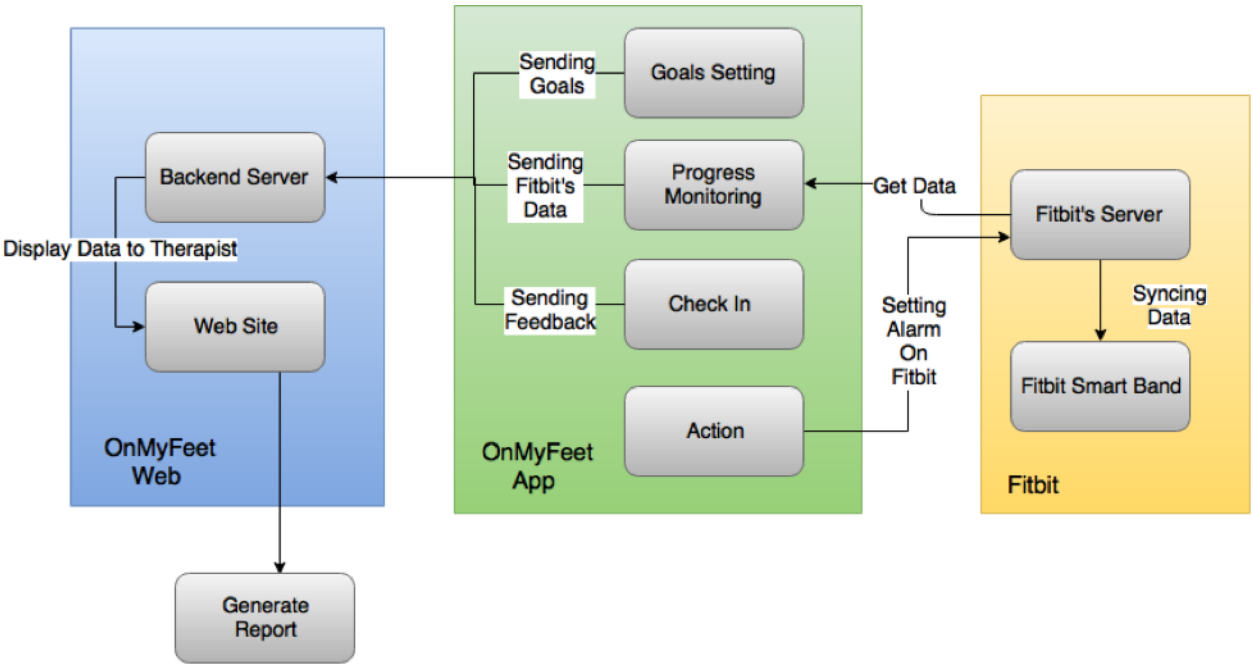

Figure 1. High level block diagram of OnMyFeet's functional components

A) OnMyFeet App

Goals Setting module allows users to set and check their rehabilitation goals and activities. After setting goals and related activities, users can rank their activities among "*Not Able*", "*Need Help*" and "*Can Do By Self*". All the data would be saved locally and sent to backend server when change has been made.

Progress Monitoring module shows all the data collected from the smart band, including data of Steps, Distance, Sleep and Intensity. All the data would be fetched and stored locally when user scrolls down the menu and triggers the refresh in the main menu screen.

Check In module is where sets of questionnaire would be provided for users to evaluate their rehabilitation status. Questionnaires finished by users can be sent to the backend server so that the therapist can check and evaluate their patients' feedback during rehabilitation.

Action module allows user to set alarms on the smart band for reminders. It also provided shortcut to other relaxation app when user feels like doing some relaxation.

B) OnMyFeet Web

Web Site is a web that allows therapist to see all the data of their patients. Therapist can also add and delete patients' data.

Backend Server is where all the data is stored and where it is retrieved from in order to keep the consistency of the data between the Web and App.

C) Fitbit

Fitbit is a wearable provider that offer API for developer to interact with Fitbit device data.

Fitbit Smart Band can keep track of user's activity data including Steps, Distance, Sleep and Intensity. All the collected data is used in OnMyFeet in order to evaluate patients' rehabilitation status.

