

CSC440 Human Computer Interaction
1st Semester 1446

Project Final Report

Project Title	Smart Home App
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Date of Submission	

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Problem Statement

In modern households, convenience, control, and energy efficiency are essential for users looking to simplify home management through technology. Existing smart home solutions often lack user-centered design, leading to usability challenges such as complex interfaces, inefficient energy management, and insufficient customization for diverse users, including elderly or disabled individuals.

This project aims to address these gaps by developing an intuitive, highly customizable smart home system. Our solution will integrate Internet of Things (IoT) technology to offer seamless control of lighting, temperature, and security, focusing on accessibility and energy efficiency. This approach will enable users to manage their homes more effectively than current market solutions.

System Analysis

Users:

The primary users are families, busy professionals, elderly individuals, individuals with special needs, and those seeking comfort, all of whom value convenience, accessibility, and efficient home management. Key features for each group include voice commands, automated control of appliances, and easy navigation.

Requirements:

1. **Ease of Use:** Interface design must be intuitive and suitable for users of all ages.
2. **Accessibility:** Voice control and customizable settings to accommodate various physical abilities.
3. **Message Alerts:** The system should provide clear and actionable alert messages to users, especially for security and device-related issues.

Proposed Solution

The proposed smart home design utilizes IoT-connected devices, enabling users to efficiently manage their home environment. Technologies employed in the system include voice control integration (e.g., with Google Home or Amazon Alexa), an interactive mobile app, and automated device management through sensors. The system is designed to be intuitive and user-friendly, providing easy control over various home devices like lighting, heating, and security systems.

Incorporating smart alert messages, the system aims to enhance user experience by notifying users of critical events, such as security breaches or device malfunctions. This approach ensures users can respond to issues immediately, improving overall system reliability and user confidence.

By comparing existing smart home apps, we ensure our design enhances functionality without reinventing the wheel. The focus is on superior usability, offering customization options that current solutions lack.

Additionally, the system will provide seamless integration with common smart devices, ensuring a cohesive and efficient user experience.

Our Prototypes

In our project we made 2 prototypes.

Prototype 1.0:

Have the screens (Home Screen, Room-Specific Control Panel, Device Control - Amazon Echo 2, Adding Room Screens, Settings Screen, Message Alert Screen).

After the first Evaluation with half of our Participant and hear their input on improvements that can be made, we added 2 more Screens to accommodate their needs in Prototype 1.1.

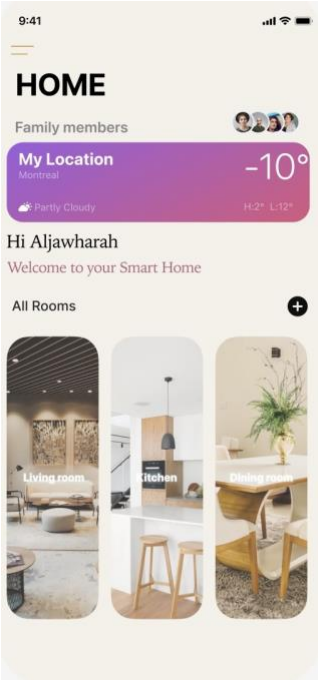
Prototype 1.1:

Have all the screens of Prototype 1.0 and the new slides the screens (Schedule Room Light, Adding Voice Command).

System Design

This section presents the design of the smart home system prototype, highlighting key screens and the design principles applied to each. It illustrates how the design focuses on user interaction, usability, and clarity. Trade-offs between conflicting principles, such as simplicity versus detailed information, were made to ensure a balance between ease of use and system functionality. Each screen is designed with specific user needs in mind, aiming to create an intuitive and responsive experience.

