Future House System

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Optimizers Software Engineering

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1. Introduction

1.1. Purpose

This document describes the final specifications for the Future House System as requested by “Esteem”, a client whose aim is to raise environmental awareness and incentivize positive actions for the home dwellers as well as home managers. The System is intended to be used by members of the general population who will own the ‘future-proofed, zero-carbon, solar-powered’ house that will be presented by Esteem as part of World Expo 2020 (possibly 2021) in Dubai. The system will track and record energy generation and energy consumption inside the house, provide control over Internet enabled devices and suggest behavioral suggestions for the home dwellers and managers. The document is created for the benefit of “Esteem”, and the developers of “Optimizers Software Engineering”. It is therefore intended that the readers are:

1. Esteem and their appointed representatives.

2. Optimizers Software Engineering.

3. Our line manager: Professor M. Hamdan.

4. Project Co-ordinator: Professor Abrar Ullah.

1.2. Scope

This document includes details about the final system design, final interface design, details of the software processes we followed during development as well as the iterations breakdown. It also includes details of technical testing, group organization, how to install the system and a final usability evaluation.

2. Overview

2.1. System Overview

Various technologies and frameworks were used in different departments of the system.

- Backend: we made use of the Django framework to power the backend REST API. And obviously it was used along with the Python programming language. In addition, PostgreSQL was used in the database.
- Web App frontend: we used mainly Javascript on the web app frontend with React as our View Library. React was used along with Redux to handle the state of the app.
- iOS App: the iOS app was made mainly using React Native framework and Javascript, along with some Native code in Objective-C and Swift.
- Android App: the Android app was made mainly using React Native Framework and Javascript, along with some Native code in Java.

2.2. User Requirements completed

Requirement	Status
Register as Home manager	Y
Register as Home Dweller	Y
Login	Y
Logout	Y
Email verification	N
Add House	Y
Remove House	Y
Control IoT Device	N
IoT Devices Feedback	Y
Recommendations	N
Sharing statistics	N
Voice control	N
Detailed data usage	N
Register multiple houses	Y
Remove House management	N
Compare data usage	N
House rooms usage	Y
Technical support	N
Send Invitation	N
Change login credentials	N
Delete account	N
Deactivate account	N

3. Design

3.1. Final System Design

The final product of Future House System is divided into the following subsystems:

Central Monitoring Unit (CMU)
The CMU is the most vital piece of hardware in the system. All the built-in electric connections inside the house will go through the CMU. The CMU is responsible for monitoring and recording the energy generation and energy consumption inside the house and uploading these data to the backend server. It also responsible for detecting any bad user behavior such as leaving lights on during the day, and making sure that the energy consumption is less than the energy generation, as well as constantly communicating with backend server to ensure the best system performance inside the house.

Hardware accessories
The house will be equipped with accessory hardware through which the user can communicate with the system and trigger some actions such as commanding an appliance to be turned on/off using voice. Also, there will be light sensors to detect if the intensity of the lighting is unnecessarily high.

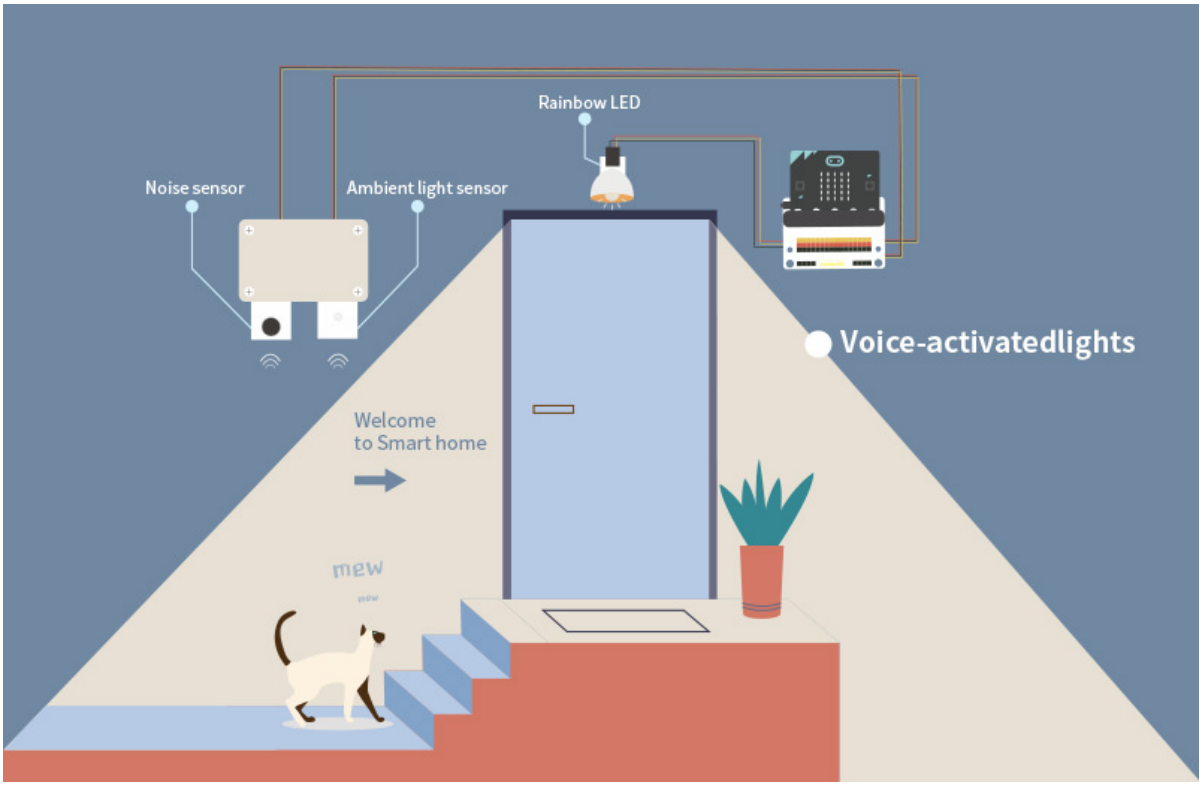


Figure 1 – Voice activated light [1].

Database
The database is where all the energy generation and energy consumption data as well as the users' data will be stored. Other forms of data such as IoT devices data will also be stored on the database. The database will provide the backend API with all the data it needs to provide the service.

Storage Bucket
The database will be connected to a storage bucket to store any necessary media.

Server
The backend server application will be responsible of processing all energy generation and energy consumption data, generating charts, providing recommendations based on the user's behavior and allow the user to communicate with the IoT devices while not home. It will also be responsible for user Authentication and Authorization.

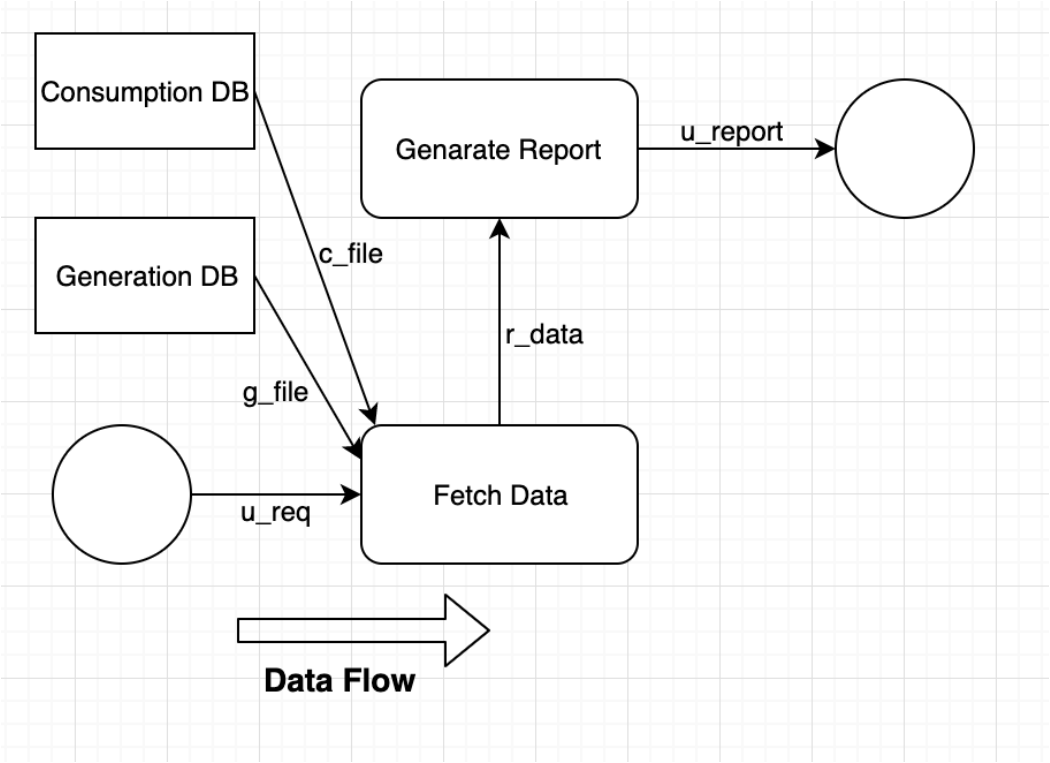
Mobile App
The frontend mobile application will be the main media through which the user can communicate with the system. There will be an iOS mobile App and an Android mobile App. Using the mobile app, the user will be able to view all the energy generation and energy consumption data, get more insights into this data using different graphs and charts, receive recommendations and control IoT devices. Also, the user will be able to receive push notifications about the current system performance or quick alerts.

Web App
In addition to the mobile app, the user will able to communicate with the system through the web app. The web app will provide some of the functionalities of the mobile applications. The user will be able to access the web app through Desktop computers or mobile phones.

Built-in App
All "Future House System" houses will have a pre-installed tablet-like screen through which the user can communicate with the system. The build-in app will provide similar functionalities to the mobile app.

