Team Leader: Elisa Iribarne
Team: Tommy Chu, Brian Ginebaugh, Nick Villa
Assignment #4 – Apartment Share Device

Section 1

Summary of assignments of individual group members for this hw (what info was developed by which team member)

	Elisa Iribarne	Tommy Chu	Brian Ginebaugh	Nick Villa
Responsibility	-Document Setup -Front-end app development	- Sensor rechargeable power research - Database systems	- Central hub functionality and configuration - System integration	-Sensor research -Bluetooth communication
Number of articles found	3	3	3	3
Percentage of effort towards this assignment	25%	25%	25%	25%

Section 2

If possible, include information obtained from technical tutorials as well as possible components that might be important and/or design information that you regard as useful. Include specific citations to the sources of your information in the text (and in figure/table captions if they are developed from references). The reference list associated with the citations should point directly to the source (e.g., if a web site, then the full URL to the actual page(s) used).

References

Reference list of additional articles found that may be useful while developing your project. Use a standard format for referencing the articles and include as "Additional Information"

Elisa's Article Summary

https://developer.apple.com/library/ios/documentation/NetworkingInternetWeb/Conceptual/CoreBluetooth_concepts/AboutCoreBluetooth/Introduction.html

This article from Apple themselves, provides the framework for programming with Bluetooth integration. Within the first overview, Apple has already explained key terms and roles to develop code

in an iPhone app. There are several sessions for different Bluetooth lessons. Apple seems to have a pretty tight grip on this documentation, understandably so, but registering as a developer with an Apple ID was not difficult and so far I have been restricted from accessing any of the articles I was interested in reading. I believe this website will prove to be a very good reference point when programming the device to work well with an iPhone. I think its much more reasonable to deal with an Iphone and then begin development for other smart phones.

They also provide developers with videos and slides:

https://developer.apple.com/videos/wwdc/2012/

Core Bluetooth 101: session 703

This provides the Bluetooth 4.0 Low Energy API, low energy is a great new technology that can be of use after the Core Bluetooth framework is done.CR2032 3V is the cell battery, which is very inexpensive, and the iPhone can now be capable of working with this through less communication time and less data transfer. Capable of 50 kbps of data transfer with the LE interface. Talks trhough Server-Client Connection, the Server would be the bluetooth device that has data, and the phone with be a client. Which transfers to the Bluetooth terms Peripheral and Central. Peripheral being the device sending data and the Central being the iPhone. The iPhone is also capable of being a peripheral but is not necessary for our project.

Also begins to talk about Advertising intervals where an accessory can begin to connect with the iPhone and be discovered. Once connected, they can begin to send data back and forth. The connection interval is the delay so that constant data transfer doesn't occur, which is consistent with the low energy philosophy.

Advanced Core Bluetooth: session 705

This lecture delved into proximity sensors and Core Bluetooth framework. Two very helpful subjects for our project specifically. Introduces new functionality building off of the LE framework. This lecture is also much more direct with the actual programming of the device.

Tommy's Article Summary

Energy Provisioning in Wireless Rechargeable Sensor Networks

http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=5935007

This article introduces wireless rechargeable sensor networks specifically focusing on wireless identification and sensing platform and RFID readers. The wireless identification and sensing platform is capable of harvesting energy from RF signals transmitted by the readers, which is highly desirable for indoor sensing and activity recognition. This article also compares two potential issues regarding positions of RFID readers: "point provisioning" and "path provisioning" schemes. Point provisioning uses the least number of readers to ensure that a static tag placed in any position of the network will receive a sufficient recharge rate for sustained operation. Path provisioning exploits the potential mobility of tags to further reduce the number of readers necessary. It investigates these two forms to

ensure that wireless identification and sensing platform can harvest sufficient energy for continuous operation.

Design and Analysis of Micro-Solar Power Systems for Wireless Sensor Networks

http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=4610922

This paper introduces analysis of micro-solar powered design focusing on long-term monitoring of the environment for the wireless sensor network. It presents a model for micro-solar systems and develop a taxonomy of the micro-solar design space identifying components, design choices, interactions, challenges and tradeoffs. It further provides an analysis of two studied design: Heliomote and Trio, as examples of micro-solar powered systems. Heliomote simplifies the design and employs single-level energy storage and hardware controlled charging. On the other hand, Trio's design considers lifetime and flexibility thus it employs two-level energy storage and software controlled charging. This paper also provides a brief design guideline for micro-solar system based on the analysis of two mentioned designed systems.

The Database Design for the Control Equipment Management System

http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6340859

This article introduces several database designed aspects and suggestive considerations for the designer. Though the scope is much greater than our current project it gives us guidelines for designing our database system. The following aspects are recommended to be paid attention to: mobilize the enthusiasm of the user fully because ative cooperation can shorten the process of demand analysis and help the designer to be familiar with it as soon as possible. The designer can then accurately figure the need from the end users. A good design will also need to consider changes of the application environment and the emergence of new technologies. The designer should take account of the scalability of the system and possibly make easy to change. However, changes cannot overturn the original design and affect the existing application programs and data greatly. Lastly, when application changes are unavoidable, the designer should consider a smooth transition according to the old design for the user when the old design is overturned. This paper also makes a detail design for the control equipment management system database with actual operation results of the system.