Prototype 1.0



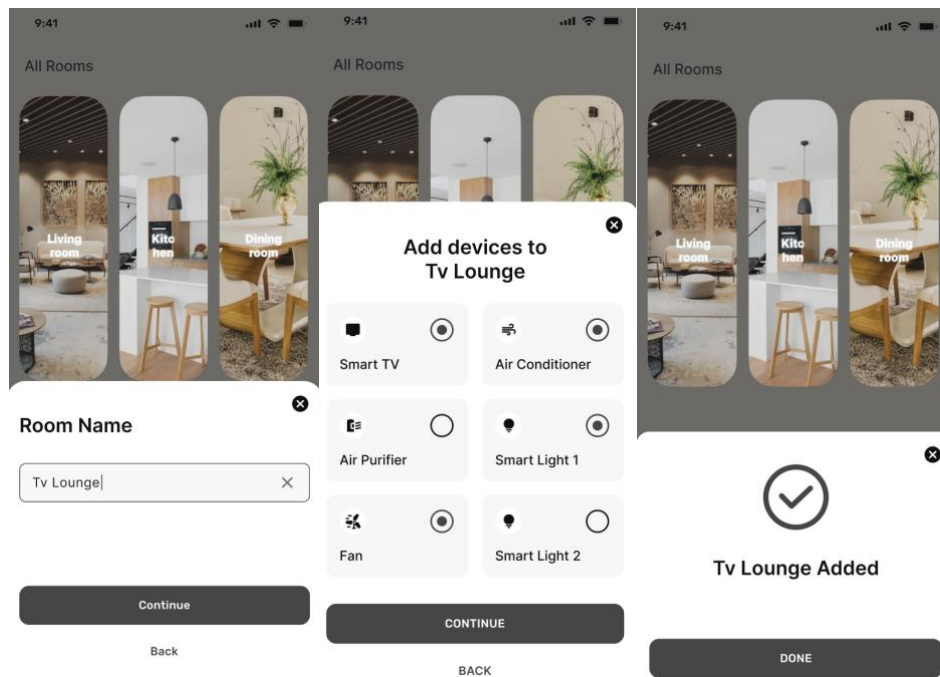
Home Screen		
The Home Screen provides a quick overview of rooms, allowing users to control various devices and access system settings.		
Design Principle	How it was applied	Justification
Consistency and Standards	The interface maintains uniform icons and labels, creating a familiar layout that helps users navigate smoothly across different sections.	Consistent design reduces user confusion and promotes faster learning, as users encounter similar visuals and terminology throughout.
Recognition rather than Recall	The Home Screen shows recognizable icons and labels, minimizing the need for users to remember functions from previous screens.	By focusing on recognition, the design eases cognitive load and helps users perform tasks more efficiently.
Trade Offs: Clarity vs. Completeness. The dashboard prioritizes clarity by displaying only essential controls, while less frequently accessed options are grouped in secondary menus. This design minimizes clutter but requires an extra step for users seeking detailed features.		



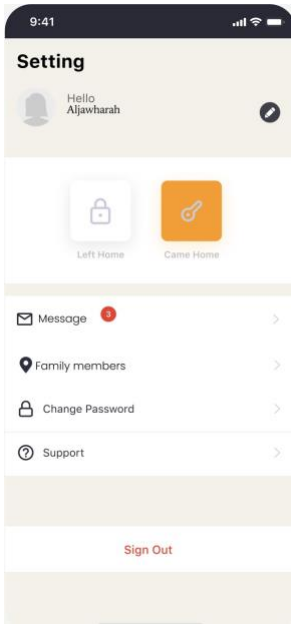
Room-Specific Control Panel		
A dedicated screen for managing devices in a particular room, allowing users to control aspects like lighting and devices.		
Design Principle	How it was applied	Justification
User Control and Freedom	Users have options to adjust settings within each room directly, with flexibility to reset or customize each device as needed.	Giving users full control within specific environments aligns the interface with users' mental models of managing separate spaces.
Trade Offs: Detail vs. Minimalism. The room screen includes basic controls upfront, with in-depth settings in submenus, balancing simplicity for novice users with advanced options for experienced users.		



