
User interface prototyping

Prototype, method, and experiment for evaluating usability of smart home user interfaces

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HCI Outline

1. Introduction to HCI
2. Basic principles and guidelines of HCI
3. User-centered design and usability testing
4. Designing Effective User Interfaces
5. User interface design principles and guidelines

6. User interface prototyping

7. Prototyping through Wireframes
8. Designing for accessibility and mobile devices

Background & Motivation

- Smart devices and home automation systems are now **widely adopted**.
- Yet, users still face **usability and configuration challenges**.
- Evaluating the **usability of smart home interfaces** remains complex.

Key Issue:

“Smart home technology is advanced, but the *user experience* is often inconsistent or difficult to measure.”

Research Focus

- Development of a **Smart Home Prototype** for experimental testing.
- **Goal:** Select and evaluate multiple **User Interfaces (UIs)** for smart home control.
- **Target Application:** Smart **heating system** — but methods are generalizable to other smart devices.

Study Objectives

1. Build a **hardware and software prototype** for a smart home setup.
2. Implement and test different **software UIs**.
3. Establish a **methodology to evaluate usability**.
4. Identify **UI features that improve user experience**.

Smart Home System Components

Hardware Used:	Software Stack:
<ul style="list-style-type: none">• Raspberry Pi (central controller)• Temperature sensors• Servo drives for physical control• Android-based smartphone• Networking and auxiliary modules	<ul style="list-style-type: none">• Home Assistant OS• Alice voice assistant• Telegram chatbot interface• Mobile app (Home Assistant)

System Architecture Overview

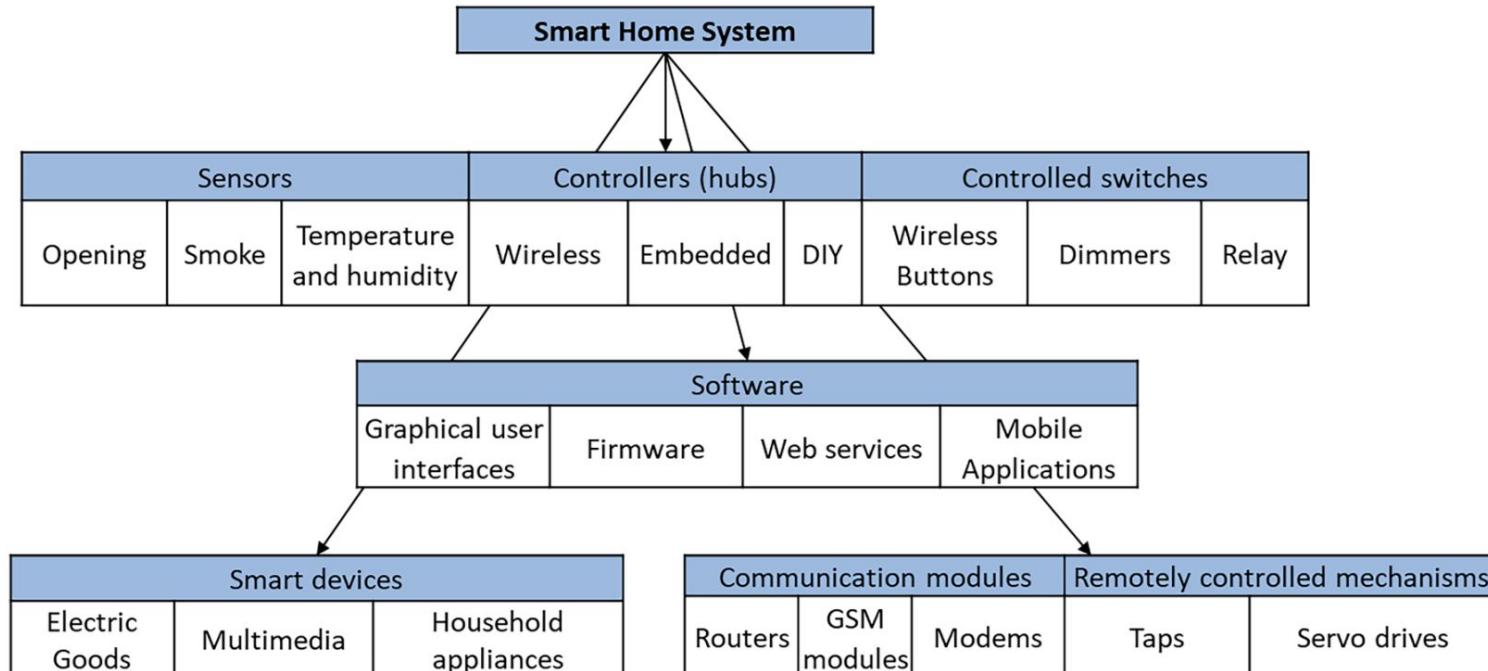


Fig. 1. Smart Home system components.

