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October 19, 2015
Dr. Andrew Rawicz
School of Engineering Science
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Re: ENSC 440W Functional Specification for “SimpleHome”

Dear Dr. Rawicz,

Attached is the functional specifications document for @HOME’s SimpleHome: A Smart Home Automation System. The document details the functionalities of our project's components by providing a break-down of the roles of each component of the system and the external requirements needed to operate the devices.

The SimpleHome hub is to be a controller that configures smart devices in an intuitive and intelligent manner. The hub can be incorporated into an existing home automation system or configured to work with @HOME’s smart peripheral devices. This low-cost system is designed with the elderly and physically-disabled in mind. However, the goal is to have our product utilized by as wide a range of people as possible.

This functional specification document aims to emphasize upon the constraints or scope of the SimpleHome system’s functionality. The goal is to outline the high priority elements of the project and lay down the details for the progression through alpha and beta phases of development. This document also details the standards used for reliability, sustainability and safety.

Sincerely,

Curtis Meerker

Functional Specification for SimpleHome

A Home Automation System

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Executive Summary

The goal of the SimpleHome project is to take regular household fixtures and intelligently automate the functions they perform. In order for this to be a viable product in the Home Automation market, four principles were set as pillars for the functionality and design specifications to be based upon. These principles are: Simple, Efficient, Inexpensive and Secure. To increase the target market the SimpleHome system is designed with the elderly and disabled in mind. This is shown in the steps taken to simplify interfaces keeping familiar exterior designs and in keeping the device at an affordable price range.

The project itself is broken into three main components each having individual requirements. The primary component of the system is the SimpleHome Hub which is the operating brain of the system. It functions as the command center for all the connected devices and relays that information to an external server to prevent data loss. The key feature that makes the hub smart is that over time it will learn to predict behaviors of the user based on inputs from users and connected devices.

The second key part of the SimpleHome system consists of the various peripheral devices. An example of a peripheral device would be a smart light switch, which allows the light switch to be physically toggled, as well as, providing the SimpleHome hub the capability to remotely toggle the switch. To provide the most general functionality the peripherals will be made to interface with common electrical devices such as light-switches, power outlets, thermostats and watering systems. These peripherals will function like the established electrical devices with the hub and user interfaces making the system smarter through scheduling and learning repeated task.

The final crucial part of this system is the user interfaces which allow the user to remotely interact with the system as well as the ability to view past system usage. This will provide the user access to their home data. All these key elements have to operate cohesively in order to form a reliable home automation system solution.

This functional specification document will delve into the specific component functionalities which allow the system to complete these tasks in a coordinated and intelligent manner. The design and implementation of SimpleHome—including the hub, interfaces and peripherals—will be accomplished and integrated into our prototype by December 7, 2015.

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Glossary

GUI	A Graphical User Interface allows users to interact with electronic devices through a visual program [1].
Intel Edison	A is a small computer system running a specialized Linux Distro communicating via Wi-Fi and Bluetooth [2].
RF	Radio frequency, all frequencies of AC current that, if input into an antenna, an electromagnetic field is generated suitable for wireless communications. These frequencies extend from nine kilohertz (9 kHz), to thousands of gigahertz (GHz) [3].
SSR	Solid State Relay, an electronic switching device that switches on or off when a small external voltage is applied across its control terminals [4].
Wi-Fi	A Wireless Fidelity composed of local area wireless computer networking technology allowing electronics devices to network [5].
ZigBee	A specification for high level communication between devices wirelessly [6].

List of Acronyms

CE	Canadian Electrical
CSA	Canadian Standards Association
CSS	Cascading Style Sheets
ECMA	European Computer Manufacturers Association
FCC	Federal Communications Commission
HTML	Hypertext Markup Language
IEEE	Institute of Electrical and Electronics Engineers
RSS	Radio Standards Specification
W3C	World Wide Web Consortium

1 Introduction

At the outset of the SimpleHome project, there were four core values established: easy-to-use, low cost, energy-efficient and secure. These values were key when formulating the list of functionalities for our smart home automation system. With the target user-base including the elderly and physically-disabled, there is a strong focus on the simplicity of the system and ease of use. Figure 1 below, gives an overview of the tasks that SimpleHome is built to monitor and control.

Figure 1 Layout of a household monitored by SimpleHome

1.1 Scope

This document outlines the functional requirements for the SimpleHome: a smart home automation system. The specifications provided here are used to formulate a proof-of-concept model and are further modified to develop a robust model for production. The functional requirements listed here, will serve as a reference for the @HOME team during the design and implementation phases of product development. It is necessary to note that minor modifications to these specifications may be required during and after the testing phase.