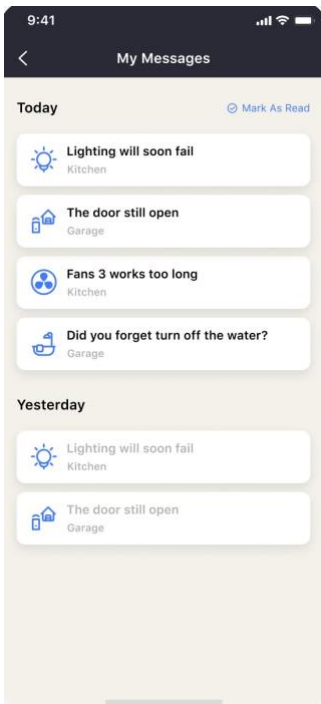
Device Control - Amazon Echo 2		
This screen provides controls and status information for the Amazon Echo 2 smart device, allowing users to monitor its power usage and access quick actions for device control.		
Design Principle	How it was applied	Justification
User Control and Freedom	Users can control various functions of the Echo device, such as muting the microphone, adjusting volume, and accessing Wi-Fi settings. This flexibility enables them to personalize device settings according to their preferences.	Offering multiple control options gives users the freedom to interact with the device in different ways, making it adaptable to diverse needs.
Visibility of System Status	The interface displays important information, such as the device's power usage (93 kWh for the current day). This helps users stay informed about the device's current state.	Clear visibility of key metrics like power usage enhances user awareness and allows for better energy management.
Trade Offs: Functionality vs. Simplicity. Including many control options (like power usage, music, and Wi-Fi settings) provides flexibility but can make the screen feel crowded. To keep things simple, only essential controls are shown upfront, while others are placed in secondary menus to avoid overwhelming the user.		



Adding Room Screens		
The screenshots illustrate the user interface for adding a new room to the smart home system. This feature is designed to enhance the flexibility and personalization of the user's smart home environment by allowing users to create specific rooms and assign compatible smart devices to each one.		
Design Principle	How it was applied	Justification
Error Prevention	Pre-populated fields and dropdowns minimize entry errors when specifying room details, such as selecting device types.	Reducing the need for manual data entry and providing predefined options lowers the chance of errors, helping users to complete the setup smoothly and efficiently.
Feedback	A "Done" button is provided at the end of the setup process, clearly indicating completion.	This final action gives users a clear sense of task completion, enhancing satisfaction and reducing confusion about next steps.
User Control and Freedom	Users can name rooms as they prefer and select specific devices to add to each room (e.g., Smart TV, Air Conditioner).	This customization empowers users to create a personalized smart home environment, aligning the system to their specific needs and preferences.
Trade Offs: User Control vs. Risk of Error: Giving users control over room naming and device assignment enhances the feeling of ownership, but it also increases the risk of errors, such as misspelled room names or assigning the wrong devices to rooms. While error prevention mechanisms (e.g., autocomplete suggestions or device categorization) could reduce these risks, they may also slightly limit the user's freedom and control.		

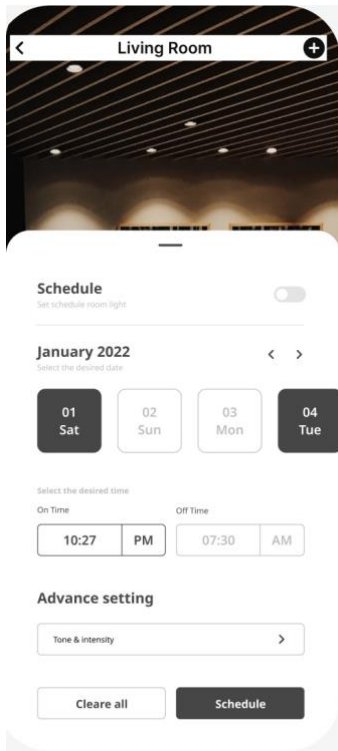


Settings Screen		
The settings screen of this smart home app features "Come Home" and "Left Home" toggles, allowing users to automate actions like adjusting lights and security based on their location. It also includes options for messaging, password changes, and support, all organized for easy navigation. This design effectively combines automation with user control for a seamless smart home experience.		
Design Principle	How it was applied	Justification
User Control	While the app provides automation, the user is still given control over these location-based features, as indicated by the separate "Come Home" and "Left Home" toggles.	Maintaining user control over automated features ensures the app respects user preferences and avoids frustrating override scenarios.
Clarity	The clear section headers, such as "Setting", "Message", and "Family members", help users quickly identify the purpose of each menu option.	Providing clear labeling and structure improves the user's understanding of the interface.
Trade-Off: Automation vs. User Control. While automation simplifies tasks like adjusting lights upon arrival or departure, it might limit user flexibility if misconfigured. The design addresses this by providing manual toggles, enabling users to override automation when desired.		