3. FUNCTIONALITY & SCREENSHOT

3.1 Log in

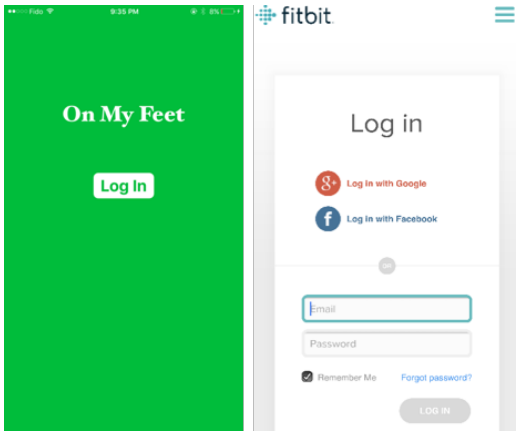

Figure 2. The Log In module interface

This part implements the OAuth 2.0 framework for authorizing our app to access data from the Fitbit API. The access token gained through the framework will be stored and further used to make HTTP request to the API, while the refresh token can be used to obtain a new access token when the current one expires without having to re-prompt the user.

When clicking the “Log In” button, the user will be redirected to the Fitbit’s authorization page, where users should type in the username and password of Fitbit’s account for user authorization.

3.2 Home screen

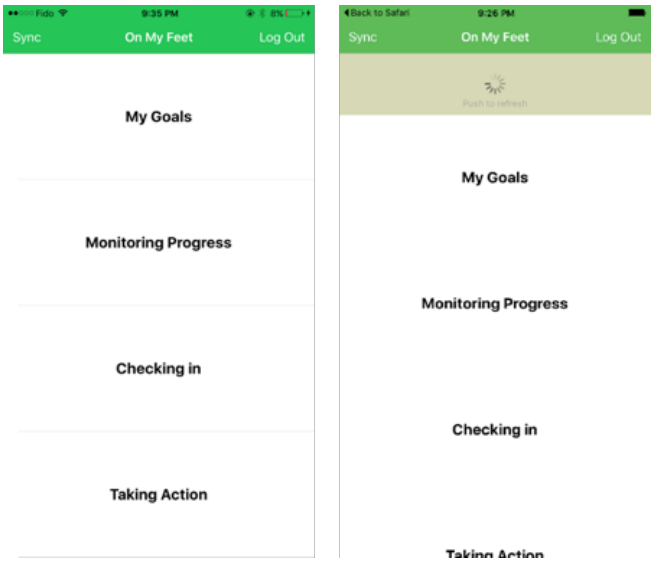

Figure 3. The Home Screen interface

This part shows the menu of the app. The whole app can be divided into four parts including setting personalized goals, monitoring activity progress acquired from Fitbit, checking in through finishing questionnaires as well as taking actions to further complete the rehabilitation treatment.

After pressing the "Sync" button, the user will be switched to the Fitbit app for data synchronization. This synchronization can be maintained as long as the Fitbit app remains active, even at the background. Five seconds later, there would be an alert message shows to remind the user to switch back to our app via clicking on it. Under the status of successful synchronization, the latest data recorded by Fitbit can be retrieved through pulling down the whole menu table for refreshing.

The user can log out the Fitbit's account through clicking on the "Log Out" button.

