**ECSE 682 Assignment 3 Report**

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**Introduction**

In this assignment, we developed a pedometer using thunderboard as a Bluetooth GATT server and smart phone as Bluetooth GATT client. The thunderboard will collect and process acceleration data to count steps. The application on smart phone will connect to thunderboard directly and receive the step number. Similar to assignment 2, in the application the user could set goals for step number, calories and distance. As shown in figure 1, the goal and current exercising data are recorded and showed in two columns. To set the goal, the user can press the “SET GOAL” button to access the view shown in figure 2. After typing in the goals, the user can press “SET” button to return, or press “RESET” button to clear the fill-in content. The step counting will automatically start. Once each goal is achieved, a notification will pop out. By pressing the “RESET” button, the user could clear the current exercise data.

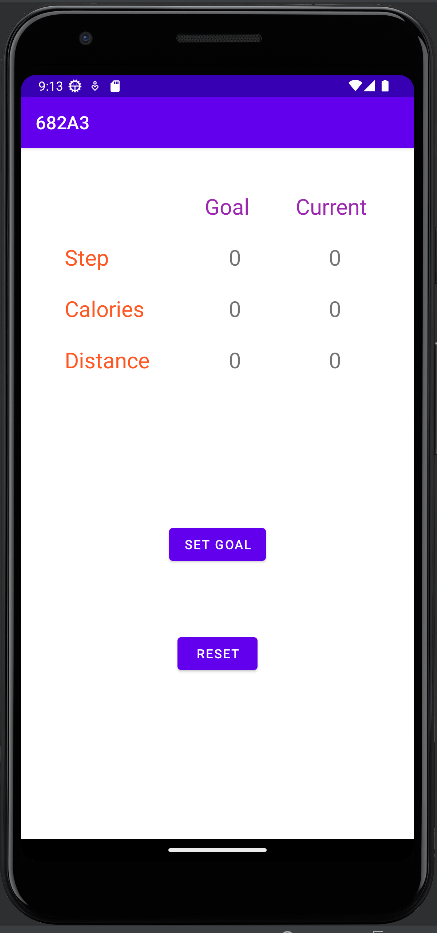
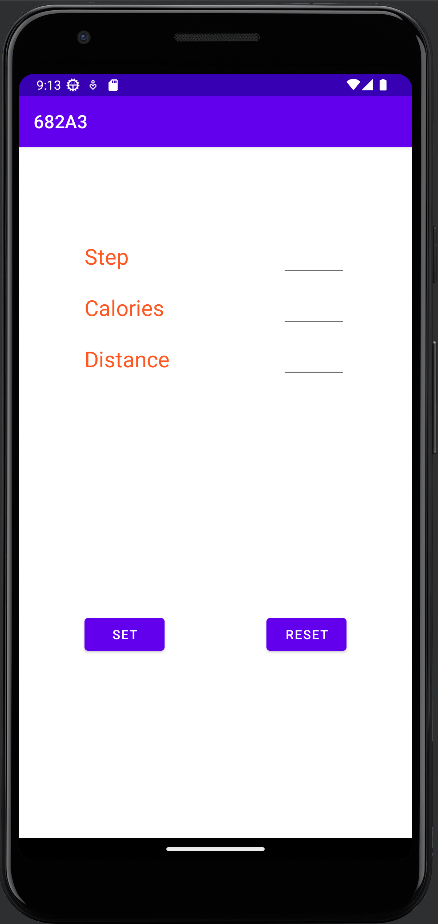
 

Figure 1. Main View Figure 2. Set goal view

**Implementation**

This project consists of 4 main parts: thunderboard step-counting algorithm, Main activity, Set goal activity and BLE service.

**Thunderboard step-counting algorithm**

Assuming that the maximum walking/running speed for human beings is 4 step per second, we set the working frequency of accelerometer to be 10 milliseconds and update the step number every 1 second.

To identify a step, we only need to count the peak number within the 100 data, assuming that the acceleration on a single axis during walking is asymptotical to a trigonometric function. Since the difference between two data point would increase when approaching the peak, a peak could be recognized when the difference between two consecutive data points is larger than the threshold. The detailed implementation is shown below in figure 3.

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Figure 3. Implementation of step recognition.

Using the Bluetooth GATT Configurator provided by Simplicity Studio, a custom service “Pedometer Data” is added, which includes the GATT characteristics such as “step\_count” and ‘reset”, as shown in figure 4. The “step\_count” characteristic is given the permission of read so that the GATT client could read the value within when connected to the GATT server. The “reset” characteristic is given the permission of write, which allows the GATT client to send data back to the thunderboard to reset the pedometer.

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Figure 4. Custom GATT service “Pedometer Data”

**Main activity**

The Main Activity is mainly responsible for creating and binding to the BLE service.

Function Set is linked to the “SET” button, which would bring up the set goal activity, as shown in figure 5. The goal will be transmitted back to main activity via an ActivityContract shown in figure 6.

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Figure 5. Launch Set Goal View

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Figure 6. ActivityContract for fetching data from the Set Goal Activity

As shown in figure 7, the function updateViews will continuously update the current step number if the thunderboard is updating and transmitting the counted step number.

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Figure 7. Function updateViews

Another important function is Reset, which is responsible for setting the current step number to zero. The implementation of reset is realized by recording the instant step number as old step number when user press the reset button. The new step number shows on the screen in the main activity would automatically minus the old step number.

**Set goal activity**

In this activity, two methods are created corresponding to the two buttons “SET” and “RESET” shown in figure 8. The number typed in by users will be recorded and transmit back to the main activity through intent.

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Figure 8. SetGoal and ResetGoal button functions

**BLE service**

When starting the application, BLE service would automatically be created. Figure 9 shows the detailed implementation of initialization of Bluetooth adapter and connection to the GATT server of a BLE device via MAC address. The operation of connecting to GATT server will call the BluetoothGATTCallback,

As shown in figure 10, the BluetoothGATTCallback contains 3 functions: onConnectionStateChange, onServiceDiscovered and onCharacteristicRead. These functions would be invoked asynchronously when relative operation is finished. For example, when the smartphone successfully connected to the GATT server, onConnectionStateChanged will be invoked, and the application would try to discover all the services provided by the GATT server. After all services are discovered, onServicesDiscovered will be invoked, and the application would try to find the “Pedometer Data” service as well as the “step\_count” characteristic using the 32-bit UUID. Every time readCharacteristic is called, onCharacteristicRead would be called and try to broadcast the counted step number to the main activity through the broadcast function.

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Figure 9. Initialization of Bluetooth adapter and connection to Bluetooth GATT server

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Figure 10. Implementation of BluetoothGattCallback.