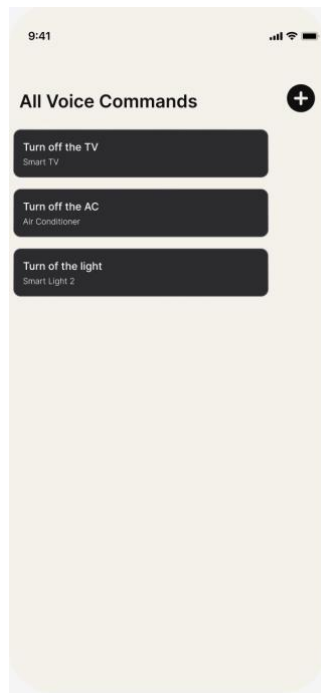
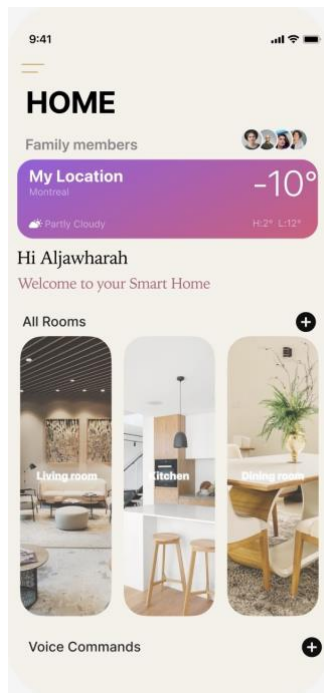


Message Alert Screen		
The message alert screen displays notifications related to the smart home system's status and potential issues. Each alert card is timestamped as "Today" or "Yesterday" for easy reference. Notifications include warnings like "Lighting will soon fail," "The door still open," "Fans 3 works too long," and reminders such as "Did you forget to turn off the water?" Each message includes an icon and specifies the room (e.g., Kitchen, Garage) to help users quickly identify and address issues. A "Mark As Read" option allows users to manage notifications efficiently.		
Design Principle	How it was applied	Justification
Error Prevention	The app provides timely notifications about potential issues (e.g., "The door still open," "Lighting will soon fail"), allowing users to address problems before they escalate.	Notifications increase user awareness of possible hazards or maintenance needs, helping prevent overlooked issues and enhancing safety.
Trade Offs: Notification Frequency vs. User Experience. Frequent alerts might be essential for safety and maintenance but could overwhelm the user. This screen mitigates this by grouping notifications by date and providing a "Mark As Read" option, balancing user awareness with control over notification management.		

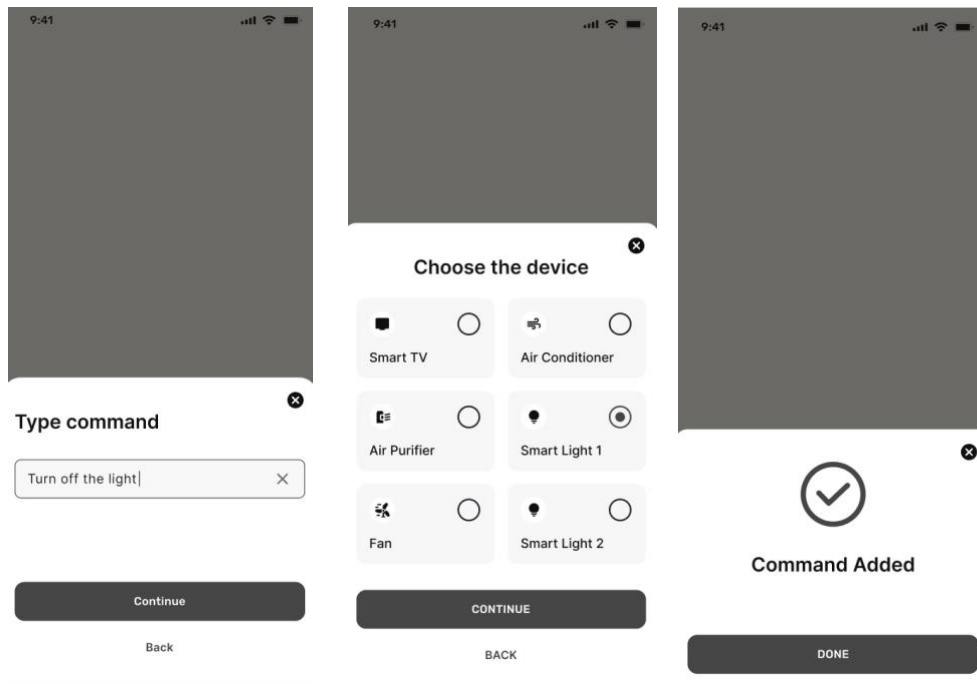
Prototype 1.1 : new screens.