3.3 Goals Setting Module

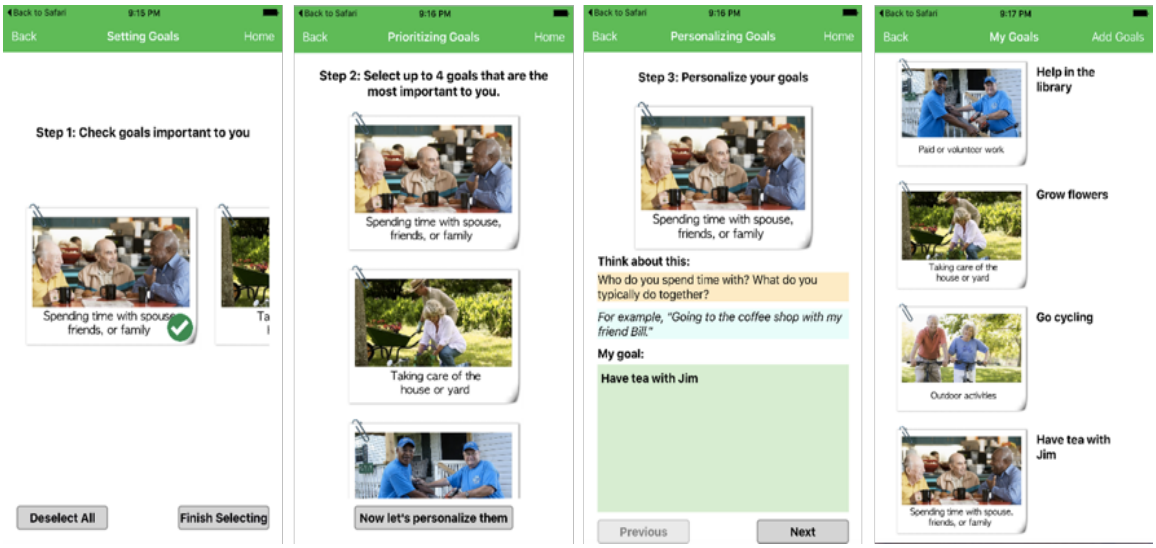

Figure 4. The Goal Setting module interface (Goals)

The goals setting module allows patients to set their personalized goals, choose activities for achieving these goals and further record their performance on completing these activities.

When choosing goals, the patient will glance over all the pictures of the goals provided, check and uncheck the goals of importance. Then the patient will be asked to limit their goals to no more than four goals.

When personalizing goals, the patient will be asked to answer a corresponding question that will help them to specify their goals. Functions such as viewing and modifying previous and next goals' content are also provided for patients to recompose their answers.

Now the patient can view the list of their already set goals including the personalized specifications accordingly. Besides, the patient can add more goals through clicking on the "Add Goals" button.

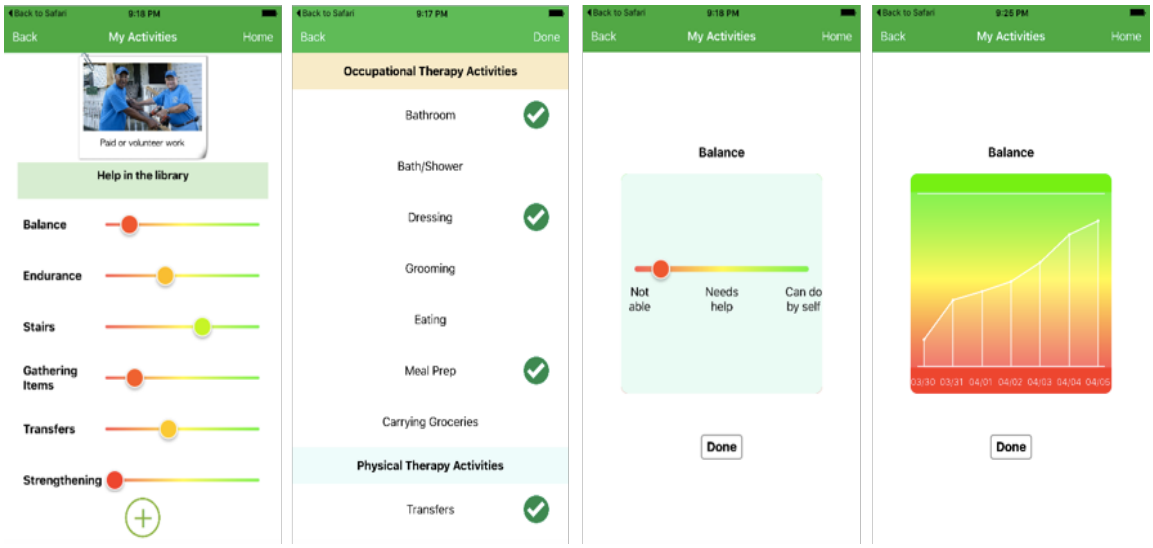

Figure 5. The Goal Setting module interface (Activities)

After setting goals, the patient can now set specific activities for each goal. When clicking on certain goal cell, the patient can view the activities along with the latest completing statues of these activities. The patient can add more activities through clicking on the "Add" button, and the activity list will appear for patients to choose more activities.

