ELEN4009 - Software Engineering
Smart Home Power Management System
Software Requirement Specification

Ari Croock (718005)
Kanaka Babshet (678851)
Alice Yang (597609)
Daniel Weinberg (547937)

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1 Introduction

1.1 Purpose

This document details the system requirements specification for the Smart Home Power Management System. The system design document will be developed from this document.
With the rapidly growing interest in new Internet of Things (IoT) technologies, networks consisting of these devices will become increasingly difficult to manage and control. Additionally, power consumption and monitoring will become a greater concern, especially in emerging markets such as South Africa.
This project aims to provide a flexible software system which is able to remotely control and monitor IoT devices, as well as perform detailed power consumption diagnostics.

1.2 Project Scope

The project is a system that will allow for remote control, monitoring and automation of IoT devices on a Local Area Network (LAN). A client-server architecture will be used since this allows a back-end server to continuously manage devices while allowing for a client to connect on-demand. The front-end will initially be implemented as a web page for simplicity and compatibility with many existing devices (such as cellphones and personal computers). The back-end provides functionality to control and monitor devices, and to log device power consumption. Additionally, the back-end will contain the web server used for interfacing with users. The front-end will consist of a web-based user interface which will provide secure access to

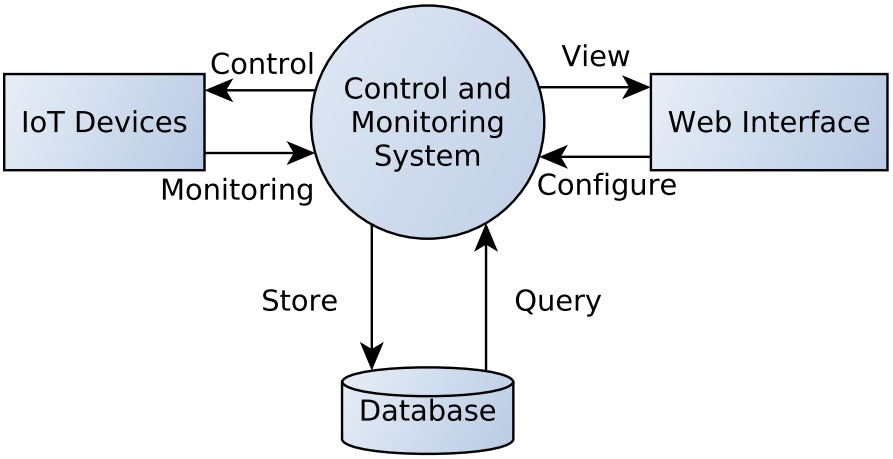

Figure 1: Data flow diagram (DFD) of the system. All data flows are bidirectional

a device dashboard. The dashboard will provide remote control and configuration of devices, as well as access to power consumption data. Addition and removal of IoT devices will also be performed through the dashboard.

2 Project Overview

Figure 1 shows a data flow diagram of the system. Data collected from IoT devices is stored in a database and used to control other devices as defined by the user. A web interface allows the user to configure devices and to view the stored data.

2.1 Assumptions

- All of the IoT devices will be connected to the same LAN
- Only a small number of simultaneous users and devices will be connected at once

2.2 Constraints

- The user interface must be accessible through a web browser

2.3 User Classes and Characteristics

- Basic users who can configure basic devices and view power usage statistics

- Advanced users who can configure custom devices and export power usage statistics for further processing

2.4 Operating Environment

Assuming that few users and devices will be connected to the system simultaneously (such as in a typical household), the system requirements are fairly relaxed:

- any modern Microsoft Windows or GNU/Linux system that supports the technologies used
- a connection to the LAN, such as Ethernet or WiFi
- low-cost hardware such as a Raspberry Pi

However, depending on the system configuration, an external storage solution may be needed for storing a large amount of power usage data.

2.5 Software Development Life-cycle

The system will be developed using an Agile software development methodology. In particular, the popular SCRUM framework will be used so that the system's requirements and design details can change quickly if need be.