Implementation Process

- Hardware setup and sensor calibration.
- Installation and configuration of open-source software.
- Integration of third-party voice and chat assistants.
- UI mapping: linking user commands → device actions.
- Testing across different control modalities (app, voice, chatbot).

User Interfaces Under Evaluation

Interfaces Tested:

-  **Home Assistant mobile app** – visual and touch interaction.
-  **Voice Assistant (Alice)** – natural language commands.
-  **Telegram Chatbot** – text-based interface.

Each interface provides **unique interaction modes** and **different cognitive loads** for users.

Evaluation Methodology

Developed a **usability assessment framework**.

Focused on **effectiveness, efficiency, and satisfaction**.

Experiment design:

- Users performed standard heating-control tasks.
- Time, accuracy, and ease of use were measured.
- Qualitative feedback collected.

Experimental Findings

Results Summary:

- The **mobile app UI** was rated most **intuitive and user-friendly**.
- **Voice interface** was fast but prone to **recognition errors**.
- **Chatbot UI** offered flexibility but required **more user effort**.

Overall Insight:

Interface familiarity strongly affects usability ratings.

Identified Drawbacks

- Limited context awareness in voice UI.
- Complex setup for third-party integrations.
- Inconsistent feedback messages across platforms.
- Hardware response lag under network latency.

Recommendations

Combine **visual + voice** modalities for flexibility.

Provide **consistent, multi-modal feedback** (visual, auditory, text).

Simplify initial **setup and configuration** flows.

Enhance **error handling and contextual prompts**.

Broader Applicability

Principles extend to other smart applications:

- Lighting systems
- Energy management
- Security and access control

Framework can guide **UI evaluation for emerging IoT systems.**

Conclusion

- The study proposed a **prototype-based evaluation approach**.
- Demonstrated a **comparative analysis** of UI modalities.
- Results highlight the **importance of usability-centered design** in smart homes.

“Future systems should integrate adaptive, context-aware UIs to enhance user satisfaction and system control.”



Smart Home

Lore ipsum dolor sit
amet, consectetur

Don't have an account? [Register Here](#)

Welcome Home,
Marry Janeson

20:08
North City, NC 24°C

Rooms

Living Room Bathroom Kitchen

Device

Air Conditioner Bulp Lamp
AC Brand

Smart TV Wifi Router

Air Conditioner

21 °C Temp

timer Cool
Fan Heat



Image Here

Organize Your Sweet Home

With the smart home application, your mobility at home will be comfortable and easy

Get Started

Welcome, Elizabeth!

Let's set up a smart home



Cloudy

17 Nov 2021

Kaliurang, Yogyakarta

30°C

Precipitation

18%

Humidity

69%

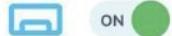
Wind

8 Km/h

My Device

See All

Air Conditioner



ON

Smart Lamp



OFF

Swipe to set temperature

18°C

Swipe to set brightness

Smart TV



OFF

Refrigerator



OFF

Swipe to set channel



Home



+

Swipe to set temperature



Profile



Succeed

The new refrigerator device has been successfully added. Click OK to set the temperature

