BLE: The Future of Bluetooth Low Energy

New Mexico

Supercomputing Challenge

Final Report

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Glossary

Central (Master): a device that receives data from other devices

Peripheral: a device that emits data or RSSI for other devices to receive

Received Signal Strength Indicator (RSSI): type of data transmitted over bluetooth; represents the how strong the signal is between a central and peripheral

Executive Summary

Bluetooth Low Energy (BLE) is a relatively new version of Bluetooth that was introduced in 2006. BLE's portability and low energy consumption allows it to be used in healthcare, sports and fitness, security, automation, entertainment, toys, pay systems, and time services. The modules are small (about the size of a penny) and do not use very much energy (27mA when it is transmitting and 0.5 uA when it is in sleep mode). Also, many smartphones and computers have the Bluetooth 4.0 protocol enabled which includes BLE. The goal of this project was to use some of these possibilities of BLE to solve everyday problems. For example, many people have valuable items like wallets, credit cards, car keys, smart phones, and tablets that they misplace frequently. By using BLE, these lost items can be located, as long as they are in the range of BLE (100 meters). Our team attempted to make a variety of programs that used BLE for practical applications. Not all programs were successful, although the programs that were successful included: an iOS app that allowed the iDevice to act as a peripheral, a master, and to track other peripherals; an app for OSX that allowed you to walk away from your computer and your

computer will go to the lock screen, signing you out; and an app for OSX allowing you to track how close you are to a certain Bluetooth Low Energy peripheral. Another program involved a bit of hardware: a moisture sensor connected to a BLE 113 module. We wrote an app for iOS to communicate with the moisture sensor to get the moisture value and determine whether a plant needed watering or not. Also, We attempted to make a triangulation program for more accurate tracking but we ran out of time and are still working on it. These applications are only examples of what BLE can do and with more time many more applications will have been made.

Introduction

Bluetooth Low Energy (BLE) is a relatively new version of Bluetooth that was introduced in 2006. BLE's portability and low energy consumption allows it to be used in healthcare, sports and fitness, security, automation, entertainment, toys, pay systems, and time services, but most of the possibilities for BLE are endless.

Problem Definition

Many people do not use BLE because it is relatively new, but they do not realize that it has such a wide variety of practical applications. For example, BLE can be used for stethoscopes, probes/sensors, EKG, heart rate monitor system, measuring blood levels, and blood pressure cuffs. Some recent security systems also use BLE for detecting if your phone is nearby and unlocking your front door or garage. Detecting your Bluetooth device can also be included in home automation. When you walk into a

room with your phone, the lights could automatically turn on and off once you leave the room with your phone. Your phone might actually be able to communicate with your microwave in the future! Using BLE, your phone can communicate with streaming devices such as Apple TV or Roku and act as a remote. With BLE, you can go buy a robot and program it with your iPad or tablet over a BLE connection. BLE is a viable use in pay systems because it is secure, localized, and easy to use. BLE can sync the time from your phone to other BLE-enabled devices such as a hotel room clock so you can see what time it is back home.

Project Goal

The goal of this project is to incorporate some of these possible uses in real life. Some of these ideas would work extremely well with BLE while others would be harder to attain. For example, turning the lights in a room on and off is a relatively simple idea but the hardware side requires access to the lights in the room which involves drilling a hole into the wall. This is one reason we did not get to building the light switch. We will be using Xcode for both OSX and iOS programming.