3 System Features

The smart home power system is made up of various features which enhance the usability of the product, along with some additional features which simplify all related functionality.

3.1 System Feature 1 - Remote On/Off Switching

Switch any of your selected appliances on or off from any personal device connected to the home network.

3.1.1 Description

The user can control the power of various appliances in the household. The appliances are connected independently, for which reason, multiple appliances can be controlled through the same interface, simultaneously.

3.1.2 Stimulus/Response Sequences

The user has to select the "Power" tab on the home page to display the on and off options.

3.1.3 Functional Requirements

- The user must be connected to the internet

3.2 System Feature 2 - User Configurable Triggers

Personalise various situations which will trigger an action.

3.2.1 Trigger 1 - Motion Detection

Set appliances to switch on or off depending on surrounding motion.

3.2.1.1 Description

The user can control whether specific appliances must be configured with motion detection or not. For example, if motion detection is set for a certain set of lights, they will detect movement in the surrounding area and switch on, or switch off when there is no motion detected for a set period of time. If the user does not want a certain appliance or set of lights to be triggered by motion, the corresponding switch is "off" on the webpage.

3.2.1.2 Stimulus/Response Sequences

The user has to select the "Triggers" tab from the home page and thereafter select the "Motion Detection" tab at the top left of the newly loaded page to display the corresponding settings.

3.2.2 Trigger 2 - Temperature Detection

Set appliances to switch on or off depending on the surrounding temperature.

3.2.2.1 Description

The user can control whether specific appliances must be configured with heat triggers or not. For example, if temperature detection is set for a certain appliance, it will detect a certain temperature in the surrounding area and switch on, or switch off if it is too hold or too cold depending on the user settings. If the user does not want a certain appliance or set of lights to be triggered by the ambient temperature, the corresponding switch is "off" on the webpage.

3.2.2.2 Stimulus/Response Sequences

The user has to select the "Triggers" tab from the home page and thereafter select the "Temperature Detection" tab at the top left of the newly loaded page to display the corresponding settings.

3.2.3 Trigger 3 - Light Detection

3.2.4 Trigger 4 - Time Scheduling

3.3 System Feature 3 - Power Consumption Monitoring

Monitor the power consumption by various appliances and sets of lights in the household.

3.3.1 Description

Since this system is based on power management, the user can easily view a detailed layout of the numerical and percentage power consumption

3.3.2 Stimulus/Response Sequences

3.4 System Feature 4 - Energy Source Management

Control and manage the different energy sources in the household such as electricity and solar power. iances and sets of lights in the household.

3.4.1 Description

3.4.2 Stimulus/Response Sequences

3.5 System Feature 6 - User Configurable Alerts

Choose which events should result in an immediate alert on your system.

3.5.1 Description

3.5.2 Stimulus/Response Sequences

4 External Interface Requirements

The external interface is the interface which allows the user to interact with the system through a hardware device using software. The external interfaces consists of a user interface, hardware interface, software interface and communication interface.

4.1 User Interface - GUI

The user interface is how the user will interact with the system. The requirements for the design of user interface must be simple and easy to navigate. A simple format of representing all the devices connected to the Smart Home Power Management System is to display the features available for all devices on a dashboard. This can been seen in Figure 2.
Figure 3 is a simple illustration of the interface between the user the light detection triggers on the system. The layout of the tab is further divided

to clearly illustrate the sub-systems which the user has access to. As seen from the figure, the switches on the triggers tab are designed in a graphical format that is simple for users to use.
Figure 4 is the settings page, in which it designed for the user to navigate through each sub-system. The *Add/Remove Device* feature is an important feature, as it is expected that the client may have to add or remove devices for future use. The settings page is set up similarly to the home page on the trigger tab, as user's familiarity to the website is of importance.