The patient can change their completing status for each activity via directly sliding the rainbow bar shown in the cell or clicking into the activity cell and sliding the bar shown. In addition, the recent seven changes of the status are also recorded, including the changing dates and the status of that time. The patient can view these records through clicking on the rainbow bar view to switch to the status progress view.

3.4 Progress Monitoring Module

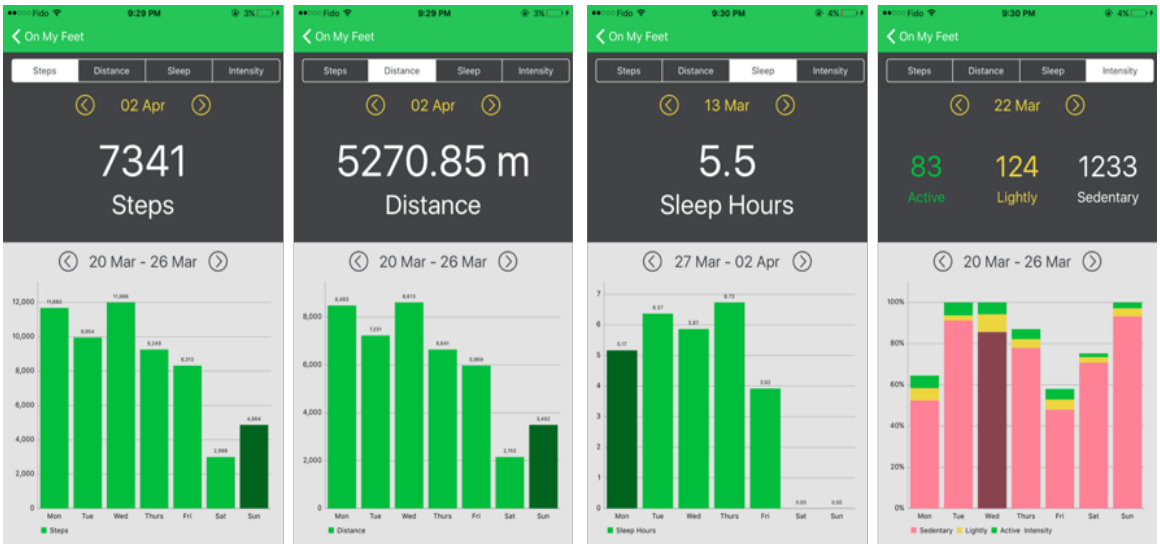

Figure 6. The Progress Monitoring module interface

This part shows the activity data fetched from Fitbit API, including walking steps, moving distance, sleep time, and activity intensity. These data can be used to supervise the active status of our patients. Users can have access to all the activity data from their registration date for Fitbit to the current data.

The patient should first sync data with Fitbit API to retrieve the latest data from it. This syncing process can be implemented at the home screen as mentioned before.

Four tags are shown on the top, which allow the patient to switch among different kinds of data. The entire interface is subdivided into two parts, where the top part shows daily data and the bottom part shows the progress status of the whole week in the form of bar graphs. Users can view the data of previous/later days and weeks via clicking on the forward/backward buttons. Those two parts of daily and weekly data are also correlated. Users can view data of specified date when clicking on certain bar in the weekly graph.