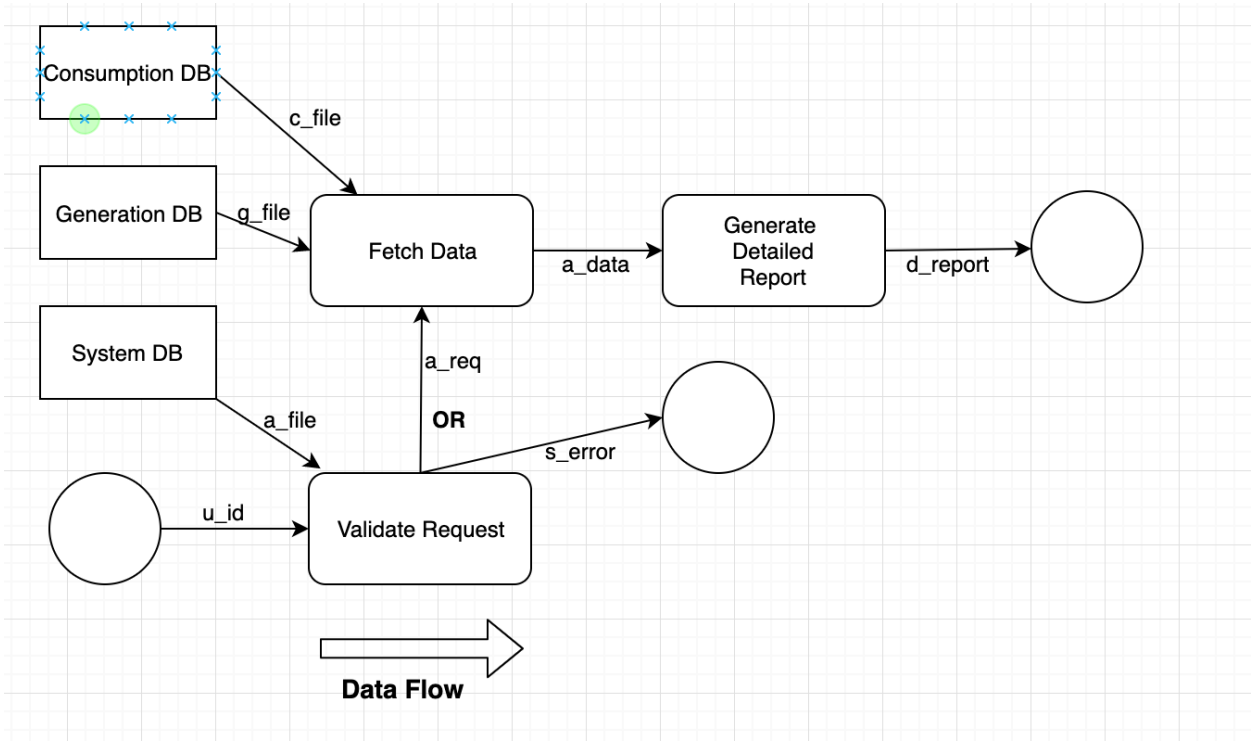
3.2. Data Flow Diagrams

A. Requesting Energy Report



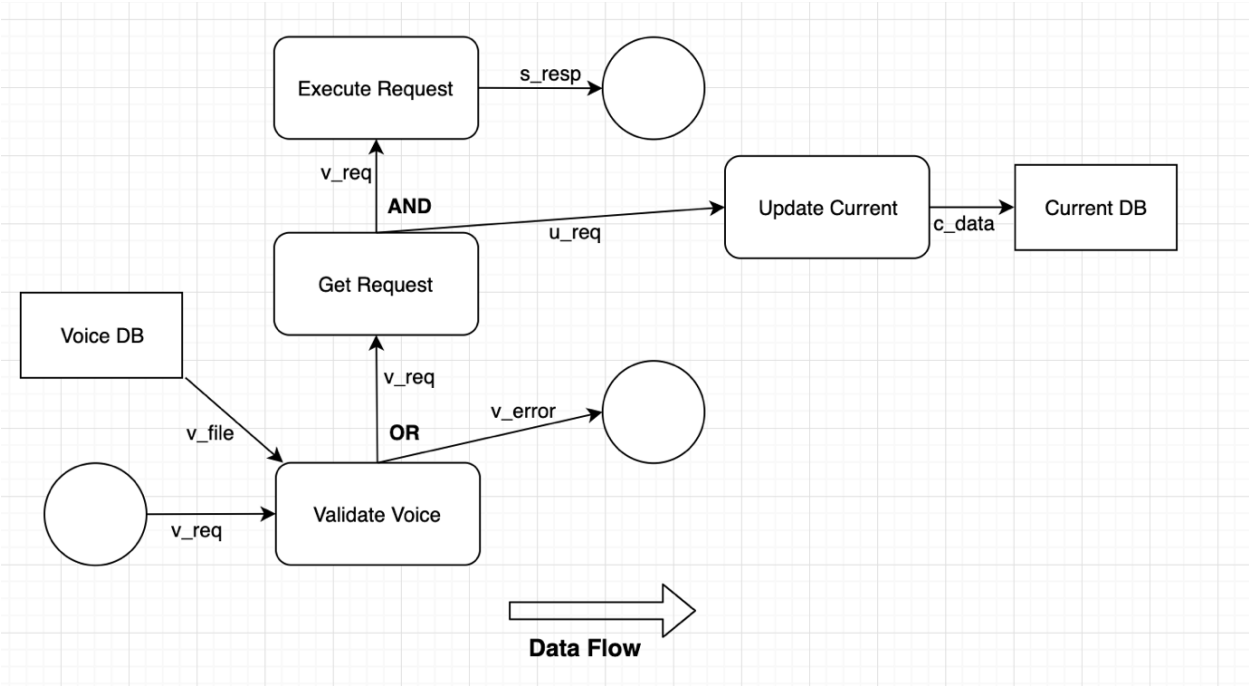
User requests energy report, system receives request and fetches required data from Consumption table and Generation table. The system then proceeds to generate the energy report data. The response is sent back to user containing the energy report data.

B. Manager Report



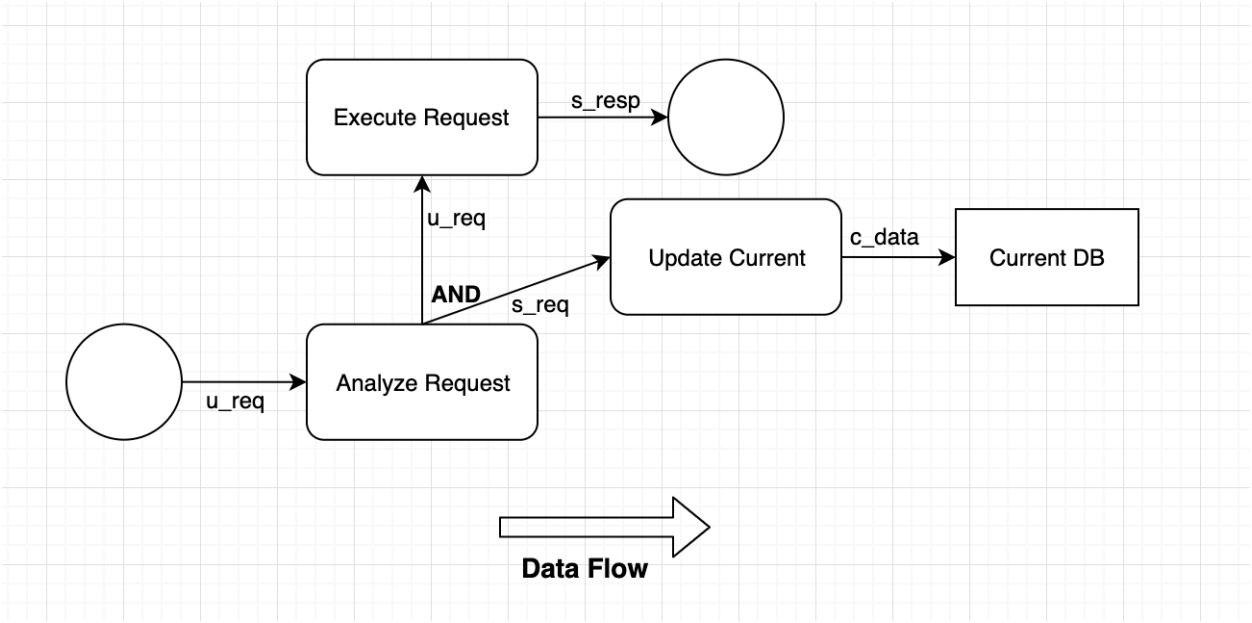
The user requests detailed energy report, the system receives the request with an authorization token. If the user is authorized and the request is validated then the system proceeds with request, else it sends out error message. The system fetches all the data required for creating this detailed report from Generation table and Consumption table and creates report data. The response is sent back to user containing the detailed energy report data.

C. Voice Request



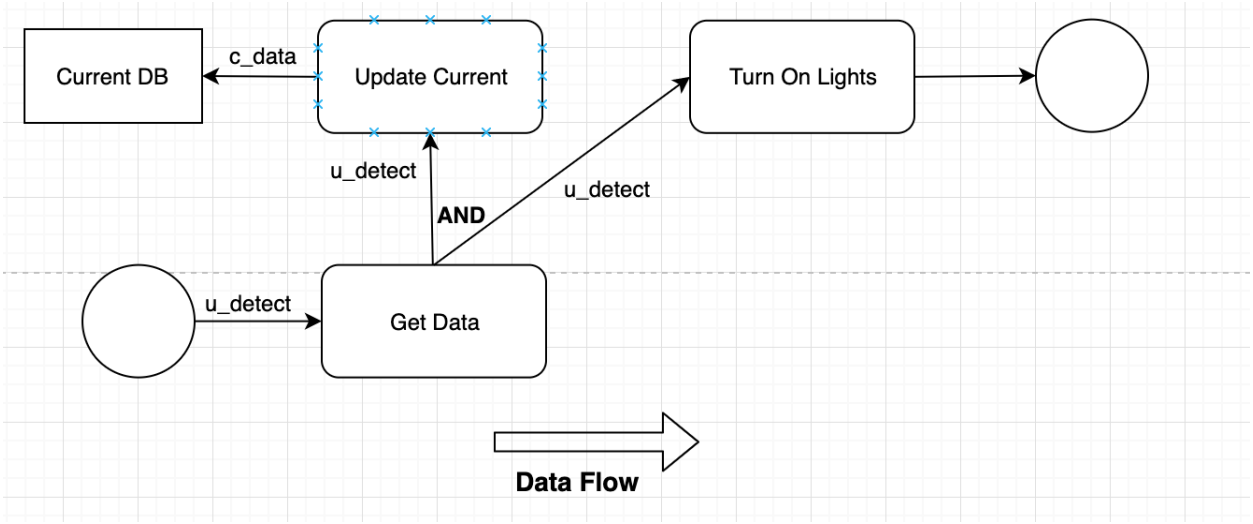
The user makes a voice request, the system picks up request and validates the voice using user voice data from Voice Database. If the voice is not valid, then system returns voice error, or else the system analyzes the request. The system executes the request and sends response to user and updates the database.