- Home Page Dashboard

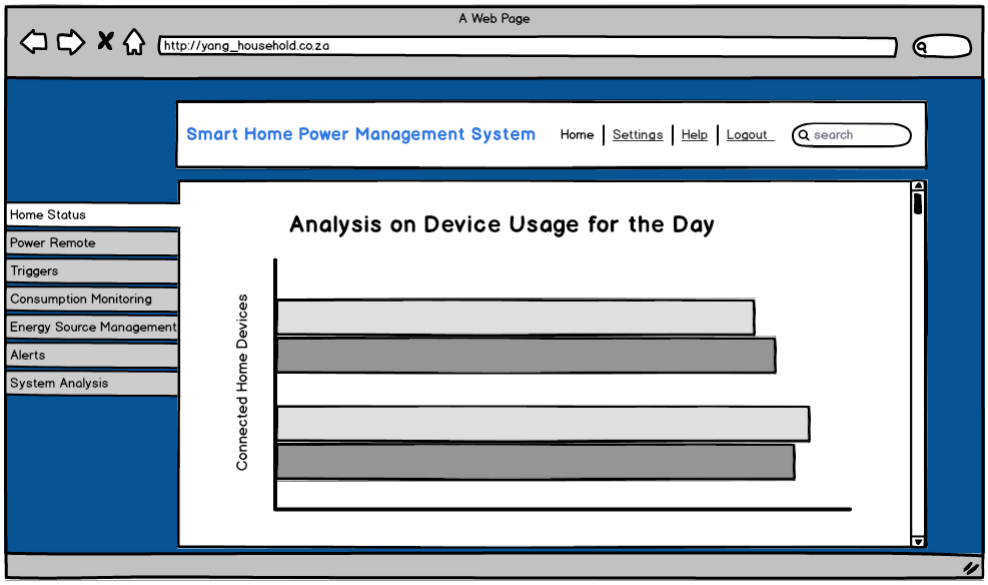

Figure 2: Figure illustrating the home page the user will see once they have logged on to access the system.

- Trigger Tab on Dashboard

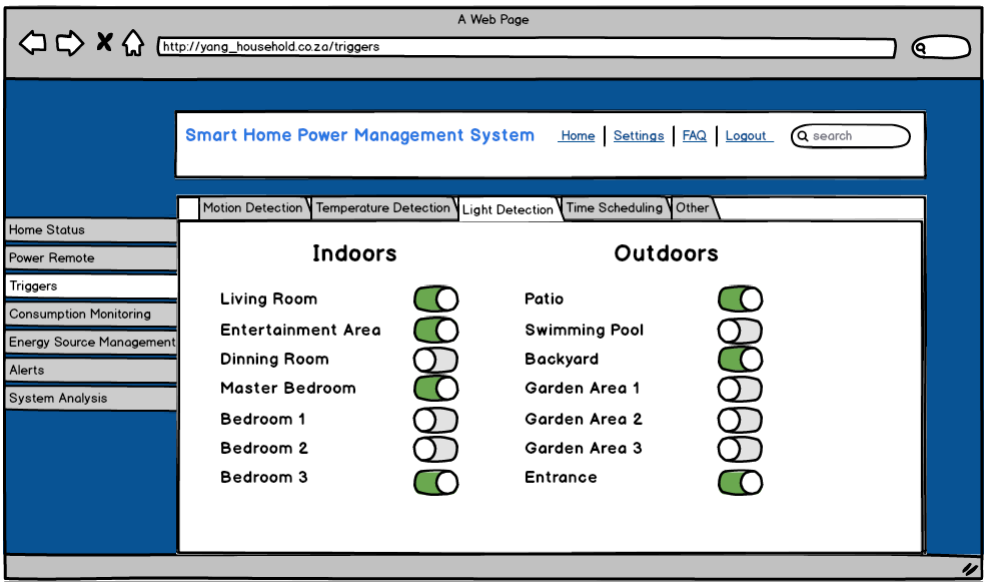

Figure 3: Figure illustrating the triggers tab, to allow users to control switching of sensors in their home through the system.