Materials and Software Used

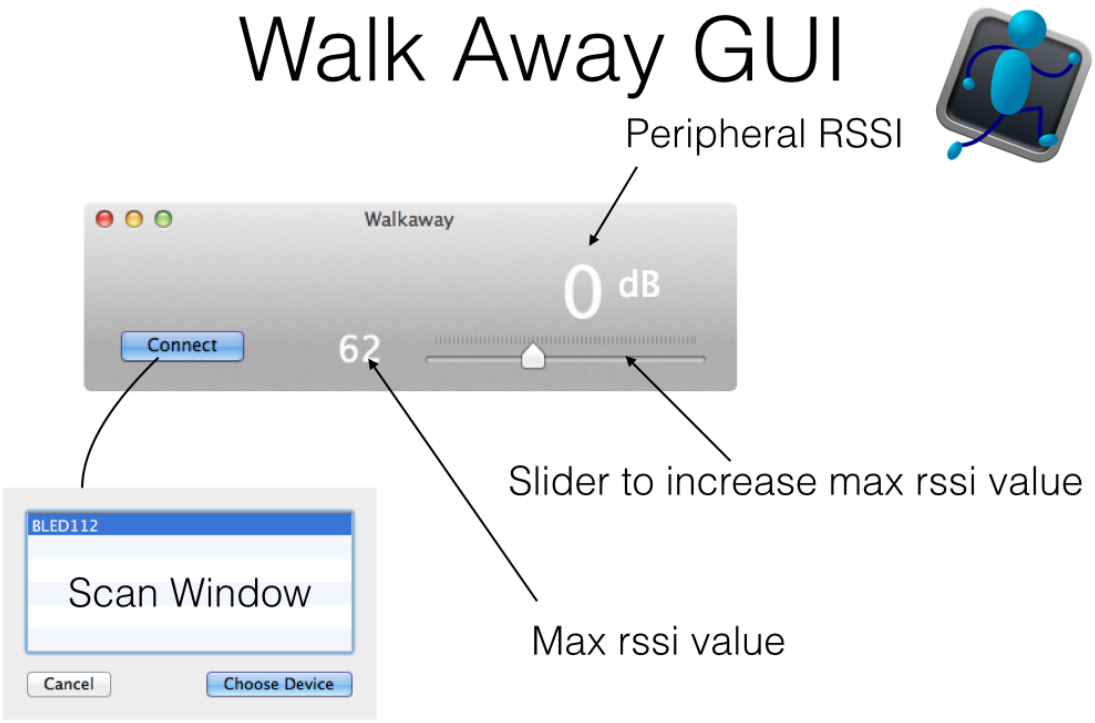
The programs in this project were constructed in Objective C. They run on either Mac OS X or iOS devices. We also used BLE113 modules manufactured by Bluegiga.

Results

The results of this project were very gratifying as we finished four programs in total: two for Mac OSX and two for iOS and a piece of

hardware that could be implemented in many different ways.

Walkaway Program for OSX:



Goes to login screen after peripheral's rssi is greater than max rssi value.

Photos taken by student

This is the Graphical User Interface or GUI of the Walkaway program our team made for Mac. The idea is that you can connect a BLE peripheral, such as your phone, to your computer, and once you start walking away from it, the computer will automatically lock its screen. This would allow people to leave their computers without having to remember to logout. The slider can be adjusted to select the RSSI boundary for the peripheral. When the RSSI goes below a certain value, then the computer logs out.