D. HTTP Request



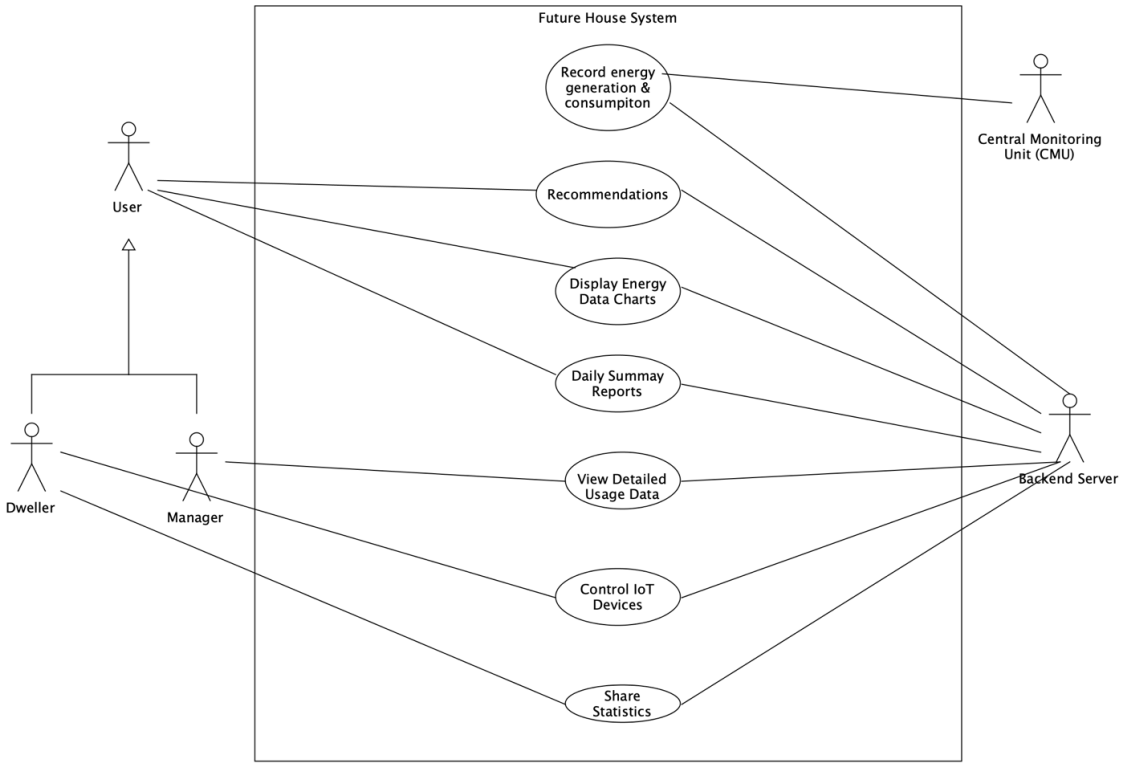
User sends a request through Application along with an authorization token. After the user is authorized, the needed request is executed and the DB is updated, then a response is sent back to the user.

E. Motion Detection



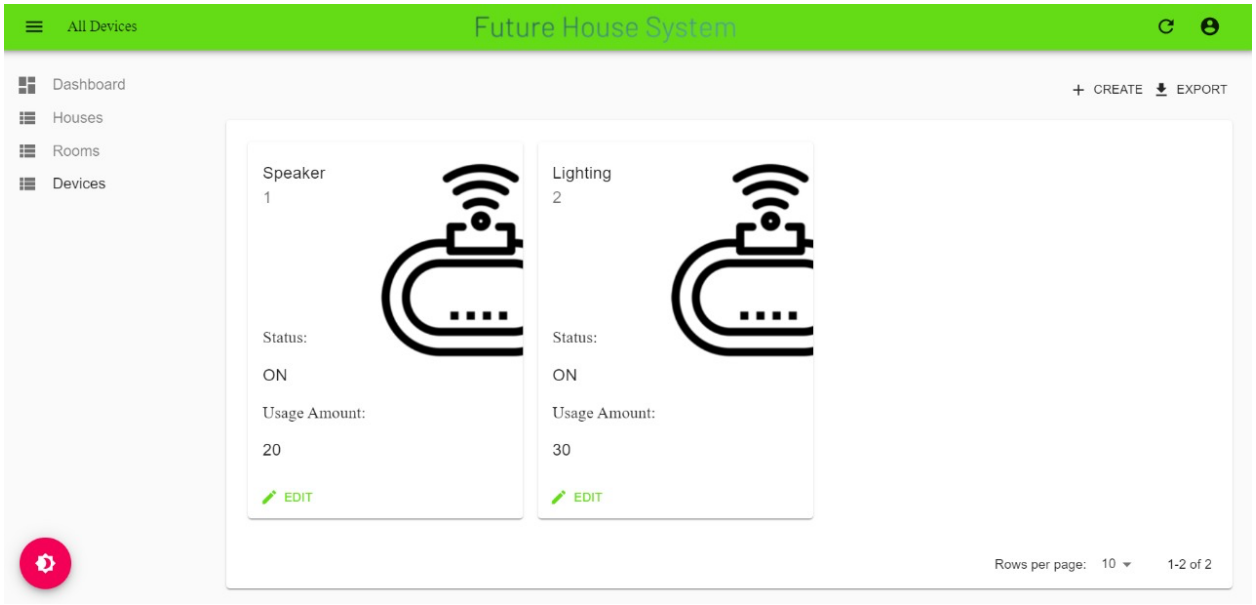
The motion sensors get triggered and the system analyzes sensor data. If the algorithm concludes the sensor was triggered by human, then it turns on lights and updates the database.

3.3. Use case diagram



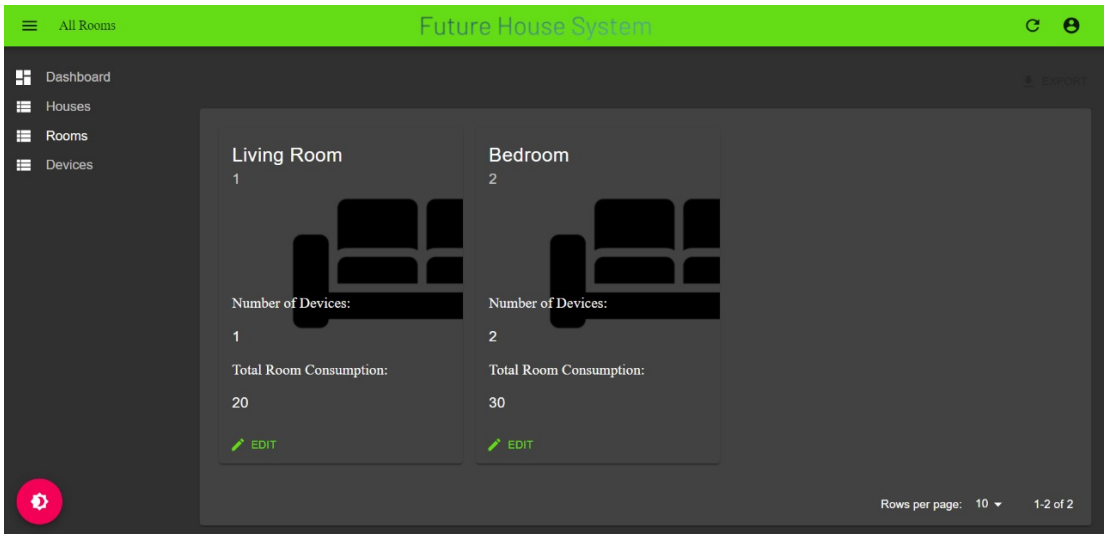
3.4. Interface Design

The following is some screenshots of some of the web app screens.

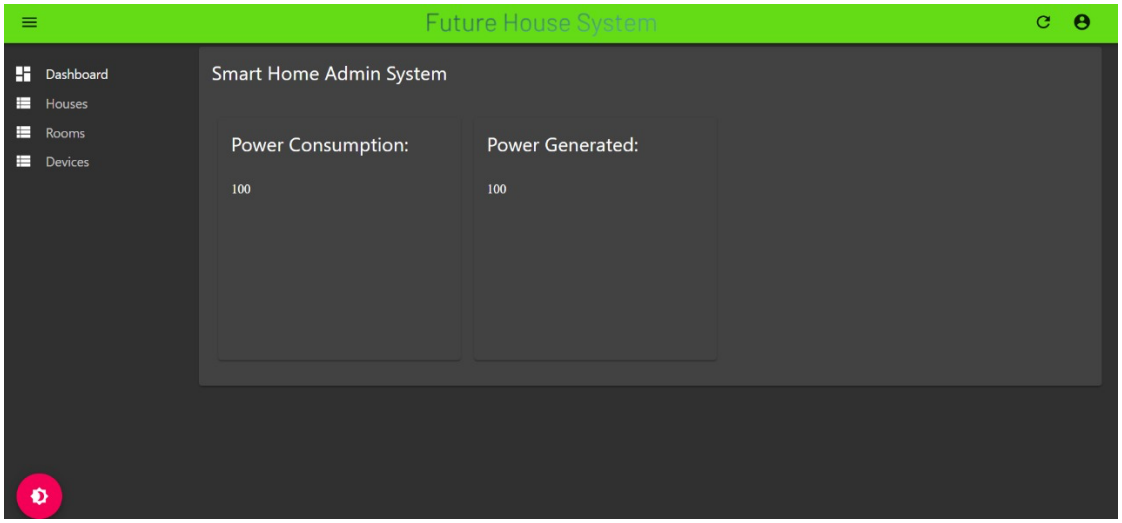


- IoT devices screen.