Schedule Room Light		
This screen allows users to set schedules for room lighting, providing control over when lights turn on or off automatically.		
Design Principle	How it was applied	Justification
User Control and Freedom	Users can customize lighting schedules based on their preferences, such as setting lights to turn on or off at specific times, enhancing flexibility and convenience.	This feature empowers users to create routines that align with their lifestyle, making the system adaptable to individual needs.
Trade Offs: Flexibility vs. Simplicity. The screen focuses on essential scheduling options for ease of use, while additional advanced scheduling features are available through submenus, maintaining a balance between user control and an uncluttered design.		



Voice Commands Button and All Voice Commands		
The addition of the "Voice Commands" button on the Home Screen provides users with quick access to view all existing voice commands in the system. This leads to a dedicated page displaying a list of all defined voice commands along with their associated devices. This change improves visibility and accessibility, allowing users to review and manage their voice commands easily.		
Design Principle	How it was applied	Justification
Visibility of System Status	A dedicated "Voice Commands" button on the Home Screen ensures users are aware of the feature's existence. The list page provides real-time visibility into all defined commands and their linked devices.	This allows users to stay informed about the system setup, enhancing confidence and usability.
Trade Offs: Flexibility vs. Simplicity. The screen focuses on essential scheduling options for ease of use, while additional maintaining a balance between user control and an uncluttered design.		



Adding Voice Commands		
The screenshots illustrate the user interface for adding voice commands to the smart home system. This feature allows users to create personalized voice commands by specifying the voice command itself, the connected device name. It enhances user customization and automation in managing smart home environments.		
Design Principle	How it was applied	Justification
Simplicity	Users only need to input two essential details: the voice command and the connected device.	Reduces complexity by focusing only on the necessary fields, minimizing potential confusion and making the process more user-friendly.
Consistency	The interface uses the same steps style for device selection as seen in other system configuration screens (Adding Room Screens)	Maintains uniformity across the system, reducing cognitive load by ensuring familiarity in design and interaction patterns.
Feedback	A dynamic preview shows how the command will operate for example , "Saying "Turn off the light" will control the smart light device".	Helps users understand the functionality of the command immediately, ensuring they feel comfortable with how it will perform.
	A "Done" button is provided at the end of the setup process, clearly indicating completion.	This final action gives users a clear sense of task completion, enhancing satisfaction and reducing confusion about next steps.
Trade Offs: simplicity vs. advanced features: Focusing on simplicity by limiting the interface to only essential fields (command and device) reduce complexity for the majority of users but sacrifices flexibility for advanced users. This balance ensures the interface is approachable for new users while potentially limiting advanced automation capabilities.		

Evaluation Plan

Hypothesis:

The smart home interface provided will allow participants to complete all assigned tasks effectively, efficiently, and with high satisfaction, demonstrating its overall usability and functionality, specifically:

1. Users will find it easy to add and configure new rooms.
2. Alert messages will be clear.
3. Adjusting lighting settings will be intuitive.
4. Users will be able to add and configure new voice commands.
5. Device integration will be straightforward and user-friendly.

Participant Organization:

This study uses a **within-group design**, where we have **6 participants** with mixed demographics (young adults, families, elderly), each will perform the same set of tasks on the interface. This approach ensures that each participant provides feedback on all aspects of the system, allowing for comprehensive evaluation across tasks.

- Participants are not divided into groups, as the focus is on testing a single interface for usability and functionality across all tasks.
- The tasks will be presented in the same sequence for all participants.