1.2 Intended Audience

The functional specification document is intended to be used by all individuals who are part of the dynamic team at @HOME. This document is expected to guide the team through the design and development stages of the product, as well as serve as a reference when formulating the progress report for the project. Additionally, it is expected of each individual to refer to this document during test-plan generation and user manual documentation phases.

1.3 Classification of Requirements

This project is designed and implemented in a modular manner with the functions being divided into three categories depending on their priority, labour time, and cost to implement. The levels are designated by the following:

[Rn - p]

Where ‘n’ denotes the sectional number in functional specification and ‘p’ denotes the priority of the specification.

Types of priority:

1 - Minimum viable product; the items of critical priority; must be adhered to in the prototype.

2 - Alpha prototype; secondary priority; will be adhered to if time permits.

3 - Beta prototype; tertiary priority; completion not planned for prototype, but would be necessary for the production quality product.

2 System Requirements

2.1 System Overview

An overview image, showcasing the connections between the various aspects of the SimpleHome system, is shown in Figure 2 below.

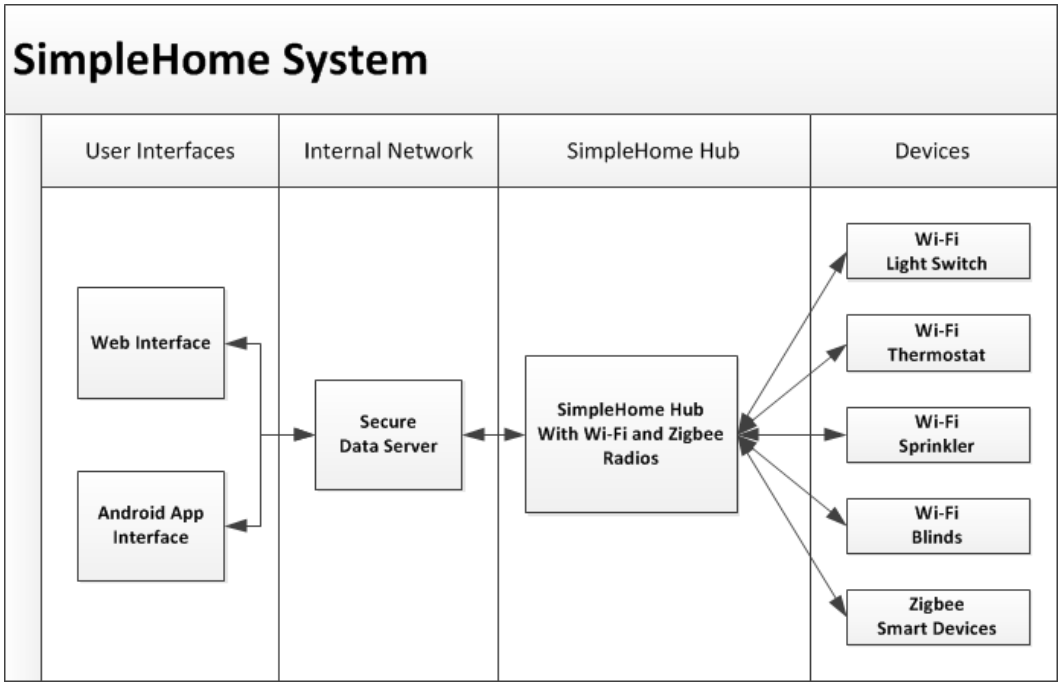

Figure 2 High-Level System Overview

As shown in Figure 2 above, the system consists of three main components: the controlling hub and database server unit, the user-interfaces and the smart peripherals. The communication medium between the external web server and the user-interface is provided by WiFi. Similarly, the controller hub populates the database hosted on the external web-server using WiFi. In the current home automation market, the most popular wireless communication medium are ZigBee and Wi-Fi. Therefore, SimpleHome's smart peripherals are controlled by the hub using the ZigBee and Wi-Fi communication mediums.

System requirements are assembled with the prime focus on our four founding principles and target audience. In order to keep the system easy-to-use, the installation of the SimpleHome system will require minimum modifications to the electrical wiring layout of the user's household. Since our system can easily be configured to work with existing in-

home devices, the SimpleHome system can be installed at a nominal cost. Our aim is to keep the hub operating at a low voltages to ensure that the controlling system is energy-efficient. Additionally, to minimize injuries to our target audience, SimpleHome will ensure that the hub casing has smooth, rounded edges.