- Main House screen



- House rooms screen (Dark Mode).



- Dashboard screen (Dark Mode).

4. Implementation

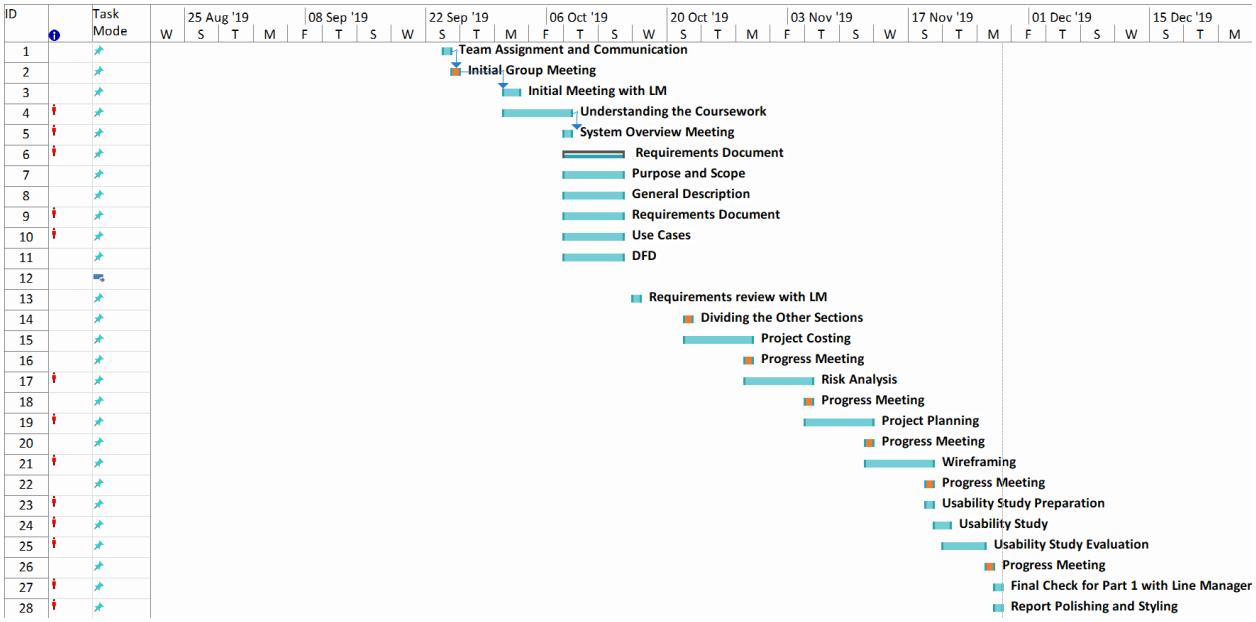
4.1. Software process

We have used a hybrid software process model called Water-Scrum-Fall [2], which combines Scrum and Water-Fall development methodologies. It is a flexible approach that embraces both traditional and Agile development principles and gives more freedom to development teams to use whatever techniques and practices that best meets the needs of their project. We have used Agile principles and Scrum communication techniques in our day-to-day product development, but we have employed traditional waterfall methodologies for planning and documenting the project's progress.

4.2. Iterations

4.2.1 . Stage 1

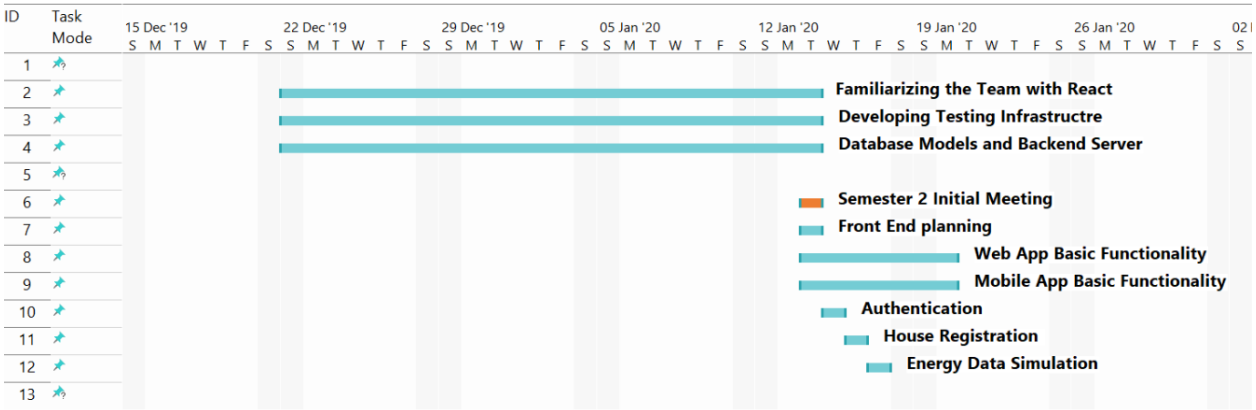
Task Name	Duration	Start	Finish	Predecessor Tasks	Team Members involved
Team Assignment and Communication	1 day	Tue 24/09/19	Tue 24/09/19		ALL
Initial Group Meeting	1 day	Wed 25/09/19	Wed 25/09/19	1	ALL
Initial Meeting with LM	2 days	Tue 01/10/19	Wed 02/10/19	2	ME
Understanding the Coursework	6 days	Tue 01/10/19	Tue 08/10/19		ALL
System Overview Meeting	1 day	Tue 08/10/19	Tue 08/10/19	4	ALL
Requirements Document	**1 wk**	**Tue 08/10/19**	**Mon 14/10/19**		**ALL**
Purpose and Scope	1 wk	Tue 08/10/19	Mon 14/10/19		ME,OB
General Description	1 wk	Tue 08/10/19	Mon 14/10/19		AR
Requirements Document	1 wk	Tue 08/10/19	Mon 14/10/19		ALL
Use Cases	1 wk	Tue 08/10/19	Mon 14/10/19		ALL
DFD	1 wk	Tue 08/10/19	Mon 14/10/19		HD
Requirements Review Meeting	1 day	Tue 15/10/19	Tue 15/10/19	6	ALL
Requirements review with LM	1 day	Wed 16/10/19	Wed 16/10/19	12	OB
Dividing the Other Sections	1 day	Tue 22/10/19	Tue 22/10/19		ALL
Project Costing	6 days	Tue 22/10/19	Tue 29/10/19		HD,IQ
Progress Meeting	1 day	Tue 29/10/19	Tue 29/10/19		ALL
Risk Analysis	6 days	Tue 29/10/19	Tue 05/11/19		OB
Progress Meeting	1 day	Tue 05/11/19	Tue 05/11/19		ALL
Project Planning	6 days	Tue 05/11/19	Tue 12/11/19		ME,OB
Progress Meeting	1 day	Tue 12/11/19	Tue 12/11/19		ALL
Wireframing	6 days	Tue 12/11/19	Tue 19/11/19		OB
Progress Meeting	1 day	Tue 19/11/19	Tue 19/11/19		ALL
Usability Study Preparation	1 day	Tue 19/11/19	Tue 19/11/19		OB
Usability Study	2 days	Wed 20/11/19	Thu 21/11/19		OB
Usability Study Evaluation	3 days	Thu 21/11/19	Mon 25/11/19		OB
Progress Meeting	1 day	Tue 26/11/19	Tue 26/11/19		ALL
Final Check for Part 1 with Line Manager	1 day	Wed 27/11/19	Wed 27/11/19		ALL
Report Polishing and Styling	1 day	Wed 27/11/19	Wed 27/11/19		ALL


ID
Task Mode
25 Aug '19
08 Sep '19
22 Sep '19
06 Oct '19
20 Oct '19
03 Nov '19
17 Nov '19
01 Dec '19
15 Dec '19
Team Assignment and Communication
Initial Group Meeting
Initial Meeting with LM
Understanding the Coursework
System Overview Meeting
Requirements Document
Purpose and Scope
General Description
Requirements Document
Use Cases
DFD
Requirements review with LM
Dividing the Other Sections
Project Costing
Progress Meeting
Risk Analysis
Progress Meeting
Project Planning
Progress Meeting
Wireframing
Progress Meeting
Usability Study Preparation
Usability Study
Usability Study Evaluation
Progress Meeting
Final Check for Part 1 with Line Manager
Report Polishing and Styling

4.2.2. Stage 2

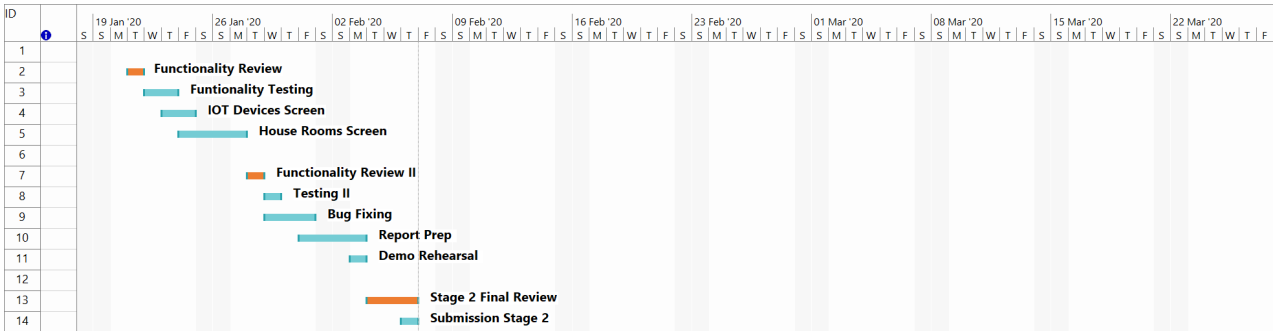
> Sprints 1 & 2

ID	Task Mode	Task Name	Duration	Start	Finish	Predecessor Tasks	Team Members
1		*Sprint 1 Start*					
2		Familiarizing the Team	18 days	Sun	Tue		ALL
3		Developing Testing	18 days	Sun	Tue		ME
4		Database Models and	18 days	Sun	Tue		OB
5		*Sprint 2 Start*					
6		*Semester 2 Initial*	1 day	Tue	Tue		ALL
7		Front End planning	1 day	Tue 14/01/2(	Tue 14/01/2(		ALL
8		Web App Basic	5 days	Tue	Mon		ALL
9		Mobile App Basic	5 days	Tue	Mon		ALL
10		Authentication	1 day	Wed 15/01/2	Wed 15/01/2		ALL
11		House Registration	1 day	Thu 16/01/2(	Thu 16/01/2(		ALL
12		Energy Data Simulation	1 day	Fri 17/01/20	Fri 17/01/20		ALL