3.5 Check In Module

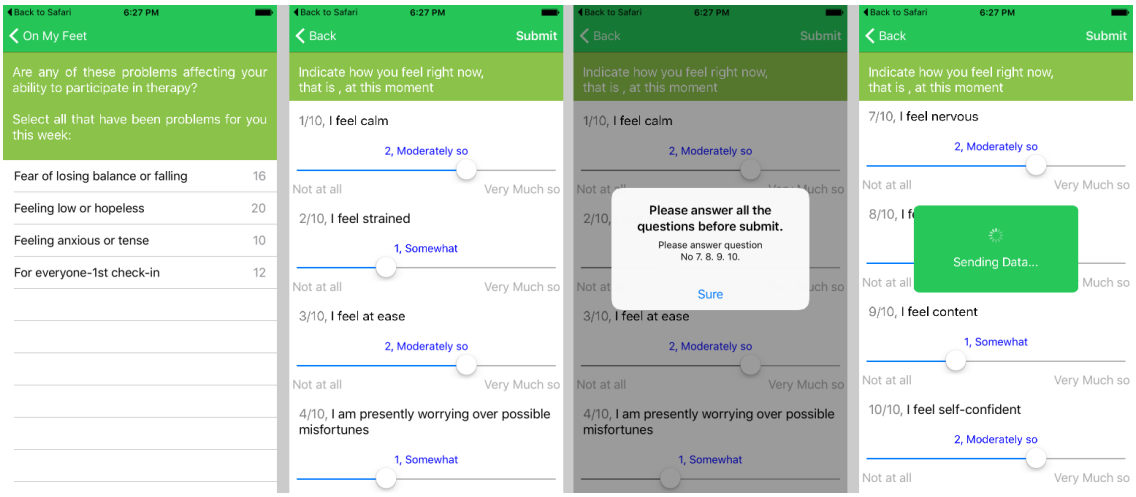

Figure 7. The Check In module interface

The Check In module provide sets of questionnaires for patients. Patients can finish the questionnaire and then send to the server. Hence, therapists can view their patient's feedback from the web portal and then evaluate patient's status during the therapy.

3.6 Taking Action Module

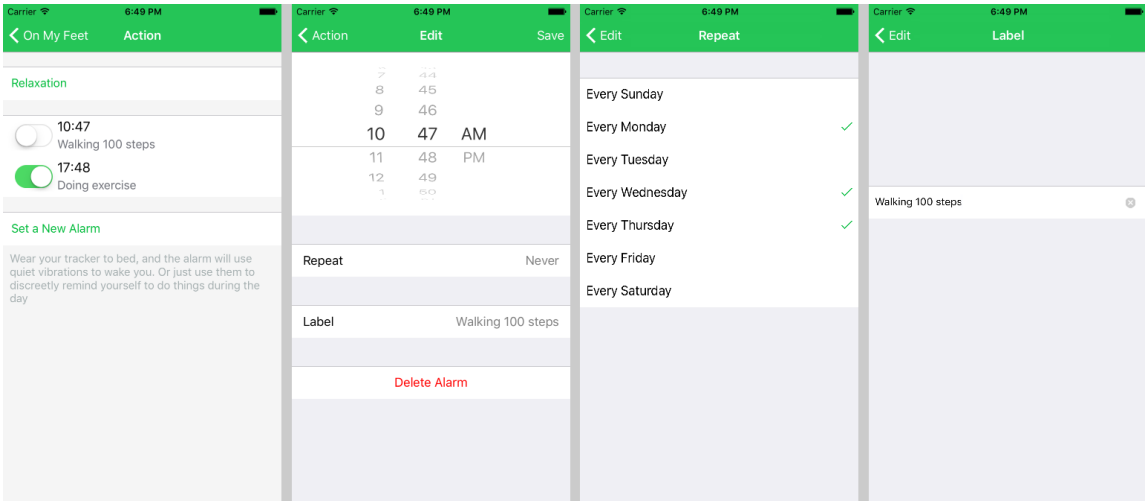

Figure 8. Taking Action module

In this module, user can do some relaxation activities or set alarm on the wearable to remind them of doing exercises or waking them up.

The relaxation activities are not currently provided in OnMyFeet, which means the app would redirect the user to another relaxation apps for this purpose.

When setting, editing or deleting the alarm, OnMyFeet would send URL request to the wearable provider's server in order to set the alarm on the wearable device. Once the alarm has been set, the wearable device would vibrate at the specified time. The users are also allowed to label the alarm and set the alarm as single or recurring event.

