Housing Automation

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## Section 1.0 - Project Vision

**1.1 - Project Background**

Home automation or “the internet of things” is not a new concept, however the benefits of an effective automation and monitoring system is something that cannot be overlooked. Elements such as building security, utilities system monitoring and even energy consumption analytics can help both a tenant or building supervisor become alert to an issue before an incident occurs. Take for example a building’s water pressure, where a small leak in the piping can eventually lead to water main break that would not only leave the building’s residences without water, but can cost management thousands to repair. Should a monitoring system be implemented to identify these issues early on, these types of scenarios can be avoided. As a result, the purpose of the home automation system is to allow for the automation of a low income housing facility consisting of monitoring and controlling security, lighting, climate, all focusing on energy saving and cost reduction.

**1.2 - Business Objectives**

* Provide landlords with a cost effective means to remotely monitor property utilities.
* Provide landlords with a cost effective means to remotely control property utilities.
* Provide landlords with a convenient method of sending tenants alerts should there be any property utility failures.
* Provide landlords with convenient cost-saving analytics based on sensor readings.

**1.2 – Security Concerns & Ethical Concerns**

* While the system shall allow the remote monitoring & control of building utilities including lighting and temperature, the function to control utilites is strictly limited to public spaces within the facility. These spaces will inclide, but are not limited to the building’s front doorway, main hallways, front reception area, public laundry rooms, basement, attic and other social spaces as to not invade on individual tenant privacy.
* While the system shall allow the remote monitoring of building utilities through the system’s various sensor data, this feature will include the monitoring of individual tenant’s utilites for the purpose of storing useage data. This feature is to be used in conjunction with the cost saving analytics that could be poteintailly used in order to better assist the landlord with identifying excessive utility costs. Note that the remote controling functionality will not extend to the individual tenant spaces.
* The system will hash the password entries during the registration and login processes in order to improve system security. The use of the home automation system shall be limited to end-users that register an account and securly login to the system.

**1.3 - Glossary of Terms**

* End-User - The intended users of the Home Automation system which is commonly referred to in this document as 1) Landlord and 2) Tenant.
* End-User Application - Refers to both the end-user web and mobile applications that are used to interface with the Home Automated System.
* Tenant - Refers to the building occupant/resident that is managed by the building landlord.
* Landlord - Refers to the building manager/supervisor that is an end user for the Home Automation system.
* Arduino Microcontroller - Refers to the microchips that directly interface with the various system sensors including lighting, temperature sensor and security.
* Python - Refers to the programming language that utilized by the arduino microcontrollers.
* MQTT Server - Refers to the back-end network server that allows for the integration of all the various system sensors (temperature, lighting, etc.) with the end user software applications and MySQL Database.
* MySQL Server - The back-end database that allows for the storing of end user account information in addition to the data recorded from the automated sensor information.
* Raspberry Pi - Refers to the physical device that hosts the virtual MQTT server in addition to the MySQL Server.
* Node - Refers to the backbone software framework that supports the communication between each of the following; MQTT Server, MySQL Server, Arduino Microcontrollers, end-user Web application and end-user mobile application.
* Android Studio - Refers to the software framework that was used to develop the end-user mobile application.
* Hypertext Markup Language - Abbreviated as HTML and refers to the scripting language that was used to develop the end-user web application.
* Cascading Style Sheets - Abbreviated as CSS and refers to the scripting language that was used to better enhance the visual appeal and ease of reading in the end-user web application.
* Microsoft Project - The scheduling software developed by Microsoft that was used in the team planning of this project.
* Gantt Chart - Refers to the visual work schedule chart as featured in Microsoft Project that outlines the various timeframes and deadlines for the team developing this project.
* Android - Refers to the required operating system that is required to use the end-user mobile application that accompanies the Home Automation System.
* User Interface (U.I.) - Includes both the visual appeal and front-end design of the application that will be used by the landlord to monitor the various sensors.

## Section 2.0 - Project Planing & Execution

**2.1 - Team Information**

* Ben Seiber – Hardware Design, Physical Modeling, Wiring, Arduino Logic
* Thomas Pionk – Raspberry Pi and Server configuration, Node Red dashboard U.I. designer
* Jheryl Lezama – Website Development, Documentation, Project Plan and Risk Analysis
* Jeff Wallace – Website Development, Database Designer, Wireframe schematics
* Daniel Wilmot – Website Development, Database Designer, U.I. development

**2.2 - Tools and Technology**

The tools utilized within this project were broken into three categories, 1) Automation Hardware, 2) Networking Hardware and 3) End-User Hardware. The software application frameworks that were used to code each hardware element are listed in the “Software Application Framework” section and lists the framework next to the respective device.

1. The physical Home Automation system hardware includes the following…
   1. LED Lighting - Responsible for simulating a building’s internal lighting system.
   2. Temperature Sensor - Responsible for simulating a building’s internal heating and cooling thermostat system.
   3. Humidity Sensor - Responsible for monitoring the humidity content of a simulated building space.
   4. Arduino Microcontrollers - Responsible for interfacing with the various Home Automation system sensors (lighting, temperature, humidity, etc.)
2. The networking hardware used in the Home Automation System includes the following…
   1. MQTT Server - Responsible for collecting the sensor data from the arduino microcontrollers and placing them within the raspberry pi.
   2. Raspberry Pi - Responsible for hosting the MQTT server, MySQL Server and the Node-Red framework architecture.
   3. MySQL Server - Responsible for storing the numerous sensor values that are used as part the cost saving analytic calculations.