- Sprints 3 to 5

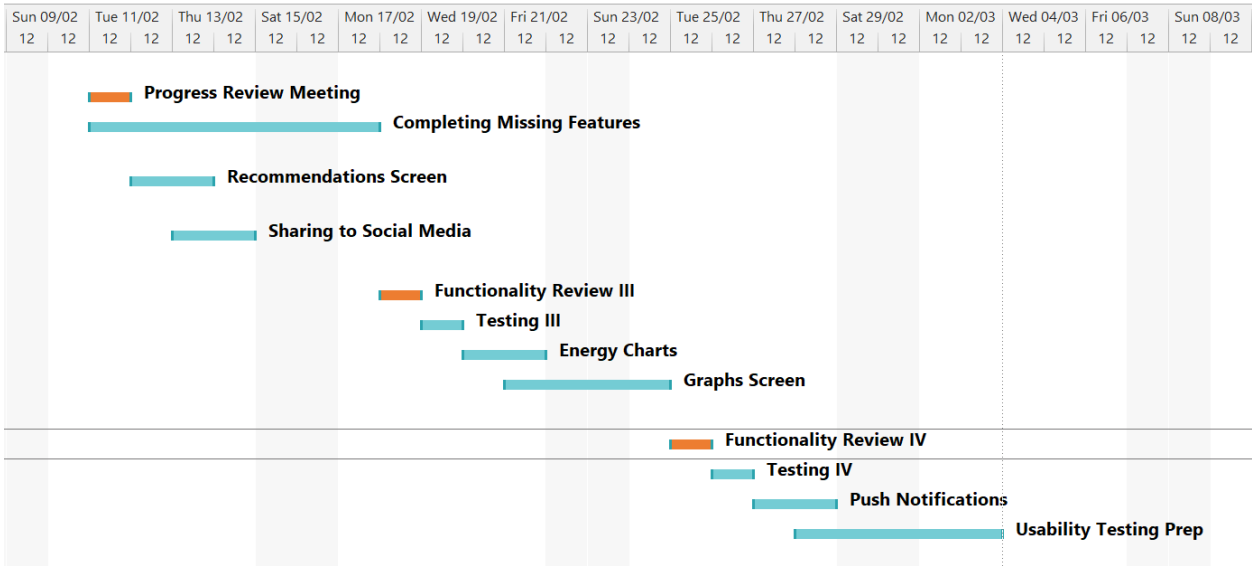
ID		Task Mode	Task Name	Duration	Start	Finish
1			*Sprint 3 Start*			
2			*Functionality Review*	1 day	Tue 21/01/2(	Tue 21/01/2(
3			Funtionality Testing	2 days	Wed 22/01/2	Thu 23/01/2(
4			IOT Devices Screen	2 days	Thu 23/01/2(	Fri 24/01/20
5			House Rooms Screen	2 days	Fri 24/01/20	Mon 27/01/2
6			*Sprint 4 Start*			
7			*Functionality Review II*	1 day	Tue 28/01/2(	Tue 28/01/2(
8			Testing II	1 day	Wed 29/01/2	Wed 29/01/2
9			Bug Fixing	3 days	Wed 29/01/2	Fri 31/01/20
10			Report Prep	2 days	Fri 31/01/20	Mon 03/02/2
11			Demo Rehearsal	1 day	Mon 03/02/2	Mon 03/02/2
12			*Sprint 5 Start*			
13			*Stage 2 Final Review*	3 days	Tue 04/02/2(	Thu 06/02/2(
14			Submission Stage 2	1 day	Thu 06/02/2(	Thu 06/02/2(



4.3.3. Stage 3

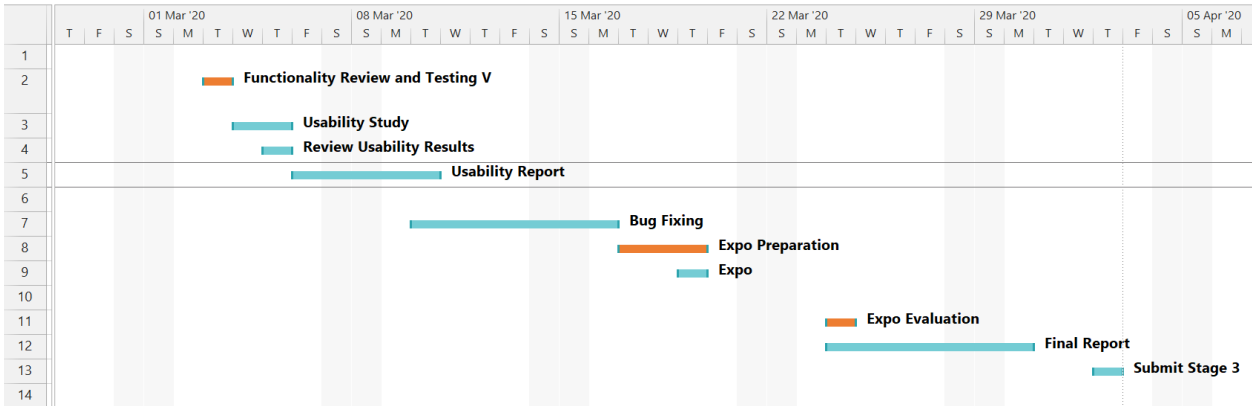
> Sprints 6 to 8

	Task Mode	Task Name	Duration	Start	Finish
1		*Sprint 6 Start*			
2		*Progress Review Meeting*	1 day	Tue 11/02/20	Tue 11/02/20
3		Completing Missing Features	5 days	Tue 11/02/20	Mon 17/02/20
4		Recommendations Screen	2 days	Wed 12/02/20	Thu 13/02/20
5		Sharing to Social Media	2 days	Thu 13/02/20	Fri 14/02/20
6		*Sprint 7 Start*			
7		*Functionality Review III*	1 day	Tue 18/02/20	Tue 18/02/20
8		Testing III	1 day	Wed 19/02/20	Wed 19/02/20
9		Energy Charts	2 days	Thu 20/02/20	Fri 21/02/20
10		Graphs Screen	2 days	Fri 21/02/20	Mon 24/02/20
11		*Sprint 8 Start*			
12		*Functionality Review IV*	1 day	Tue 25/02/20	Tue 25/02/20
13		Testing IV	1 day	Wed 26/02/20	Wed 26/02/20
14		Push Notifications	2 days	Thu 27/02/20	Fri 28/02/20
15		Usability Testing Prep	3 days	Fri 28/02/20	Tue 03/03/20



- Sprint 9 to 11

	Task Mode	Task Name	Duration	Start	Finish
1		*Sprint 9*			
2		*Functionality Review and Testing V*	1 day	Tue 03/03/20	Tue 03/03/20
3		Usability Study	2 days	Wed 04/03/20	Thu 05/03/20
4		Review Usability Results	1 day	Thu 05/03/20	Thu 05/03/20
5		Usability Report	3 days	Fri 06/03/20	Tue 10/03/20
6		*Sprint 10*			
7		Bug Fixing	1 wk	Tue 10/03/20	Mon 16/03/20
8		*Expo Preparation*	3 days	Tue 17/03/20	Thu 19/03/20
9		Expo	1 day	Thu 19/03/20	Thu 19/03/20
10		*Sprint 11*			
11		*Expo Evaluation*	1 day	Tue 24/03/20	Tue 24/03/20
12		Final Report	1 wk	Tue 24/03/20	Mon 30/03/20
13		Submit Stage 3	1 day	Thu 02/04/20	Thu 02/04/20



4.3. Technical Testing

Throughout the development process various testing software were used. To test the mobile applications the Detox testing software was used. In addition to testing software, we used traditional testing techniques as well such as print statements and break points. Also, we used manual Human-Device testing to ensure a reliable smooth flow throughout the application.

4.4 Robustness and Constraints

Since the system is simple, it is as robust. The simplicity of the system contributed towards its robustness, our system is robust as it functions without major hurdles. However, there are some problems which exist in the Web App code and some limitations which occur due to the online hosting service which we decided to use for the data simulation. This online server would sometimes crash, and as a result, our servers become inaccessible. This is a known constraint with the tradeoff that the database was freely synced, which meant there were no overhead costs for that operation. However, it came at the cost of API limits, which could be a concern with more users.

Furthermore, there are some issues with regards to Security and Authentication in the Web App, as attempting to use OAuth could not be implemented properly in time, and thus, a local solution had to be employed instead, which is less secure.

5. Organization

5.1. Group Organization

Stage 1

In stage 1 we tried to split the tasks of writing all the necessary documents. Every two weeks all the work done would be gathered up, styled and put in the report accordingly.

Pre Stage 2

The team members who was not familiar with React has spent the time in pre stage 2 during the winter break learning about React. In the meantime, the backend developer (Omar Basem) has built the backend server API which will feed the iOS, Android and Web applications.

Stage 2

In Stage 2 we started working on the iOS mobile App, Android mobile App and Web app frontend. Since only one member of the group (Omar Basem) knows mobile app development, so he focused his efforts on the mobile applications, and the rest of the team was working on the web app frontend. We were also working on the Stage 2 documents in parallel.

Stage 3

In stage 3, Omar Basem continued working on the mobile applications, the rest of the team was working on the web app frontend. We were also working on the Stage 3 documents in parallel.