3.7 Therapist's Web Management System

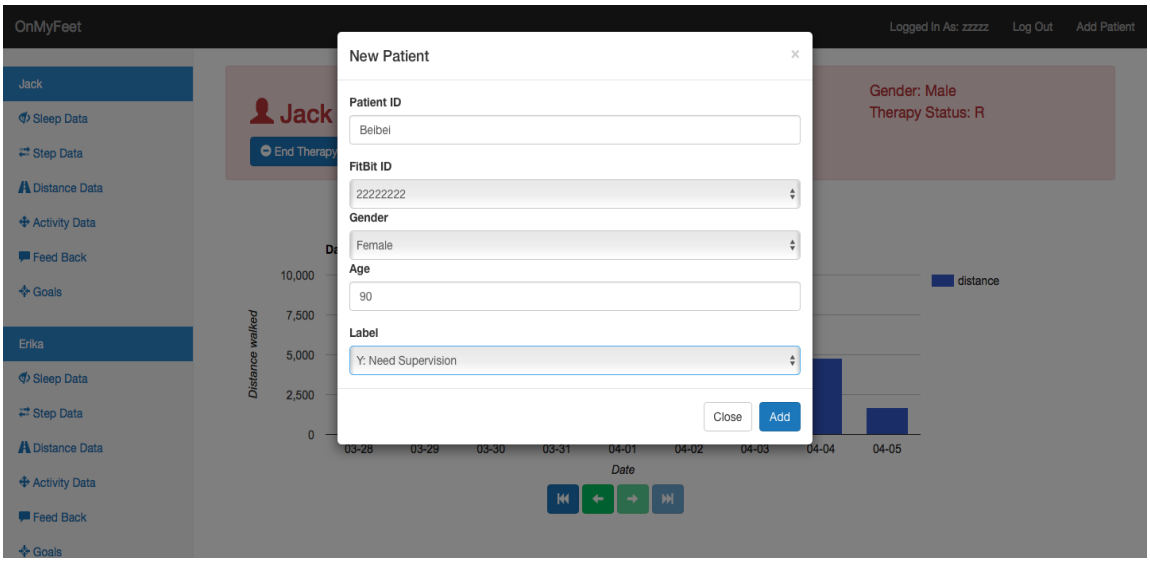

Figure 9. Adding patient in web portal

The Therapist's Web Management System aims to help visualize patients' health data and render it to therapist. Each therapist has an account and they can log in to get all the health information their patients have uploaded via mobile devices.

After successfully logging in, the therapist can add a patient by clicking "add patient" button at the top right corner when a new patient starts his/her therapy. Each patient gets a Fitbit wearable device and the therapist needs to specify which band the patient is wearing.

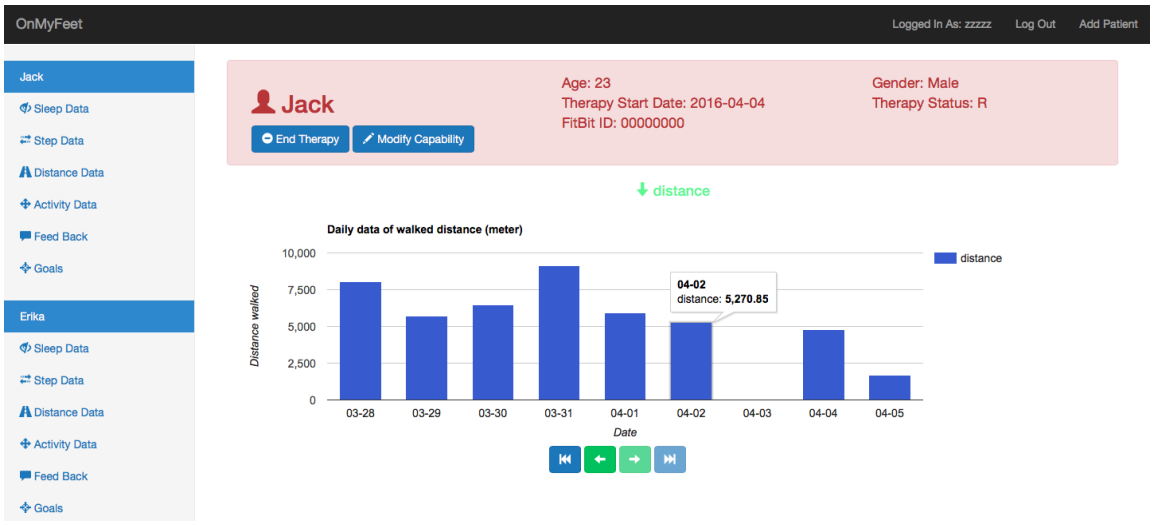

Figure 10. The interface of the web portal (Distance)