- Settings Page

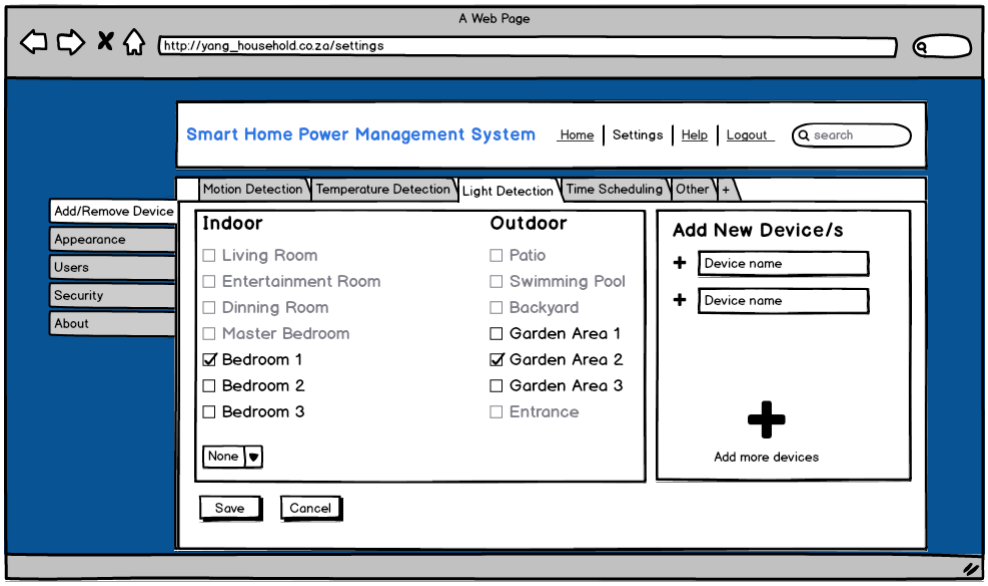

Figure 4: Figure illustrating the settings page.

4.2 Hardware Interface

The user interface is implemented on a web based platform that is accessible through a browser. The hardware required to access the system can be either of the listed devices found in the list below:

- Large Desktops (1200 - pixels)
- Medium Desktops (992 - 1199 pixels)
- Small Devices (768 - 991 pixels)
- Extra Small Devices (max 767 pixels)

4.3 Communication Interface

The Smart Home Power Management System is a web-based application that requires a internet connection for the communication between the hardware devices, system and IoT devices. The main connection between the system and the IoT devices is through the user's home wireless connect (WiFi). For the hardware device to communicate with the system any type of internet connection will do.

5 Other Non-Functional Requirements

5.1 Performance Requirements

The smart home power system is an application and system that is designed for efficiency. This means that the application as well as the connecting household components need to respond quickly and in real time.

The application will most likely undergo several updates and changes for the user's benefit. The system is required to update on user command. Updates will include further improvements to the application as well as fixes for issues that arise in operation.

5.2 Safety Requirements

The application as well as the system components need to take certain safety concerns into account.

Due to the fact that the application is essentially controlling most of a home's appliances and electricity usage, it is important that it monitors everything it is controlling to prevent problems that may arise. The application needs to ensure that any device connected in the system does not reach a dangerous level of usage. In this case, the application should either

switch off the device in question or notify the user that something is not functioning correctly and needs to be addressed.

5.3 Security Requirements

Due to the fact that the system controls a user's home, it therefore requires security considerations to be taken into account.

The system needs to ensure that only the user has access to the application to prevent external parties gaining control of the connected components within a house. This can be done with a signup, login and authentication process. The components within the house that the application connects with, need to be protected from external parties and therefore they must be explicitly authenticated.

5.4 Software Quality Attributes

The application is web based and needs to be user friendly. The functioning of the application needs to be simple so that no additional documentation or prior knowledge or experience is required.