6. System Install

6.1. How to install the system?

Fig 2. – A solar powered house[3]

Our Future House System can be installed into any house provided it has the necessary surface. The house needs to have a large enough surface area on the roof to install the solar panels. Also, a Central Monitoring Unit (CMU) along with other hardware accessories such as light sensors and microphones will be installed. In addition, a built-in tablet-like screen will be setup for the customer inside the house.

The user can then download the mobile application from the App Store or the Play Store, create an account and register their house. The user can also use the built-in screen or the web app.

In case of any technical issues that arise the user can contact us through any of the platforms.

6.2. User Guide

- First time user
- Access the webpage, you will be greeted with the login page, click on register here.
- Fill up the form, submit it and now you have your account with your house registered
- After registration, you will be logged in and can view the webapp dashboard.

- Adding New Device
- Go to devices page, click on the + add new device and connect and view your IOT device
- You can also edit your IOT device later

- Adding New House
- Go to houses page, click on the + add new house
- You will be prompted to enter your unique house ID, and your house will be connected
- You can also edit the House name and details later

- Editing Room Details
- Go to rooms page, click on the edit on the room card
- And edit room details

7. Uniqueness

7.1. Specialty and extra features

The specialty of our Future House System lies in the user friendliness and simplicity of the system. It also includes special/extra features in it such as:

Voice-Control: The users can control the system through voice commands

Pet Mode: Keeps Air-Con and required systems running when the user leaves the pets in house, also alerts the user if the system detects any emergency.

Power-Saving: The system has two modes that the user can switch to: Power Saving and Max Power Saving mode, these modes will reduce energy consumption by managing energy usage appropriately.

Dynamic Throughput: The system manages overall power throughput automatically based on battery level.

Auto-Sleep: System goes to sleep when it detects no users in the house.

Interactive Leader board: The system keeps a leader board of users based on the user's eco stat and awards badges for achievements which other users can view.

8. Usability Evaluation

8.1. Aims & Objectives

This section describes the UI design decisions of the Future House System as well as the usability experimental plan, experimental method, data collection and testing protocol. In addition, in includes analysis for the usability study responses, results and conclusion of our usability study.

8.2. Design decisions

8.2.1. Design Overview

The first thing we needed to consider when making the design decisions, is who will be using our product. Our product will be used by people of all ages: children, adults and elderly, so we needed to focus on making the design not complex and the most usable possible. The following sections shows screenshots of our design for the web app on Desktop, along with some design explanation.

8.3. Experimental Plan

8.3.1. Experimental method

The experimental method we used is a “Usability” study rather than an “Experimental” study. We observed the participants actions, and how they interacted with the different screens we present to them. The main objective of the testing plan is to test the usability of the user interface of the Future House System in order to get some feedback on whether the design we built is good or bad, and how easy it is to use the application.

Data Collection

The data was collected in compliance with GDPR. No personal information was obtained from the subjects at all. Every subject was given an ID. This means that the data is “Anonymous and unlinked” by GDPR standards. Data was collected through the prequestionnaires and post questionnaires, in addition to our observations.

Testing Protocol

During testing the participants, we followed the following protocol:

a. Welcome the participants and explain to them aim of this session which is to try out some of the features of a demo app which aims to provide control system over a solar powered house.
b. Give the participants more insight into the system’s main functionalities.
c. Explain to the participants how the test will be run, and that all their responses will stay anonymous.
d. Ask the participants to answer the prequestionnaire.
e. Start testing: show the participants several mock-up screens asking some to describe what they see on each screen in addition to other questions specific to every screen.
f. Ask the participants to answer the postquestionnaire, and thank them for participating.

8.3.2. Subjects Details

Due to the COVID-19 situation we were not required to carry out a usability study. However, we still managed to carry out a usability study with some of our family members, and online with some friends. We carried out our usability study on 11 subjects. 5 of them were aged 18-29, 2 were aged 30-49 and 4 subjects were 50+. As for the gender, 7 were males and 4 were females. 5 subjects considered themselves experienced with technology, while 4 subjects did not, and 2 subjects reported maybe. All of the subjects reported that they have not used a Smart House Control System before. The graphs below represent our subjects:

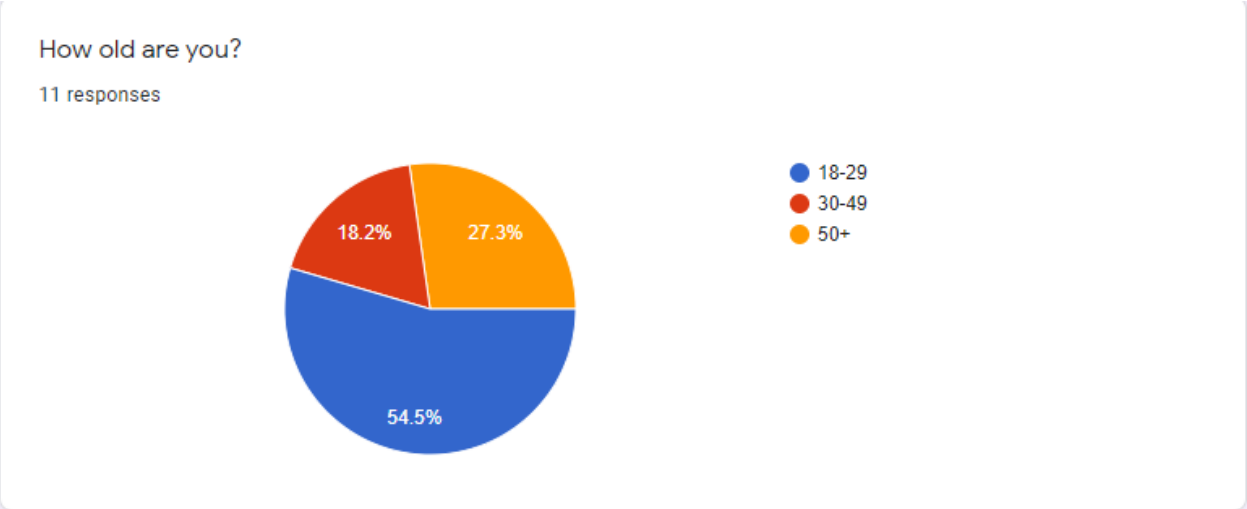


Figure 2 – Chart representing **Age** of subjects

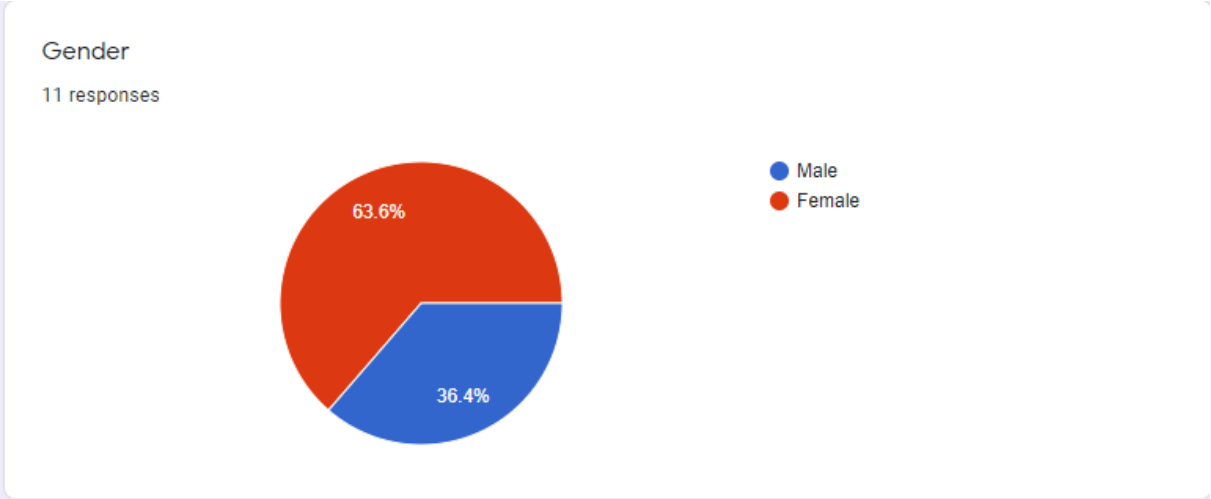


Figure 3 – Chart representing **Gender** of subjects

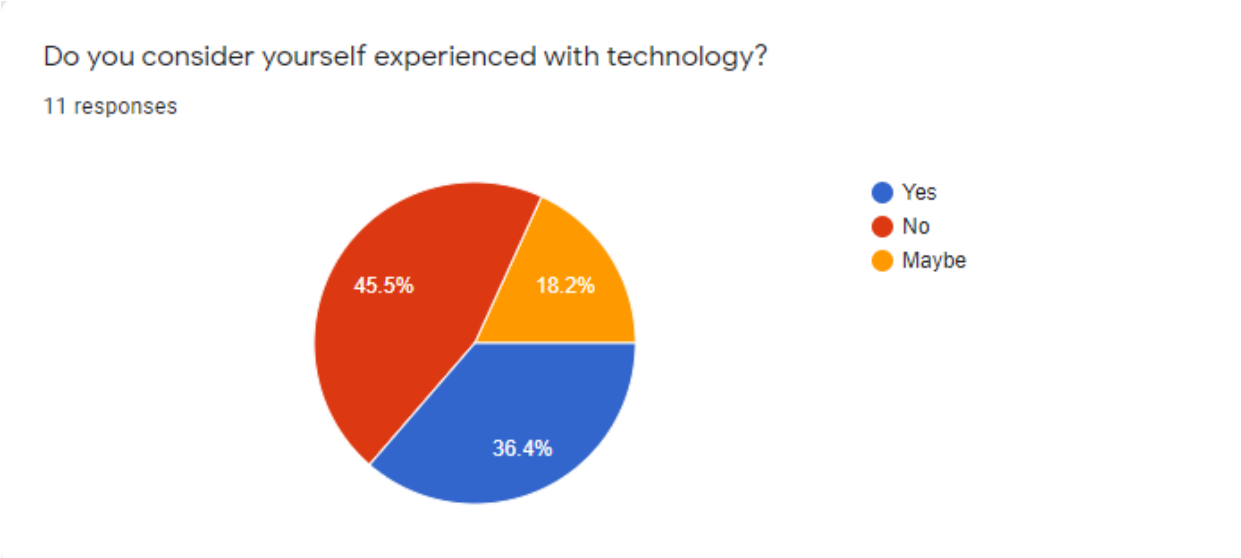


Figure 4 – Chart **representing whether subjects consider themselves experienced with technology**.