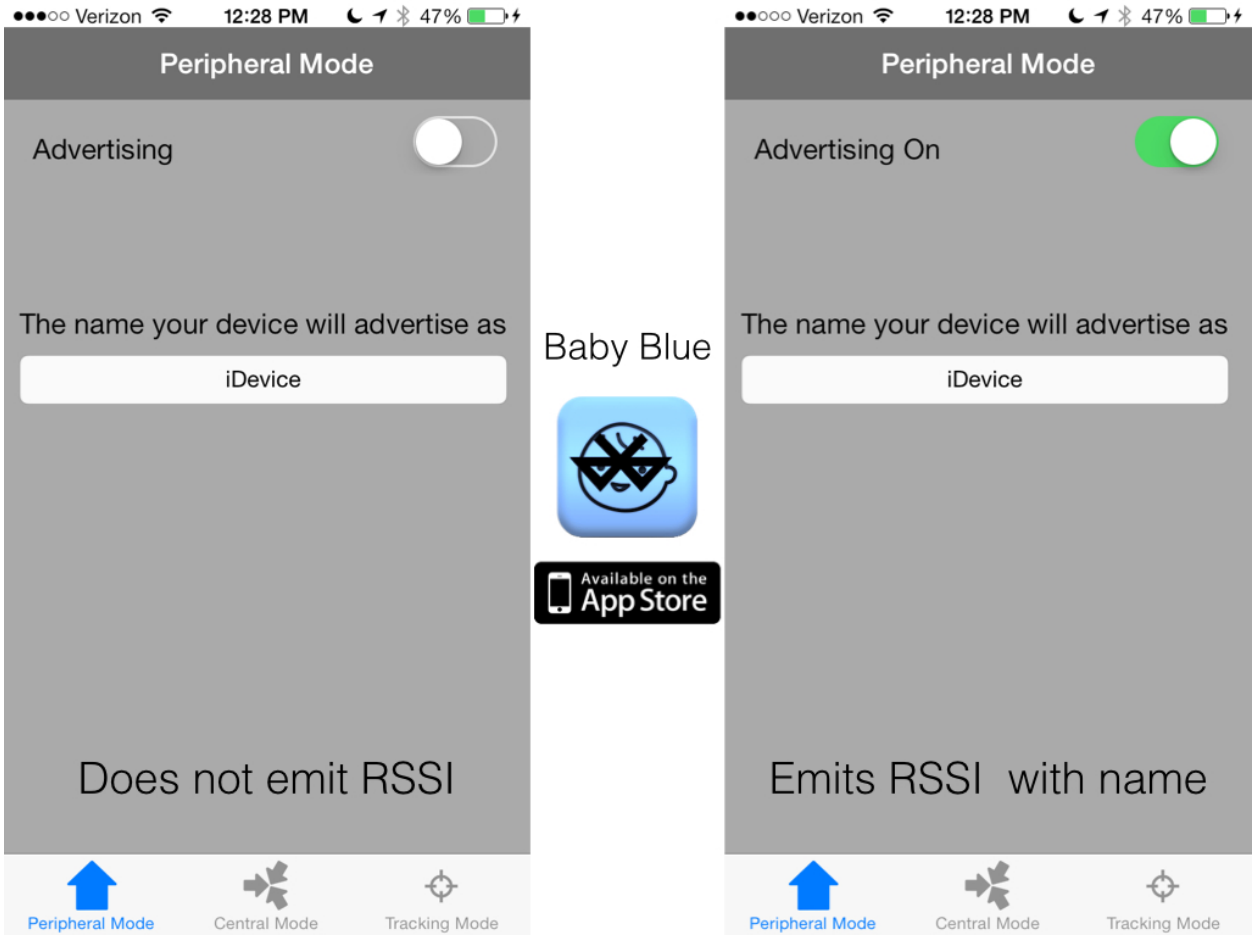
BlueStalking Program for OSX:

BlueStalking is a program for Mac that helps locating a BLE device, such a smartphone inside a building. It visually represents a peripheral's RSSI. RSSI is the distance from the peripheral to the central, so it cannot pinpoint the exact location of the peripheral. The idea of Blue Stalking is to tell the user if he or she is coming closer the peripheral. When the program is opened, the home screen shows a computer (representing the computer running the program) and a "Connect" button. The connect button allows the user to connect to any device that is emitting BLE and within range. When a peripheral is connected, the RSSI value is displayed on the top left region of the window and a circle appears. The radius of

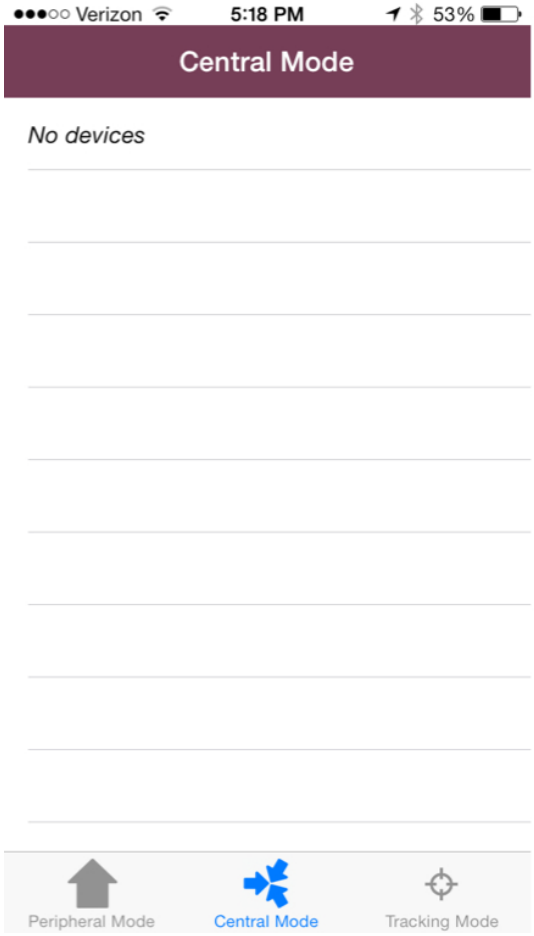
the circle represents the RSSI and the circumference represents the possible locations of the peripheral in relation to the computer. When the peripheral gets closer, the circle becomes smaller and when the peripheral gets farther away, the circle increases in size.