Brian's Article Summary

Implementation of Bluetooth Sensors via Bluetooth Protocol

https://www.bluetooth.org/en-us/specification/adopted-specifications - PDF Download (Core Version 4.1)

The hyperlink above links to the Bluetooth website, where the core specifications can be downloaded in PDF form (Core Version 4.1). Because our use of bluetooth with involve extremely small sensors in various environments, it is likely that custom sensor modules will need to be developed. Understanding the bluetooth protocol, including the transfer of data and the pairing of devices, is going to be a necessity when designing these small devices. While products such as smartphones have bluetooth

functionality built in to their OS, or have some sort of API making it easy to develop in, custom sensors will require a much more in-depth understanding of the protocol itself.

It is likely that, because of the bandwidth and network usage these sensors will require, that the newest core protocols will not need to be used. While later versions may have improved security and increased bandwidth, finding bluetooth devices running older protocols that still meet our needs may be more enticing from a cost perspective.

In terms of security, Bluetooth versions after Core Specification 2.0 + EDR moved away from simple 4-digit pin numbers to a process called Secure Simple Pairing, which uses ECDH public key cryptography to prevent passive eavesdropping attacks.

Venice Service Grid - a Lightweight Service Grid Example

http://www.v-grid.info/html/pdf/VeniceAtAGlance.pdf

While this database functionality goes beyond what we need for this project, it is based on open source initiatives and offers plenty of technical documents about it's implementation. This framework offers support for technologies such as single sign on, metering services, and time-keeping services, which are just a few examples of services we will need to run the back-end of our application and web service.

For testing purposes, this Service Grid is readily downloadable and can be run in linux or VMWare. It offers far more functionality than we need, but will allow us to create a basic data storage and compute service to drive the back end of our application. Whether or not this is the final technology that would be used, I do not know, but it provides an easy-to-use starting point as well as a great learning tool to develop the data storage and compute services we need on our own.

Nick's Article Summary

A Low-Cost, Composite Sensor Array Combining Ultrasonic and Infrared Proximity Sensors

http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=525872

In industry, the use of both ultrasonic and infrared sensors is pervasive due to their low cost and flexibility in applications; however, low cost devices often offer low resolution and spatial uncertainty of features of the detected objects. In order to overcome this, multiple sensors can be combined and overlapped into a sensor array to better perceive many features of the environment. This paper describes an approach to the design of composite proximity sensor arrays; the proximity sensor arrays are composite in nature because each sensing element combines both an ultrasonic sensor and an infrared detector. Utilizing this type of sensing array leads to the ability to derive the perception of sensed objects, including their size, shape, location, and even the color of the object.

In addition to the design of the composite sensor array system, the paper also describes the advantages of using a microcontroller-based control unit for the sensor array. In using a microcontroller for for the sensor array, different firing strategies of the sensors can be accommodated, though only one receptor can be active at the same time. In this case, multiple microcontrollers can be utilized to

improve flexibility in deciding how many sensors may be active at the same time, as well as providing modularity to the system that other receptors may be added.

TinyKey: A light-weight architecture for Wireless Sensor Networks securing real-world applications

http://ieeexplore.ieee.org/xpls/icp.jsp?arnumber=5720202

Though security may not be paramount in novel applications of wireless sensor networks (such as detecting the amount of a particular apartment resource is left in a shared living situation), the security of a WSN has many unique aspects; security in these applications is mostly meant to protect the resources of sensing nodes as well as the data transferred throughout the network itself. In this article, the authors present TinyKey, a security architecture which focuses on mechanisms which the authors say have been neglected by most other WSN security applications such as key management (TinyKey deploys with its own key management system).

A flexible and highly sensitive strain-gauge sensor using reversible interlocking of nanofibres

http://www.nature.com/nmat/journal/v11/n9/full/nmat3380.html

The above article details a complex layered matrix of sensor arrays for possible use cases including flexible, skin-attachable strain-gauge sensors in artificial systems. On the whole, for this group's purposes, we would not need the advanced and complex functionality of the sensor array described in this paper (a sensor array that can mimic the characteristics of the human skin); however, the simple architecture of a flexible and highly sensitive strain sensor which detects pressure, shear, and torsion may be of great use in sensing daily inventory needs in a household setting.

This paper goes on to describe the technical workings of the device, which is composed of interlocking arrays of coated polymeric nanofibres supported on individual layers. When a stimulus is applied, the interconnection of sensors (and in turn the electrical connectivity) changes. When interpreted with their strain-gauge factors, a very accurate pressure reading can be made which would be an invaluable asset given the form factor of the device.

I pledge my honor that I have abided by the Stevens Honor System.