2.2 General Requirements

[R2.2 - 1] The SimpleHome hub will connect to peripherals wirelessly

[R2.2 - 1] The SimpleHome hub will be a simple plug-in and run system

[R2.2 - 2] The SimpleHome hub will predict behavior of user

[R2.2 - 2] The SimpleHome hub shall only require standard outlet power to run

[R2.2 - 2] The SimpleHome hub shall auto-detect peripherals after power-on

[R2.2 - 2] The retail price of the SimpleHome hub will not exceed $30

[R2.2 - 3] The SimpleHome hub may have backup power supply for safe power down

2.3 Physical Requirements

[R2.3 - 1] The controlling hub unit will be unobtrusive in a domestic, household environment

[R2.3 - 1] The casing for the hub will be smooth and have rounded edges

[R2.3 - 1] The hub will be lightweight and will weigh less than 10 pounds

[R2.3 - 1] The length of the hub's casing will be less than 15 centimeters

[R2.3 - 1] The hub will be wall mountable

[R2.3 - 2] The hub will have feet for placing on a shelf

2.4 Electrical Requirements

[R2.4 - 1] The power consumed by the hub will be less than 3 Watts

[R2.4 - 1] The hub will operate at low voltages; roughly, less than 10 Volts

[R2.4 - 3] The hub shall have an AC power connection

2.5 Environmental Requirements

[R2.5 - 1] The hub will operate in a temperature range from 0^0C to 50^0C

2.6 Standards

[R2.6 - 1] The hub will conform to IEEE 802.15.4 standard for ZigBee communication [7]

[R2.6 - 1] The hub will conform to the IEEE 802.11 standard for WiFi communication [8]

[R2.6 - 2] The hub will comply with CSA's Canadian Electrical (CE) Code [9]

[R2.6 - 3] The hub will comply with CAN/CSA-C22.2 standards for household electrical appliances [10]

[R2.6 - 3] The system will comply with the FCC Part 15 standards [11]

[R2.6 - 3] The system will conform to the RSS-210 radio-communication standards [12]

3 Peripheral Devices

3.1 Overview

The peripherals are going to work as the eyes, ears, and hands of the SimpleHome system. They report all the telemetry of the home to the main hub, which in turn analyzes the data and sends commands to specific peripherals to carry out functions which the user requests or is accustomed to. A sample task-list for the peripherals would include: turning off the light, turning on the air-conditioner and contacting the police when the security peripheral detects an intruder in the house. The peripherals will interact only with the hub in which they will receive all their commands from and send all the telemetry data to.

Our peripheral lineup will include a light-switch, power outlet, automated blinds, high current outlet, sprinkler control, and a smart peripheral that uses Intel Edison. The highest priority peripherals are the light-switch and the power outlet peripherals, which are switching peripherals used to control light switching and power outlet switching. The automated blinds and the sprinkler control peripherals are a secondary requirement in which we control the blinds, and garden sprinklers using our system.

3.2 General Requirements

[R3.2 - 1]	All peripherals will have limited power consumption
[R3.2 - 1]	All peripherals will self-connect to the SimpleHome hub
[R3.2 - 1]	All the peripherals will also support manual toggling
[R3.2 - 3]	There will be a Smart peripheral, utilizing Intel Edison
[R3.2 - 3]	There will be a doorbell peripheral that has a camera attached to it

3.3 Physical Requirements

[R3.3 - 1]	The alarm peripheral will have a magnetic switch
[R3.3 - 1]	For each peripheral the RF noise generated must be minimal

3.4 Mechanical Requirements

[R3.4 - 1] Peripheral enclosures must be designed to prevent components from moving about

[R3.4 - 2] There will be a water sealed switching peripheral for the sprinkler system

3.5 Electrical Requirements

[R3.5 - 1] Peripherals will require 120V AC

[R3.5 - 1] All peripherals should consume between 1 – 4 watts of power

[R3.5 - 1] The sprinkler system should operate at approximately 24VAC.