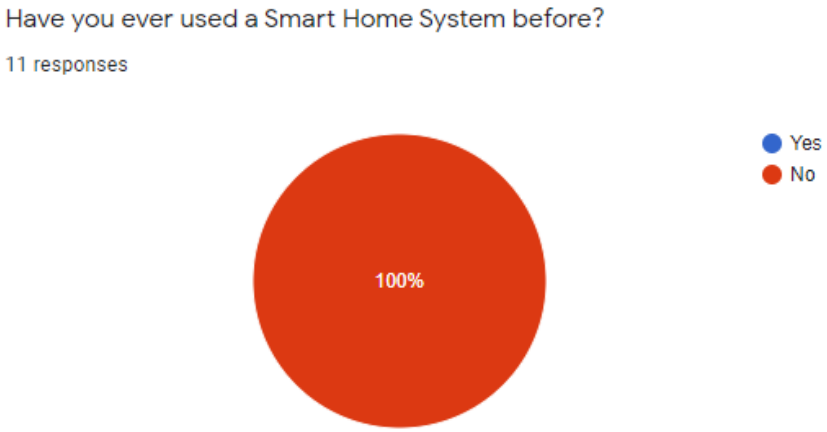


Figure 5 – Pie chart representing whether subjects **have used a Smart Home System before.**

8.3.3. Result analysis

Quantitative responses analysis:

The following is the quantitative responses analysis. The scale is as follows:

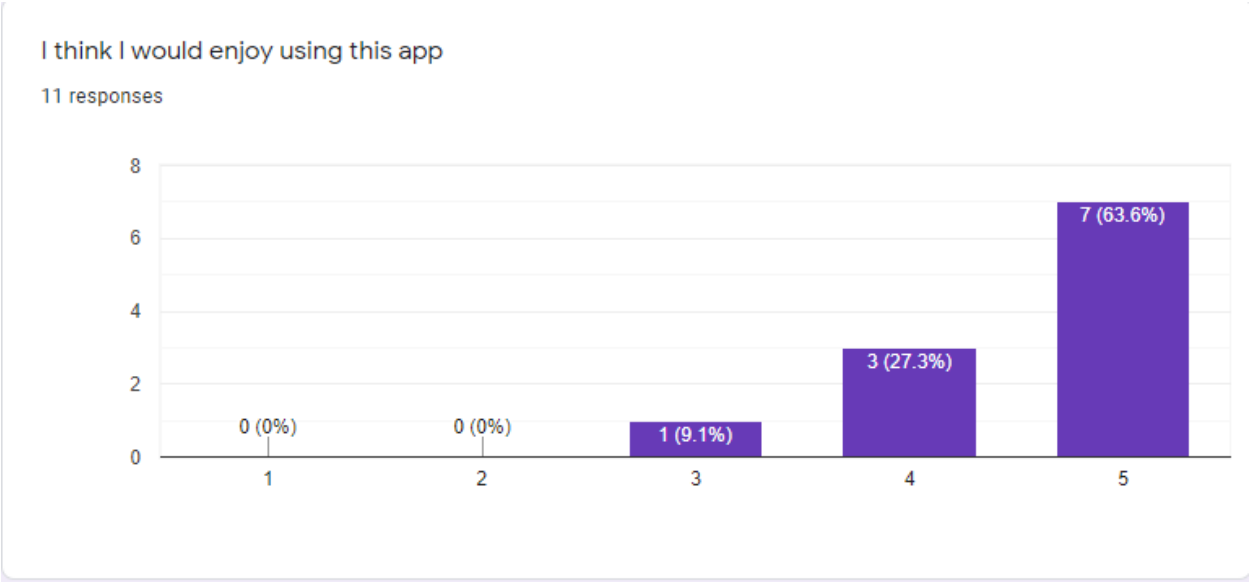
1 – Strongly Disagree

2 – Disagree

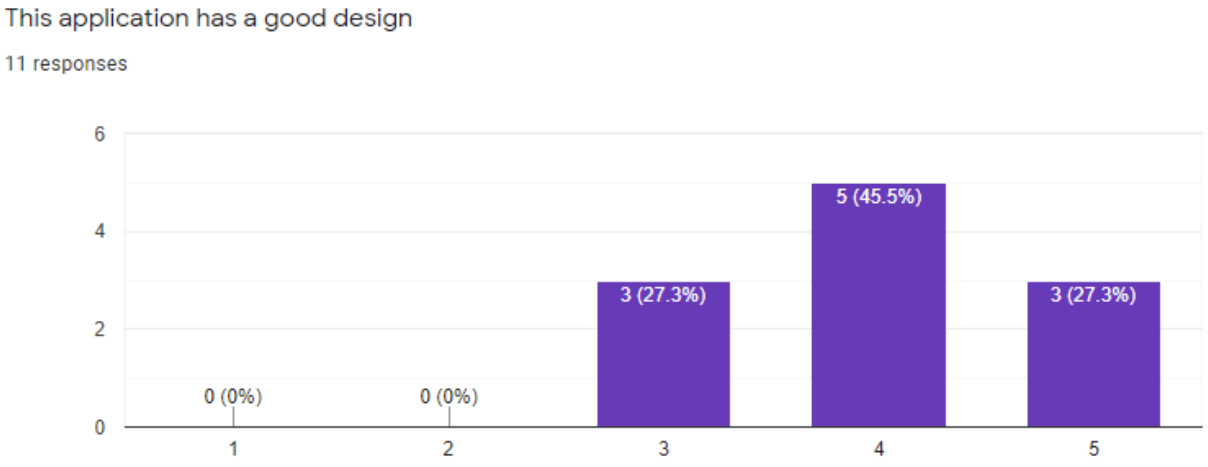
3 – Neutral

4 – Agree

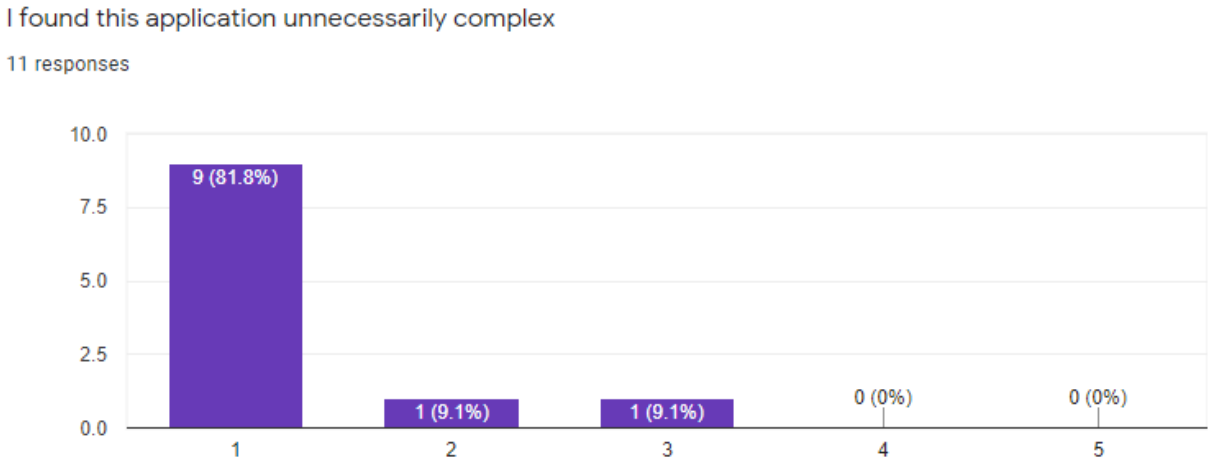
5 – Strongly Agree



- 91% of the subjects “Agreed” or “Strongly Agreed” that they would enjoy using this application.



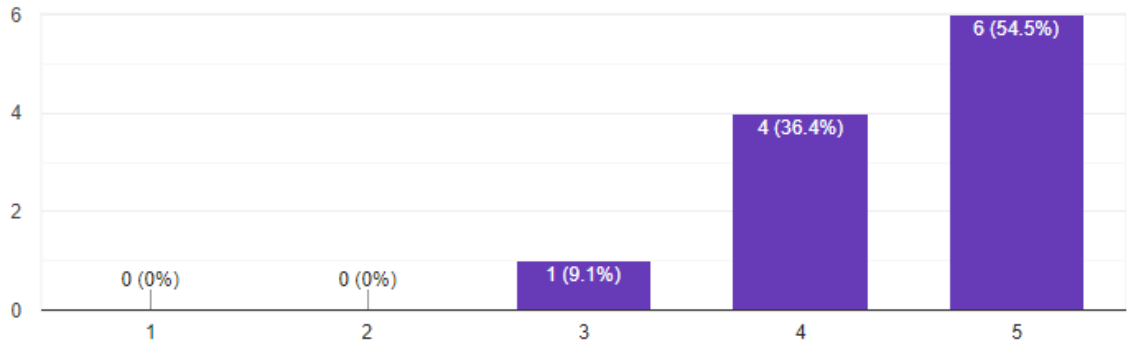
- 73% of subjects “Agreed” or “Strongly Agreed” that the app has a good design.



- 91% of subjects thinks that the application is not complex.