1. The software application frameworks utilized in this project are as follows…
   1. Mobile Application (Android Studio)
   2. Web Application (Sublime Text Editor)
   3. MQTT Server Configuration (Command Line, Node-RED)
   4. Raspberry Pi (Command Line, Python, Node-RED)
   5. Database (Command Line, MySQL Workbench)
   6. Arduino Scripts (C Programming)
   7. Team Collaboration (Github, Google Drive, Google Hangouts, GroupMe)
2. The End User Hardware that is required to run the Home Automation system is as follows…
   1. Laptop or Desktop for use with web application
   2. Mobile Android OS Device for use with mobile application

**2.3 - Project Plan**



**2.4 - Best Standards and Practices**

* The website will hash the password entry during both the login and registration process.
* The mySQL database will store passwords as hashes as to improve system security.
* The servers will only be accessible on a private network.

## Section 3.0 - System Requirements Analysis

**3.1 - Functional Requirements**

1. **Requirement 1 - Web Registration:** The system shall allow landlords the ability to register using either the web or mobile application.
   1. **Actor(s):** Landlord
   2. **Description:** This will allow the landlord to register a new account should one not already exist via the web or mobile application.
      1. The system will use a MySQL Database to store the account information.
      2. The system will save a landlord’s account information with no data loss.
      3. The system will hash the password entry as to improve system security.
2. **Requirement 2 - Login Page:** The system shall allow landlords the ability to login to their account via the web or mobile application.
   1. **Actor(s):** Landlord
   2. **Description:** This will require that the landlord use either the web or mobile application to securly login to their account should one already exist within the database in order to use the home automation system.
      1. The system will use a MySQL Database to store account information.
      2. The system will save the landlord account information with no data loss.
      3. The system will hash the password entry as to improve system security.
3. **Requirement 3 - Remote Monitoring:** The system shall allow landlords the ability to remotely monitor the various home automation sensors including lighting, temperature, humidity, etc. via the web or mobile application.
   1. **Actor(s):** Landlord
   2. **Description:** This will allow the landlord with the means to remotely monitor the various sensor readings via the web and/or mobile application.
      1. The ability to remotely monitor the various system sensors shall only be granted to users who have both registered and securly logged into the system via the web or mobile application.
4. **Requirement 4 - Remote Control:** The system shall allow landlords the ability to remotely control the various sensors for lighting, temperature, humidity, etc via the web or mobile application.
   1. **Actor(s):** Landlord
   2. **Description:** This will provide the landlord with the means to remotely control the various sensor readings from within the web and mobile application.
      1. The ability to remotely monitor the various system sensors shall only be granted to users who have both registered and securly logged into the system via the web or mobile application.
5. **Requirement 5 - Storing Sensor Log:** The system shall provide landlords the ability to store sensor information within the back-end database via the web or mobile application.
   1. **Actor(s):** Landlord
   2. **Description:** This will provide the landlord with the means to create a stored log of sensor readings that can then be used to generate cost saving analytics.
      1. The system will use a MySQL Database to store sensor readings.
6. **Requirement 6 - Retrieving Sensor Log:** The system shall provide landlords the ability to retrieve sensor information from the back-end database via the web or mobile application.
   1. **Actor(s):** Landlord
   2. **Description:** This will provide the landlord with the means to retrieve/access the saved log of sensor readings that can then be used to generate cost saving analytics.
      1. The web and/or mobile application will provide the means to interface with the MySQL Database in order to retriieve the stored sensor readings.
7. **Requirement 7 - Generating Cost Saving Analysis:** The system shall provide landlords with cost saving analytics based on sensor information that could be used to lessen utility expenses in the hopes of benefiting both the landlord and tenant.
   1. **Actor(s):** Landlord
   2. **Description:** This will provide the landlord with the access to cost breakdown analysis using the log of the various sensor readings.
      1. The web and/or mobile application will act as the interface for viewing the cost saving analysis.

**3.2 - Non-Functional Requirements**

1. **Requirement 1 – Web Registration**
   1. **Description:** This will allow building administrators to create a personal account from the registration page.
      1. The system will use a secure MySQL database to store user login information (email, password, etc.).
      2. The system will use a secure MySQL database to store sensor data (lighting, temperature, etc.).
      3. The system will save user login information (email, password, etc.) within the database with no lost data.
      4. The system shall hash user passwords to improve system security.
2. **Requirement 2 –** **Networking Framework**
   1. **Description:** The system shall implement a MQTT Server to provide the back-end networking functionality.
      1. The MQTT Server will be hosted on a raspberry pi.
      2. The networking software for the back-end framework will be handled via NodeRed.
3. **Requirement 3 – MQTT Server Ability:** The server shall be available for 99.98% of the time.
   1. **Description:** This will allow the building administrator to have access to the database 99.98% of the time in order to use the Home Automation system.
      1. The server allows for the back-end network communication between the MySQL server and the system sensors.

**3.3 – Wireframe Designs**



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Section 4 – User Stories, Scenarios and Use Cases

**4.1 – User Stories**

1. As a landlord, I want a secure registration process that safely stores my personal information within the system database.
2. As a landlord, I want a secure login process that grants me access to the system.
3. As a landlord, I want a way to manage both my properties and various sensors.
4. As a landlord, I want a way to store sensor data in logs that can be later retrieved for the purpose of analysis.
5. As a landlord, I want ot be able to generate cost saving analytics that could be used to save on utility expenses.

4.1 - Scenarios

4.2 - Use Cases