[R3.5 - 2] Peripherals will have surge protection

3.6 Environmental Requirements

[R3.6 - 1] The light switch peripheral will operate between -10 ^{0}C and 70 ^{0}C

[R3.6 - 1] The sprinkler peripheral will use water pumped between 40 psi and 45 psi

[R3.6 - 1] The automatic blinds peripheral will operate between -10 ^{0}C and 70 ^{0}C

3.7 Standards

[R3.7 - 1] The hub will conform to IEEE 802.15.4 standard for ZigBee communication [7]

[R3.7 - 1] The hub will conform to the IEEE 802.11 standard for WiFi communication [8]

[R3.7 - 2] The hub will comply with CSA's Canadian Electrical (CE) Code [9]

[R3.7 - 3] The hub will comply with CAN/CSA-C22.2 standards for household electrical appliances [10]

[R3.7 - 3] The system will conform to the RSS-210 radio-communication standards [12]

4 User Interface

4.1 Overview

The SimpleHome system user will communicate with the system and control peripherals through a web-based graphical interface, accessed from a personal computer or smart handheld device on an Android platform. The GUI website is hosted on a web server accessible through the Internet.

From the GUI homepage, the user will have access to an authentication page and information page describing the details of our company including individual responsibilities and product information. Once the user signs in with their credentials or creates an account, they may access the controls and historical trends of their peripherals from one of the categorized pages: (1) Lighting, (2) Temperature, (3) Security and (4) Other. The user can utilize the website or Android app to change the current state of devices and monitor energy consumption trends. Users that are not authenticated will be unable to view or control peripheral information in any of the categorized pages. The flow chart describing the details of the user interface is shown below in Figure 3.

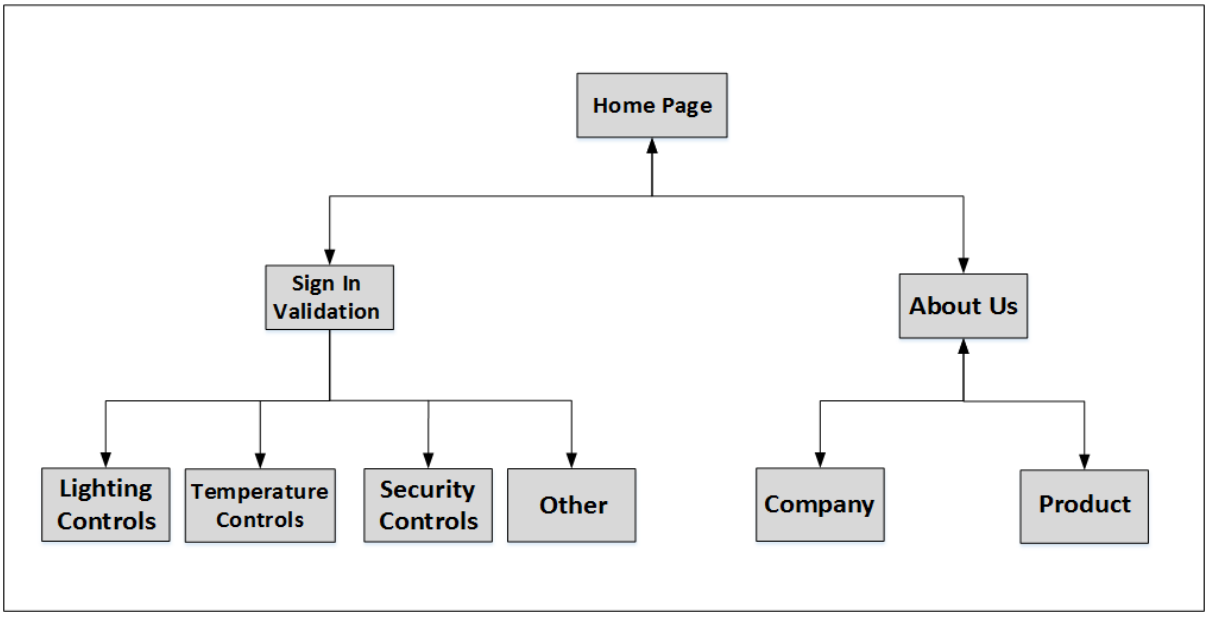

Figure 3 Operational Layout for Website and Android App Interface

The user-interfacing media can be developed on a large variety of devices including desktop and notebook computers, smartphones and tablets. For the purposes of the prototype system however, @HOME will develop a webpage and an Android application for use on a large variety of devices.