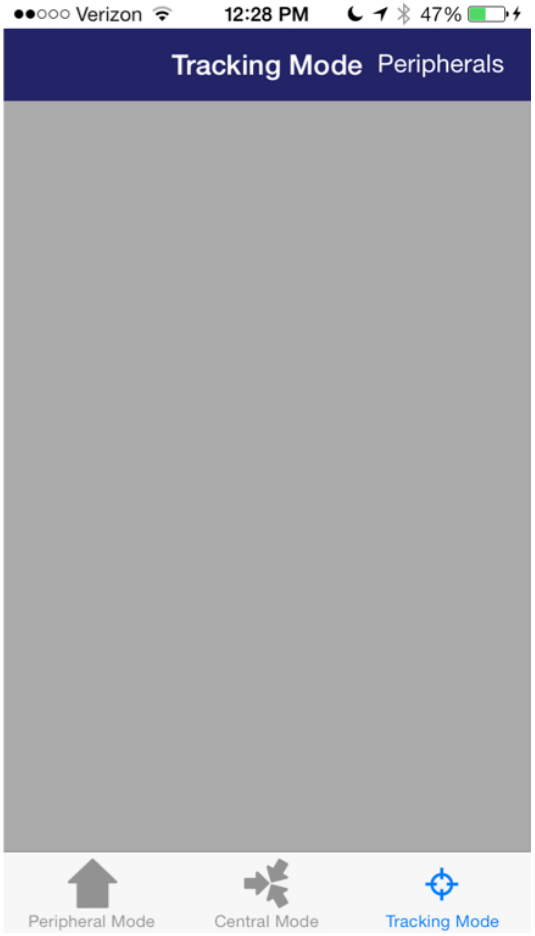
Baby Blue for iOS:

The idea here was to create an app for an IOS device that allows the device to be used in a peripheral, central, and tracking mode.



This is the peripheral mode of the app we built (Baby Blue). It has two other modes called Master and Tracking mode.