I was able to describe every screen with confidence and ease

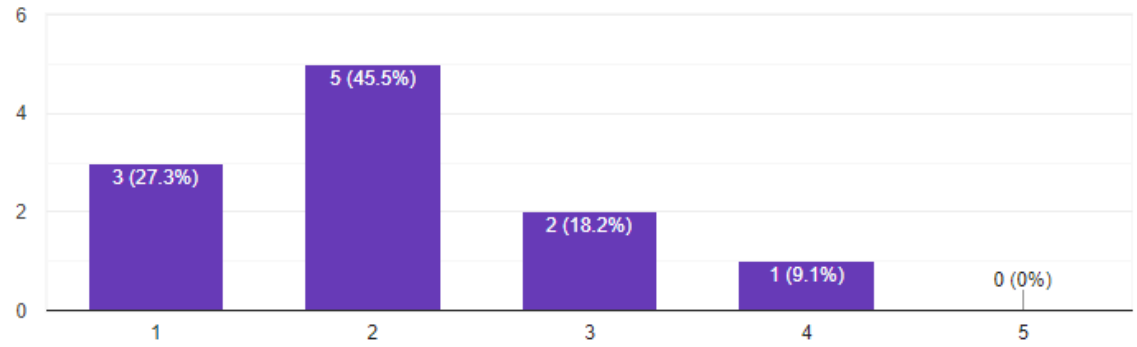
11 responses



- 91% of subjects was able to describe every screen with confidence and ease.

I think I would need the support of a technical person to be able to use the app

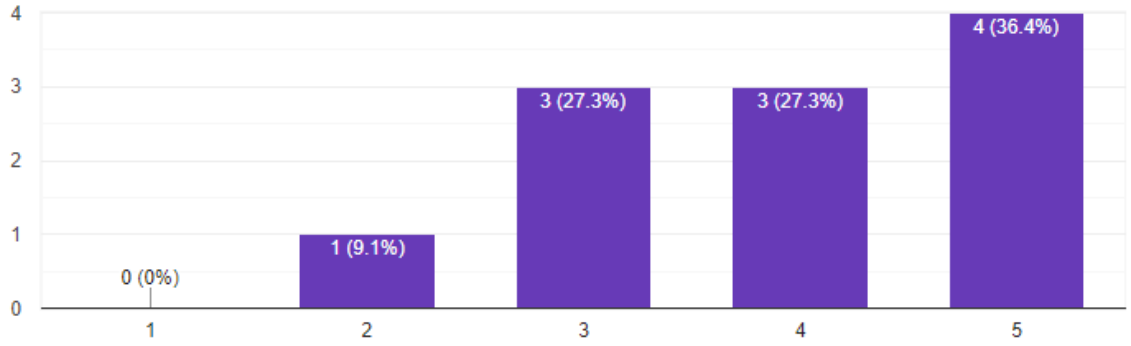
11 responses



- 73% of subjects thinks they would not need the support of a technical person to be able to use the application.

I think I would be using this app frequently

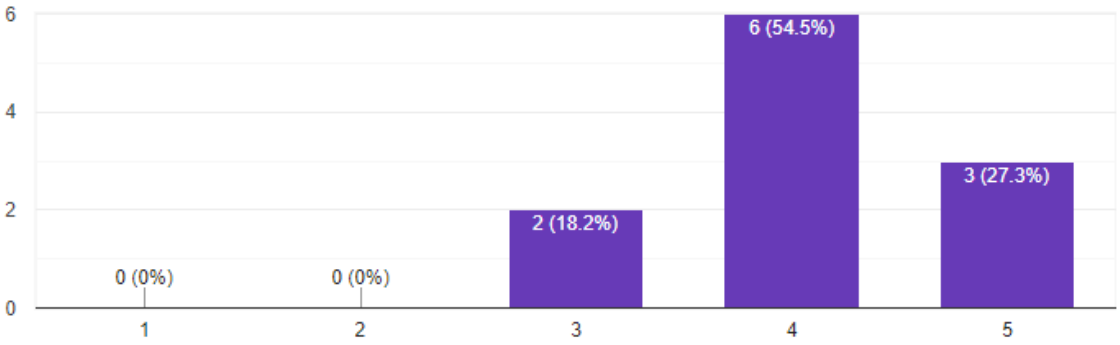
11 responses



- 64% of subjects think they would be using this app frequently.

The overall experience with this app was enjoyable

11 responses



- 73% of subjects found the overall experience to be enjoyable.

8.3.4. Conclusion

To conclude our usability study, most of the responses and the feedback we got on the experience and the design of the application were positive. 91% of the subjects “Agreed” or “Strongly Agreed” that they would enjoy using this app and found it easy to describe every screen. However there is always room for improvement. One improvement could be to add a way of gamification. Our design was simple and easy to use, and appealing enough for the average user.

8.4. Usability Appendices

8.4.1. Usability testing test plan

1. Objectives

We are testing the usability of the user interface of the Future House System in order to get some feedback on whether the design is good or bad, and how easy it is to use the application.

2. Participants

Future House System will be used by people of all ages, but all our subjects will be at least 18 years old.

3. Task Scenarios

• What they see:
We will show the participants some mock-ups and get feedback from them on what they think is displayed on the mock-up screen.
• Task 2 – Perform some tasks:
We will ask the participants to perform some tasks through the mock-ups, for example: “If you want to view the IoT devices page where shoud you click?”.

4. Metrics

• Ratings given by participants in the questionnaires (quantitative – subjective).
• Participants opinion (e.g. what they think can be improved (qualitative – subjective).

5. Questions

Before, during and after testing we will ask the participant the following questions:
• Do you consider yourself experienced with using technology?

- What do you think of the design of that screen?
- Do you think that part of the screen is useful?
- What do you think of the overall design and usability of the application?

Remember to say something like this with each new subject:

I'll ask you to look at the various screens and describe what you see, and I will ask you to complete a few simple tasks. I'll be taking notes to record your feedback and actions but my notes won't identify you and they will be completely anonymous. Following this we will ask you to complete an anonymous questionnaire to collect your general comments/feedback on the app. There are no right or wrong answers, and your interpretation of the information presented will be very useful in improving the design. Please tell the facilitator if you wish to stop at any time.

8.4.2. Mock-up testing protocol

Facilitator initials:
Session number:

Future House System testing protocol
20 November 2019
Heriot Watt University

Notes for facilitator
Please read through the aims and introduction with the participant and take notes alongside each of the questions to record the session. Please use a new protocol sheet for each participant and record your name and session number on the top right corner. In your notes please record the participant's responses and any issues they may have had in completing the tasks.

Aim

The aim of this session to try out some of the features of a prototype app which aims to provide control system over a solar powered house. The app is in early developmental stage and your input will be used to improve the functions and the way that the information is presented.

Introduction

The control system will record the energy consumption and generation in a House, and display these information to user inside the app in the form of different charts, as well as provide control over IoT devices in the house, give some recommendations based on the user's usage to improve the energy efficiency inside the house.
I'll ask you to look at various screens, both mobile and desktop, and describe what you see, and I will ask you to complete a few simple tasks. I'll be taking notes to record your feedback and actions, but my notes won't identify you and they will be completely anonymous. Following this we will ask you to complete an anonymous questionnaire to collect your general comments/feedback on the app. There are no right or wrong answers, and your interpretation of the information presented will be very useful in improving the design. Please tell the facilitator if you wish to stop at any time.

Let's begin.

8.4.3. Blank Pre-Questionnaire

Future House System Application Pre-Questionnaire

For all the following questions tick only one answer:

1. Age
• 18-29
• 30-49
• 50+

2. Gender
• Male
• Female

3. Do you consider yourself experienced with technology?
• Yes
• No
• Not sure

4. Have you ever used a House Control System application before?
• Yes
• No

8.4.4. Blank Post-Questionnaire

Future House System Application Post-Questionnaire

Thank you for participating in this usability testing. Please take the time to answer the following questions.

On a scale from 1 to 5, 1 being “Strongly Disagree” and 5 being “Strongly Agree”, answer the following questions:

1. I think I would enjoy using this app.
Strongly Disagree 1 2 3 4 5 Strongly Agree

2. This application has a good design.
Strongly Disagree 1 2 3 4 5 Strongly Agree

3. I found this application unnecessarily complex.
Strongly Disagree 1 2 3 4 5 Strongly Agree

4. I would imagine that most people would learn to use this app very quickly.
Strongly Disagree 1 2 3 4 5 Strongly Agree

5. I was able to describe every screen with confidence and ease
Strongly Disagree 1 2 3 4 5 Strongly Agree

6. I think I would need the support of a technical person to be able to use the app.
Strongly Disagree 1 2 3 4 5 Strongly Agree

7. I think I would be using this app frequently
Strongly Disagree 1 2 3 4 5 Strongly Agree

8. The overall experience with this app was enjoyable.
Strongly Disagree 1 2 3 4 5 Strongly Agree

9. What did you like about this application?
……
……

10.What did you not like about this application?
……
……

11.What do you think can be improved in this application?

……

……

That’s the end of the questionnaire. Thank you for participating with us.

5.4.5. Blank consent form

Future House System
Heriot-Watt University

Consent to Act as a Subject in an Experimental Study

Principal Investigator: Omar Basem, Ibrahim Qureshi, Mahmoud Elsheikh, Harshan Divakaran, Malek Hammad, Arathi Ramdas

Description: The purpose of this study is to study the usability of the user interface of the Future House System. There are minimal risks for you to participate in this study. All personal information will be kept confidential in a secure filing cabinet or in password-protected computer directories. Your participation will not affect how well you do in your courses (if you are a student) or affect your relationship with the university in any way You are free to decline to participate in this study. Should you decide to participate, you are free to end your participation at any time. Such a decision by you will not adversely affect or alter you status with the university in any way.

Voluntary consent: I certify that I have read the preceding and that I understand its contents. Any questions I have pertaining to the research have been and will be answered by the team. My signature below means that I have freely agreed to participate in this study, and that I agree to the publication of the results for scientific purposes and to the distribution of the recordings and transcripts of the sessions for research purposes so long as my identity is not revealed.

_____ _____
_____
Date Subject Signature
Inv. Initials

Investigator's certification: I certify that I have explained to the above individual the nature and purpose, the potential benefits, and possible risks associated with participation in this research study, have answered any questions that have been raised, and have witnessed the above signature.

_____
_____
Date Investigator Signature

9. References

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3. Lara. Solar Powered Houses. September 2019 [Internet]. Available from: https://www.mippin.com/solar-powered-houses-10-important-considerations-to-discuss-with-your-home-builder/