4.2 General Requirements

[R4.2 - 1] The user will access the graphical user interface through the website or Android app

[R4.2 - 1] The user will access the peripheral controls and information after authentication from a password login

[R4.2 - 1] The user may control a device's state (on/off) or vary intensity through categorized peripheral pages

[R4.2 - 1] The user may view and monitor statistics of historical and real-time energy consumption data from a chart

[R4.2 - 1] The user interface will present data collected in real time

[R4.2 - 1] The user interface will be easy to use and present data in an ordered and logical manner

[R4.2 - 1] The user interface will be compatible with Internet Explorer, Chrome, Firefox, Safari Browsers

[R4.2 - 1] The user interface will be compatible with Windows, Linux and Mac Operating Systems

[R4.2 - 1] The user interface will be consistent across the Website and Android App

[R4.2 - 2] The web server will be encrypted and accessed securely

[R4.2 - 2] The user will be given direct feedback from peripherals after sending commands

[R4.2 - 3] The website theme may be customized by the user

[R4.2 - 3] There will be a version of the app which will operate on all Windows, BlackBerry and iOS-based devices

4.3 Standards

[R4.3 - 1] The user interface code will comply to ECMAScript (Standardized JavaScript) specification for ECMA Standard ECMA-262 Edition 6 [13]

[R4.3 - 1] The user interface code will comply to the HTML5 Specification under the W3C Web Standard [14]

[R4.3 - 1] The user interface code will comply to the CSS Style Sheets Level 2 Revision 1 Specification under the W3C Web Standard [15]

[R4.3 - 1] The user interface code will comply to the Mobile Web Best Practices 1.0 under the W3C Web Standard [16]

5 Sustainability, Safety and Reliability

5.1 Overview

Sustainability, safety, reliability and durability are some of the most important aspects which need to be considered during any product development cycle. @HOME will focus on ensuring our prototype for SimpleHome is sustainable. We will, also, generate ideas on how future productions can meet the cradle-to-cradle design standards. SimpleHome's safety requirements are established with a focus on the end-user and the household safety standards. It is essential for the SimpleHome hub to be in a cool and dry environment, in order to obtain maximum functionality. A few peripherals will be required to work outside the home and will need to meet their specific environment-based requirements. Since our goal is to make the lives of our target audience easier, it is essential to make SimpleHome a simple, reliable and durable product. It is important to note that our users will not get to access the inner-workings of our overall system, thus, the possibility of accidental or intentional misuse is relatively high.

5.2 Sustainability Requirements

[R5.2 - 1]	Before Project Demonstration,a re-purpose, re-use and recycling plan will be made for all parts bought and used for creating the SimpleHome prototype
[R5.2 - 1]	All testing boards will be made from re-purposed wood
[R5.2 - 2]	Peripheral and hub casings will be made of recyclable plastic
[R5.2 - 3]	E-Waste recycling options will be included in the device documentation
[R5.2 - 3]	@HOME will take discarded SimpleHome systems to a recycling facility that will be ISO14001 compliant [17]

5.3 Safety Requirements

[R5.3 - 1] All physical components will be placed in enclosures

[R5.3 - 1] All electrical wiring, which is part of the SimpleHome system, will be well-insulated

[R5.3 - 1] Hub and peripheral enclosures will not have sharp edges

[R5.3 - 1] Unauthorized access to user data from the user interface is denied

[R5.3 - 1] All electronic components must fail-safe

[R5.3 - 1] All components interacting with AC lines will maintain shielding and should meet the standard household electrical code

[R5.3 - 3] SimpleHome will inform the user when there is an electrical failure among its parts

5.4 Reliability and Durability Requirements

[R5.4 - 3] The main hub will maintain functionality for at-most 11 years [18]

[R5.4 - 3] The hub will survive a drop test from waist high

6 User Documentation

6.1 General Requirements

[R6.1 - 3] The user manual will explain step-by-step setup of SimpleHome

[R6.1 - 3] The user manual will explain the main functions of SimpleHome

[R6.1 - 3] The user manual will contain a Frequently Asked Questions (FAQ) section

[R6.1 - 3] The user manual will contain a troubleshooting section detailing possible errors, along with how to fix them

[R6.1 - 3] The user manual will contain where to find further assistance, and contact details

7 Conclusion

The functional requirements of all systems and subsystems, which together form the SimpleHome system are outlined in this document. These requirements are established with a prime focus on the product goals: easy-to-use, energy-efficient, inexpensive and secure. The hub, peripherals and accessible user-interface are integrated into a cohesive solution for all home automation needs.

The functional specifications elaborated upon in this document outline the basic framework, which the @HOME team will be following in order to incorporate all the necessary features into our product. A prototype meeting the primary specifications will be completed by December 7, 2015. In the scenario where the @HOME team reaches its milestones ahead of time, we will attempt to accommodate the secondary objectives, as specified in this document.

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