Part 1: Usability Tests

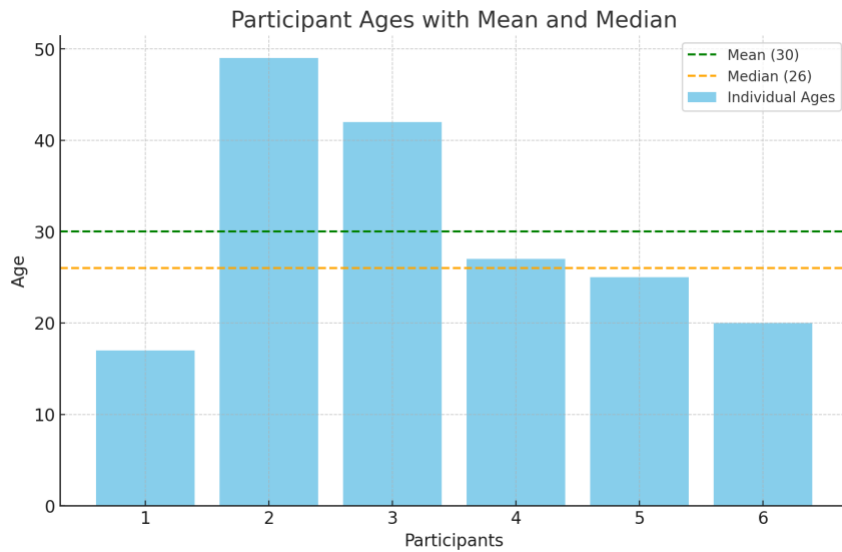
1.1 Participant Profiles

Participant name	Age	Gender	Grade	Average knowledge of the concept (1-5)	Use of handheld device(1-5)
1 Azam	17	Male	High school	5	5
2 Mohammed	49	Male	Graduate	3	2
3 Abeer	42	Female	Graduate	4	4
4 Khaild	27	Male	Graduate	5	5
5 Sadeem	25	Female	Graduate	5	5
6 Munira	20	Female	Undergraduate	5	5

Given ages: **17, 49, 42, 27, 25, 20**

1. **Mean (Average Age):** $(17+49+42+27+25+20)/6 = 30$
2. **Median (Middle Value):** When sorted (17, 20, 25, 27, 42, 49), the middle two values are 25 and 27, so the median is $(25+27)/2 = 26$.
3. **Mode (Most Frequent Age):** Each age appears only once, so there's no mode in this case.

Graph on the measures:



1.2 Timeline

Participant name	Day	Date	Start session time	Finish session time	Duration of session	Prototype version
1 Azam	Monday	4/11/2024	8PM	8:12PM	12 minutes	1.0
2 Mohammed	Thursday	7/11/2024	9PM	9:16PM	16 minutes	1.1
3 Abeer	Thursday	7/11/2024	9:20PM	9:32PM	12 minutes	1.1
4 Khaild	Thursday	7/11/2024	9:35PM	9:45PM	10 minutes	1.1
5 Sadeem	Monday	4/11/2024	8:15PM	8:24PM	8 minutes	1.0
6 Munira	Monday	4/11/2024	8:27PM	8:35PM	8 minutes	1.0

1.3 Performance Measures and Feedback

Metric	How was it measured?
Effectiveness	Task success rate: Percentage of tasks completed successfully. Error rate: Number of errors per task or session.
Efficiency	Time to complete each task. Click Count : by recording the number of clicks needed to complete a task.
Satisfaction	User Questionnaire on interface satisfaction.
Error Recovery	Recovery time: time taken by user to correct errors and resume tasks. Assistance required: Number of times user needed external help to recover from errors.

1.4 Tasks

Task #	Task	Objective of the task
1	Adding new room	Measures ease of adding and configuring new rooms in the system. Assessing clarity and simplicity of the process.
2	Reviewing alerting messages	Evaluates how well users understand alert messages, their clarity, and whether they provide actionable information.
3	Adjust lighting settings	Measures intuitiveness of control sliders and responsiveness.
4	Voice command functionality	Evaluates the accuracy and responsiveness of voice commands within the smart home system. Includes tasks like turning on/off devices or adjusting settings using voice.
5	Device integration setup	Tests how easy it is for users to add new smart devices to the system. Focuses on the ease of discovery and pairing of devices.