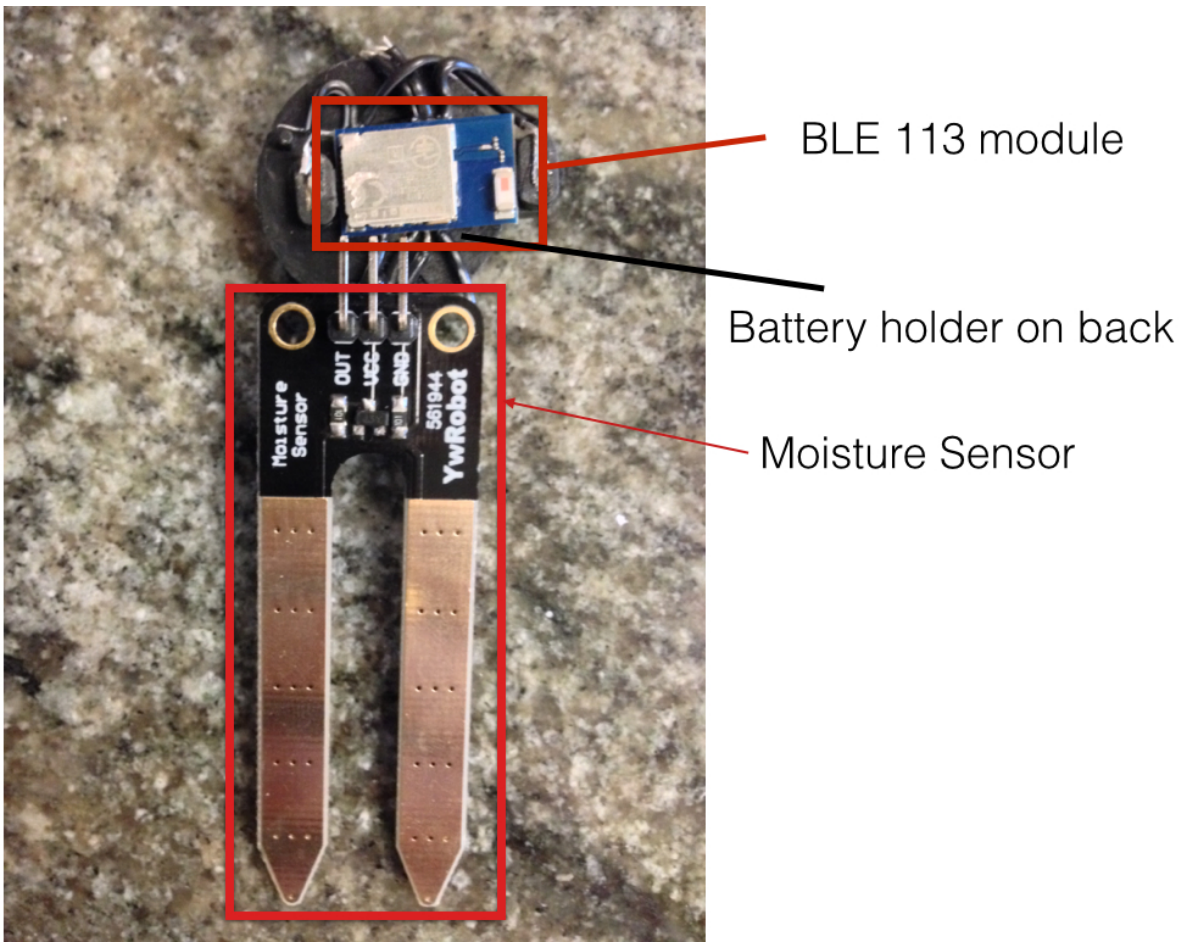


Above is the central mode on the right and the tracking mode on the left. The central mode receives data from other bluetooth peripherals and displays these peripherals. Tracking mode displays visually the RSSI of a peripheral. It draws the circumference of a circle to display the distance from the peripheral to the iPhone.

WaterMe app for iOS:

Another app created was the WaterMe app. This app, like Baby Blue, allows you to connect to other peripherals as long as they are moisture sensors. A moisture sensor is a bit of hardware created by soldering a

moisture sensor to a BLE 113 module. The prototype that was built for this project looks like this:



Using WaterMe you can specify how much water your plant needs and WaterMe will tell you when to water your plant. Because the distance BLE can communicate is 100 meters you won't be able to connect to your moisture sensors from anywhere outside the 100 meter radius.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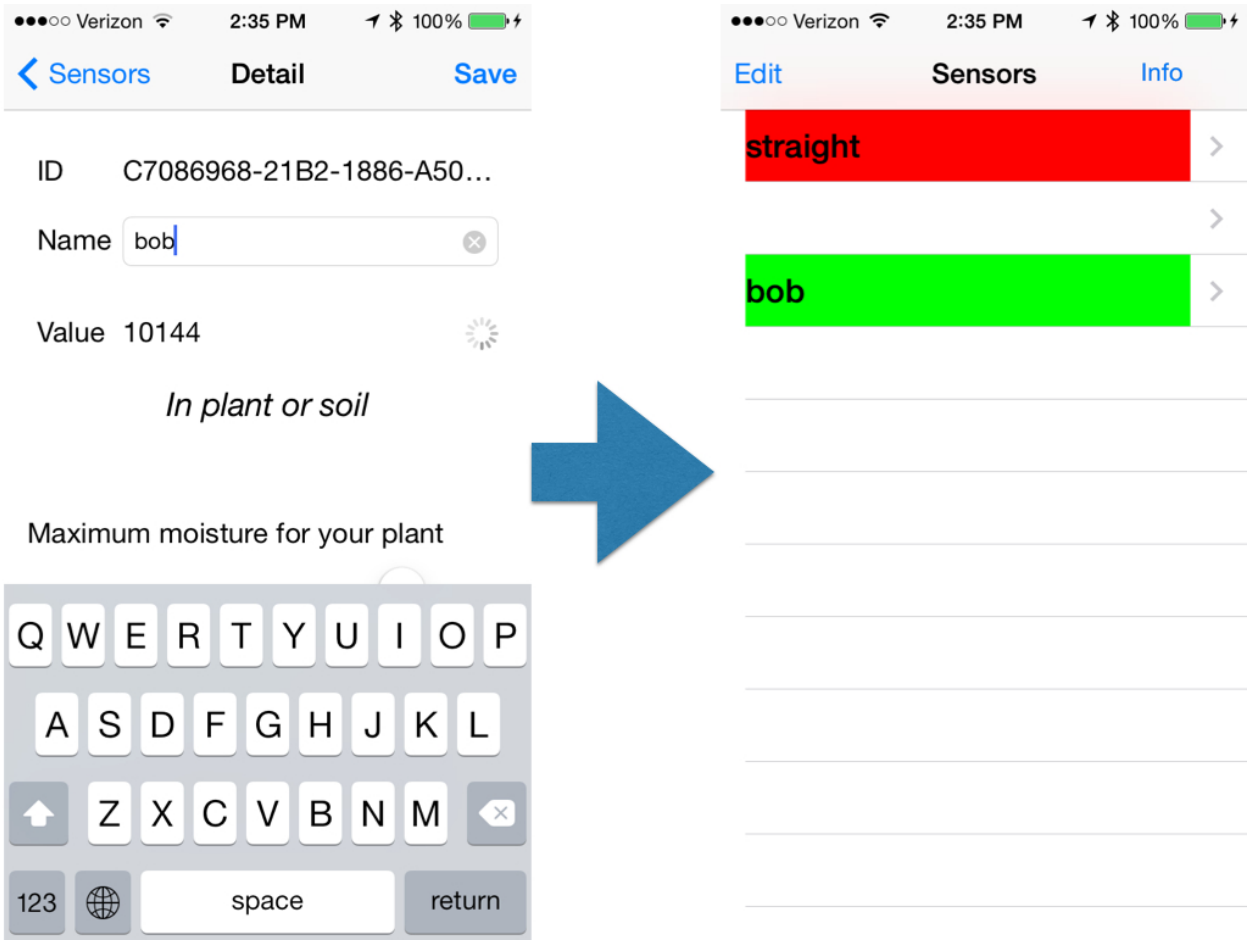
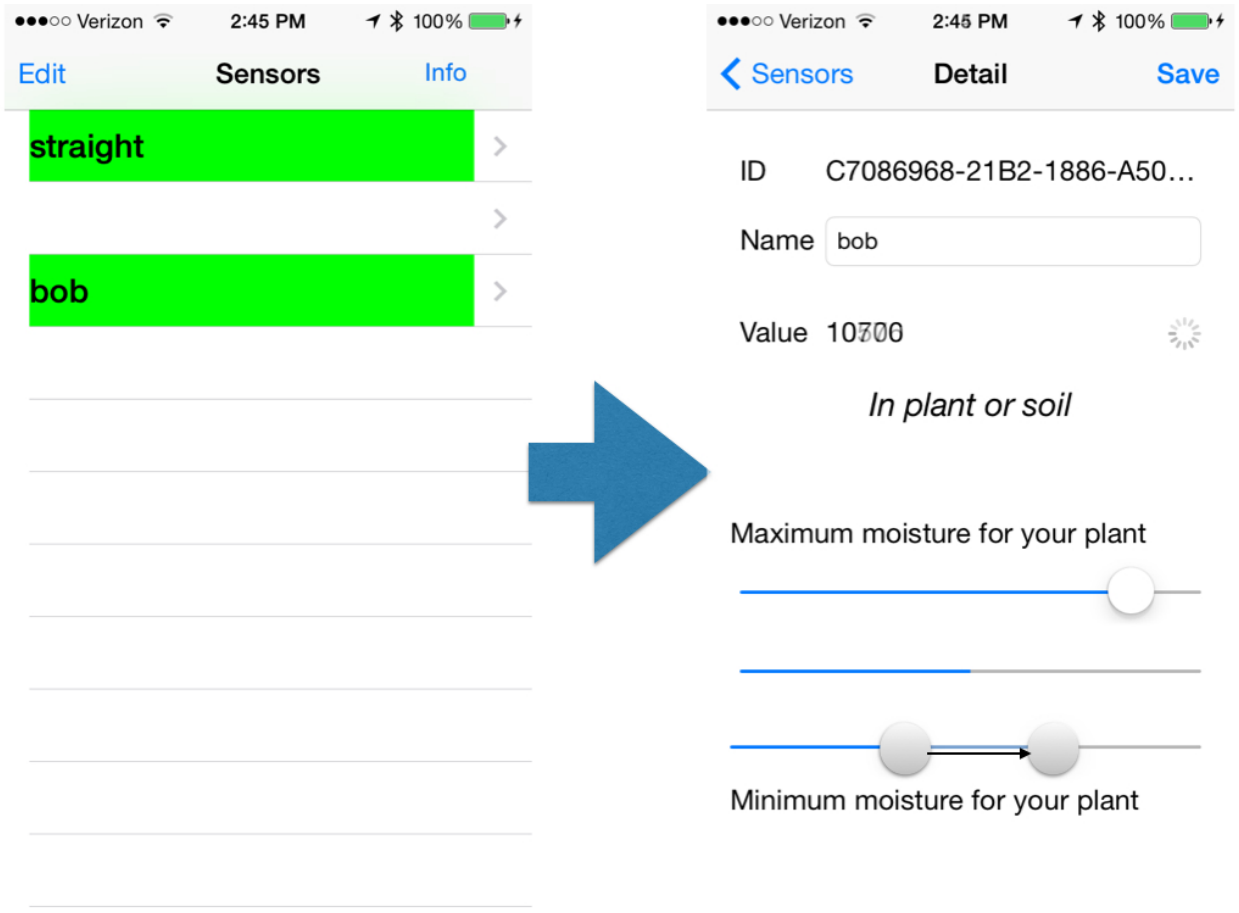
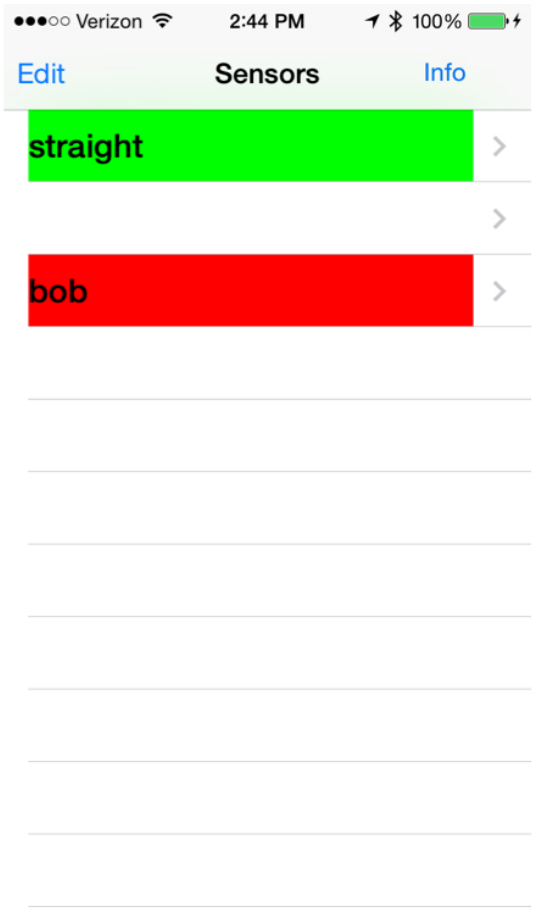