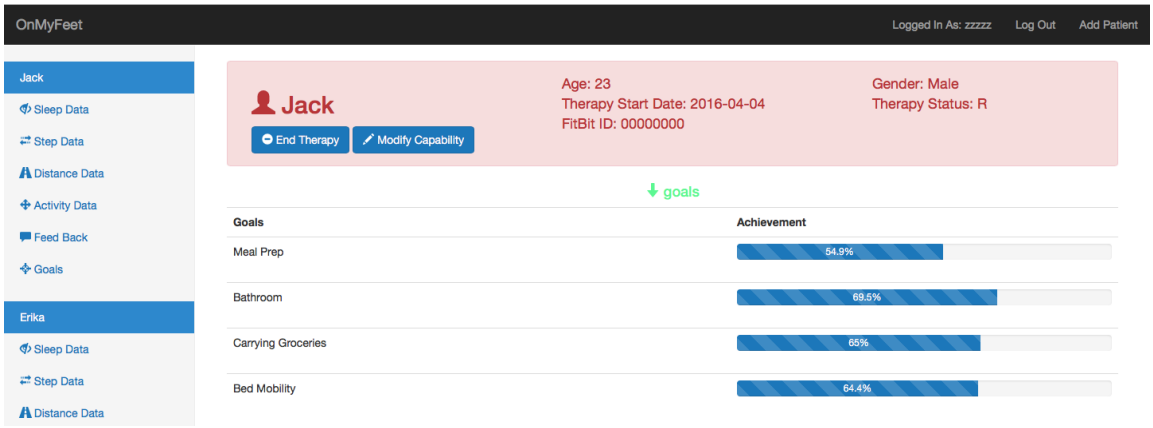

Figure 11. The interface of the web portal (Goals)

Figure 10 and Figure 11 show how the data of patients would be displayed on the web.

Therapists can end their patients' therapy by clicking the "*End Therapy*" button. The document of the discharged patient then can be printed as hard copy (to be done in the future) and then be deleted forever from the database.

Therapists can also change the capability of their patients by clicking the "Modify Capability" button. The background color of the information section will change accordingly.

4. WHAT DID WE LEARN

4.1 Programmers

A) Technical

- OAuth 2.0 authentication protocol, which was used to connect to the Fitbit, and retrieve data from the wearable.
- Server integration - The app can post or get data from the server.
- Building database effectively.

B) Non-technical

- Efficient work distribution.
- Using Github to collaborate among team.
- How to start a project from the ground up.

4.2 Specialist

I have learned a lot about communicating specialist information to a non-specialist group. I have had a chance to learn about usability issues with older adults, and legal and ethical issues in using health technology within healthcare settings. I have also learned about the capabilities of mobile technology, and the limitations, including a lack of open-source wearables.

5. MEMBER CONTRIBUTION

5.1 Programmers

Xiongbin Zhao

- Integrated the Fitbit API in the app.
- Implemented the Progress Monitoring module, where all the data retrieved from Fitbit's server would be displayed and stored in local database.
- Implemented the Check In and Taking Action Modules.
- Implemented the CoreData database.

Siyang Zhao

- Build server and provide API.
- Build therapist management system website.

Kexin Zhu

- Program for the Goal Setting Module.
- Sync goal data between the app and the server.
- Implemented the CoreData database.

5.2 Specialist

Andrea Iaboni

- I contributed my specialist knowledge about the field of rehabilitation psychology
- I provided the content for the app
- I provided general information about how to make the interface more user-friendly for seniors.

6. FUTURE WORK

A) Optimize the data-syncing procedure of the app

In the current OnMyFeet, user needs to manually trigger the data-syncing. Ideally, all the syncing should take place on the background to make sure all the data displayed are the latest data. Also, the app should be able to notice data changes in the server and update local data accordingly**.**

B) Multiple wearable devices support

Currently, OnMyFeet can only work with the Fitbit Device. An improvement upon this should be integrating multiple wearable devices support in the app so that users can use any kind of wearable devices.

C) Better OnMyFeet server integration

All the questionnaires, goals, activities currently used in the app have been stored in the device. However, it would be necessary to deploy the data pool on the server so that therapists can make changes to all the data when needed, using the web portal.

D) Refine the web portal's functionality and security

As for current version, little attention had been paid to the security. However, security issues must be guaranteed if the project is going to be put in use. We also need to add the functionality of printing a hard copy report onto the therapist management system website to allow this information to be added to the medical record.