1.5 Feedback Collection

- Participants will share feedback through a combination of methods:
 - **Post-Test Questionnaire:** Participants will rate their satisfaction, perceived ease of use, and any challenges faced for each task.
 - **Open-Ended Questions:** Open-ended questions to explore overall impressions, suggestions, and usability challenges.

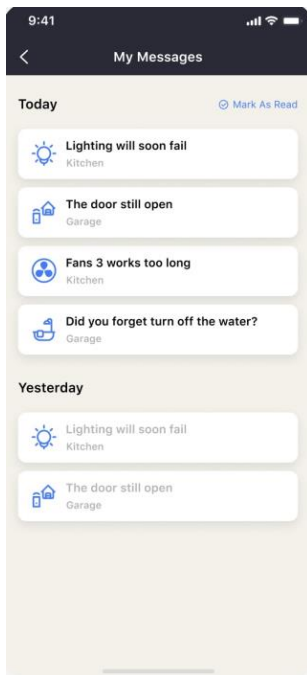
Part 2: Usability Results

In this section, we will describe the usability problems identified during user testing, with examples to highlight design issues. The severity of the problems is based on three factors: frequency of occurrence, impact, and persistence. After each issue, recommendations for addressing specific usability problems will be provided.

2.1 Critical Problems

- 2.1.1 – Lack of Actionable Alert Messages

One of the critical issues discovered during user testing was that alert messages in the system do not provide actionable steps for the user. Users were confused when receiving security-related messages, as they simply stated the issue but did not guide the user on what actions to take. This can lead to confusion, particularly in situations where immediate action is required, such as security breaches or device malfunctions.



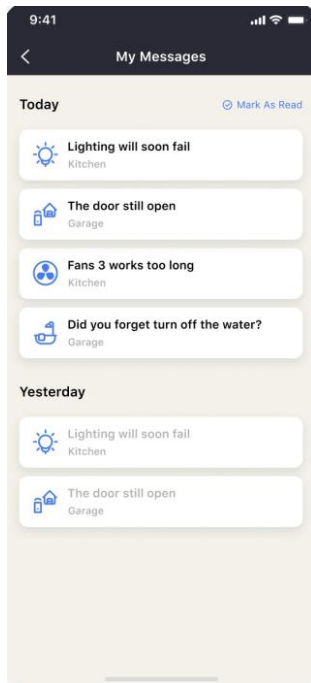
Related Task: Reviewing alerting messages.

Results: Users were unsure how to respond to the alerts, which led to frustration and insecurity, as they didn't know how to fix or prevent the issues. They expected actionable options (e.g., "Disable device" or "Review settings") but were only given a message without further instruction.

2.2 Major Problems

- 2.2.1 – *Overwhelming Number of Notifications*

A major usability problem encountered was the overwhelming number of notifications users received. While notifications are important for alerting users about system activities, there were too many, especially when unrelated or minor events triggered them. This created notification fatigue, where users ignored or missed critical alerts.



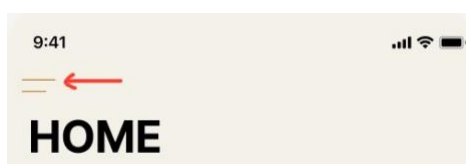
Related Task: Reviewing system notifications.

Results: Users found it difficult to prioritize important notifications when they were bombarded with too many alerts. As a result, they sometimes missed critical notifications, such as system failures or security issues, because they were lost in the sea of less important ones.

2.3 Minor Problems

- 2.3.1 – *Unlabeled Icons Representing Settings.*

A minor issue identified during testing was the use of small icons to represent settings without any accompanying labels. These icons were not immediately clear to users. Users had difficulty distinguishing between the various settings, as the icons alone did not provide enough context for the action associated with them.



Related Task: Accessing and adjusting system settings.

Results: Users expressed confusion when trying to access specific settings, as the icons didn't provide a clear indication of what each represented. The "Settings" label did not clarify their function, leading users to hesitate before selecting them.