Here is the detail view of the sensor “crooked”. As you can see we can change the name to bob, hit the “Save” button at the top right and the sensor will be renamed to “bob”.

You can also hit the “Save” button to preserve the maximum and minimum moisture slider values. For example, let us go back to “bob”.



If we move the minimum moisture slider to be above the progress bar that represents the moisture value.



Then, “bob” turns red because he needs more moisture. The sensors talk for the plants and tell you when you need to water them based on your input of the value of the minimum moisture and the maximum moisture using sliders.

Achievements

Our team had many successes with making different programs that utilized BLE’s wide range of applications. Our greatest achievement was the WaterMe app that successfully communicates with moisture sensors that you can put in plants to measure moisture.

Conclusion

Our team was able to successfully make several programs that use BLE to add convenience in life. These programs would help people to locate lost objects and be less conscientious about locking their computer. We also attempted to make another program that converts RSSI to distance. The program would use a triangle of BLE modules that track a peripheral and use several RSSI values to pinpoint where the peripheral is at. Unfortunately, our team was not able to make a successful program for this concept and would like to continue working on it in the future. The programs we made are just a preview of all the possibilities BLE has for the world.

Code

Our code is available in a Github repository at this address: https://github.com/tatefly/ble-repo

Acknowledgements

Thanks to Rob Aulwes and Latchesar Ionkov for helping with the code and providing supplies for our project.

Thanks go to Pauline Stephens for making this project possible.

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