Part 3: Recommendations

Usability Issue	Recommendation	Severity (Critical/Major/Minor)
Lack of Actionable Alert Messages	Alert messages should not only notify users but also provide clear, actionable steps. For example, if there is a security issue, the system should offer options like "Secure now," "View more details," or "Contact support." This will enhance user confidence and security.	Critical
Overwhelming Number of Notifications	Implement a system to categorize and prioritize notifications, providing users with the option to filter by urgency. Allow customization of notification preferences, so users can opt for receiving only critical alerts or group similar notifications together.	Major
Unlabeled Icons Representing Settings	To improve usability, each icon should have a clear label or tooltip that describes its function. Alternatively, using more descriptive icons or adding short text labels next to the icons would help users quickly identify what each setting represents, reducing confusion and improving ease of use.	Minor

References

- 1- Adding Room components
Creator: Visiata Systems International
Source: Figma Community, <https://www.figma.com/community/file/1195358562820260316>
- 2- Devices components and Amazon Echo Screen
Creator: Nickelfox Design
Source: Figma Community, <https://www.figma.com/community/file/1107916749311239293/smart-home-management-app>
- 3- Setting Screen and Messages Screen
Creator: 555fraiz
Source: Figma Community, <https://www.figma.com/community/file/914471741180506296/app-smart-home-exercise>
- 4- Family members and weather components in home screen
Creator: Aksonvady
Source: Figma Community, <https://www.figma.com/community/file/1085504531661017935/smart-home-app>
- 5- Schedule components
Creator: Darsh Bhavsar
Source: Source: Figma Community, <https://www.figma.com/community/file/1060784421131783646/smart-home>
- 6- All Rooms components and rooms images
Creator: fullymadeking
Source: Figma Community, <https://www.figma.com/community/file/1195664624960482056/smart-home-app>

Consent Form



نموذج الموافقة على المشاركة

تهدف هذه الدراسة إلى اختبار تصميم واجهات المستخدم لبرنامج للجوال. إن مشاركتكم في هذه الدراسة تطوعية وستبقى غير معروفة. سيطلب من المستخدم خلال الجلسة استخدام البرنامج للقيام بمهام محددة والإجابة على بعض من الأسئلة وستقوم مراقبة وتسجيل بعض الملاحظات أثناء استخدامه كما أنه سيقوم بتسجيل خطوات تصفحه.

أوافق على حفظ واستخدام إجابات الأسئلة أثناء الجلسة

أوافق على كتابته وتسجيل خطوات التصفح أثناء الجلسة

تستغرق الجلسة 10-20 دقيقة، بإمكانك إيقاف الجلسة في أي وقت إن رغبت بذلك.

أفيد بأنني قرأت وفهمت ما المطلوب مني خلال المشاركة في الدراسة.

الاسم _____ التوقيع _____

التاريخ _____ مراقبة الجلسة _____

Facilitator Script

“Hello and thank you for participating in this evaluation session. My name is [Facilitator name], and I will be facilitating this session. The purpose of today’s session is to gather your feedback on the system you just used, focusing on its usability and design. Your input is incredibly valuable and will help us improve the interface.”

“Before we begin, I’d like to remind you that there are no right or wrong answers, this is not a test of your abilities, but an evaluation of the system. Please answer honestly based on your experience with the system. If at any point you have questions or need clarification, feel free to let me know.”

Questionnaire

“Please rate each question based on your experience, using a scale from 1 (Strongly Disagree) to 5 (Strongly Agree).”

Post-Test Questionnaire:

1. The interface was easy to navigate.
2. It was straightforward to switch between room controls.
3. I found the temperature and lighting control features intuitive.
4. The icons and labels were clear and understandable.
5. I felt in control when setting up automated schedules for lighting or temperature.
6. I would feel comfortable using this system in my own home.
7. Overall, I was satisfied with the layout and design of the interface.

Open-Ended Questions:

1. What features did you find most useful or user-friendly?
2. Were there any features that you found confusing or difficult to use? If so, please explain.
3. Do you have any additional feedback or suggestions for improvement?

Closing

“Thank you for taking the time to share your feedback. Your responses are helpful and will play an important role in improving the system. Have a great day!”