OK



Main light

Living room

Light

Wi-Fi

Microwave

Conditioner

Robot cleaner

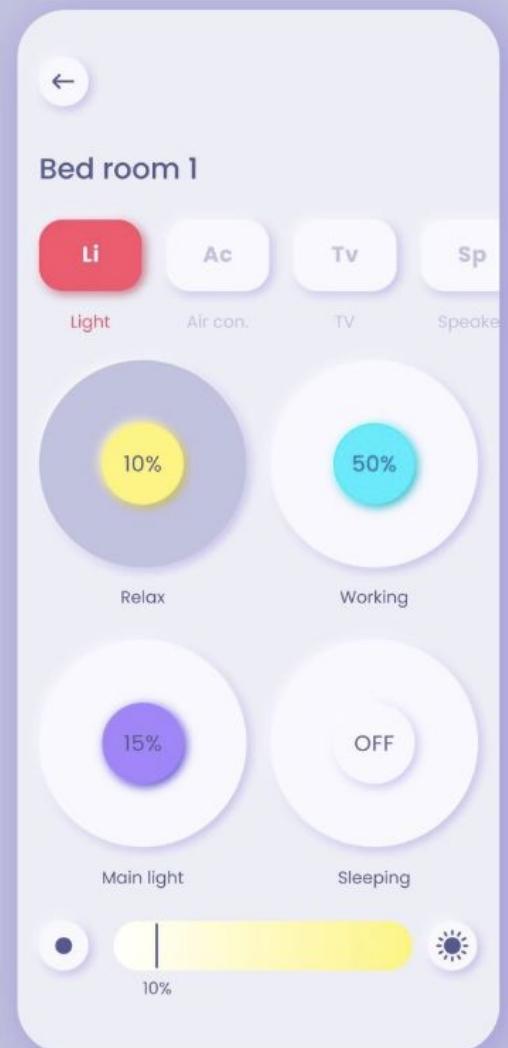
Lighting

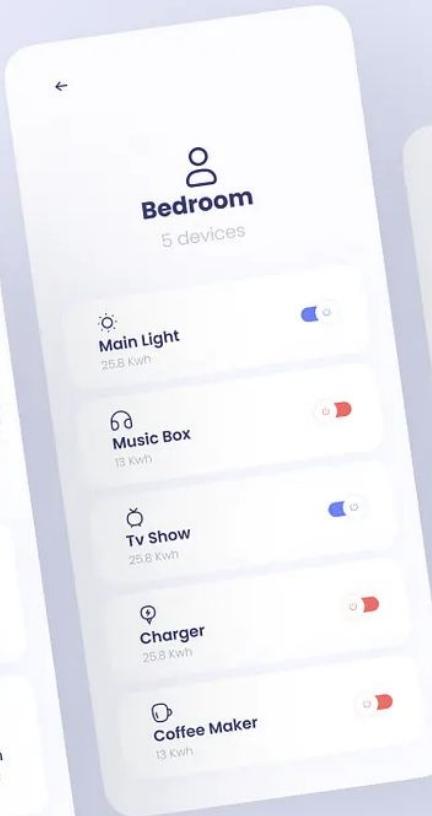
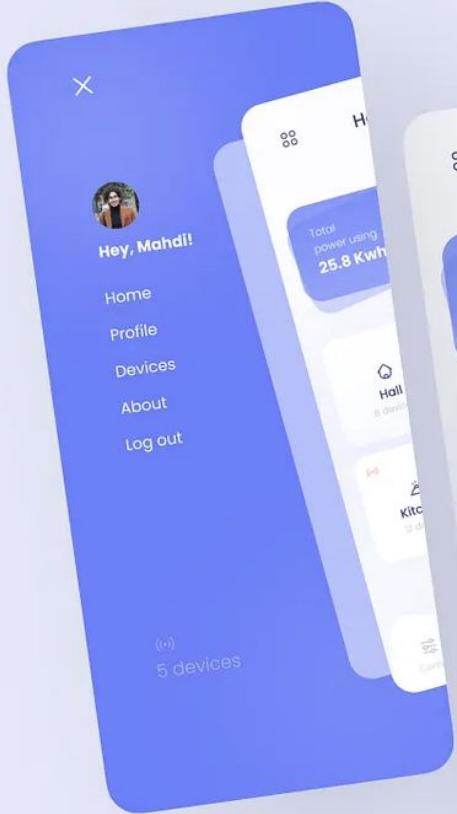
Intensity

Lighting color

Enable







My Home



Bedroom



Lighting
6 devices



HVAC
3 devices



IR Control
2 device



Curtains
2 device



Sensors



Security

Wifi connection lost



My Home



All Devices
45 devices



Bedroom
15 devices



Livingroom
12 devices



Bathroom
8 devices



Kitchen
18 devices



Storage room



Study room

Lighting



Bedroom bulb



Bed lamp



Dimmer



Tubefig

Bed lamp

ON



Mode

Morning

Day

Night

Intensity



Shades



My Home





The image displays three screenshots of a mobile application interface, likely for a smart home system.

Screenshot 1: Home Dashboard

- User Profile:** Hi, Nicole (Pro)
- Header:** Monitor and control your home
- Dining room:** 20°C, 320kwh
- Bath:** 20°C, 320kwh
- Summary:** 932kwh (Data updated 3 hours ago)
- Devices:**
 - 4 Devices: Lamp (status off)
 - 2 Devices: Air Purifier (status off)
 - 8 Devices: Smart CCTV (status off)
 - 3 Devices: Air Conditioner (status off)

Screenshot 2: Air Conditioner Control

- Section Header:** Air Conditioner
- Switch:** On
- Meter:** 24 °C (Cold) ← → 32°C
- Buttons:** Heat, Cold, Air, Humid
- Accounts:** Accounts (3)
- Schedule:** Schedule (On), From 10:00 AM, To 2:00 PM

Screenshot 3: Home Analysis

- Header:** Get Started
- Section Header:** Home Analysis
- Summary:** 932kwh (Bigger than last month 3%)
- Bar Chart:** A bar chart showing energy usage per month. The bar for April is orange and taller than the others, indicating a 3% increase over the previous month.
- Section Header:** Per-device Usage (23)
- Data:**

Device Type	Number of Devices	Usage (kwh)
Television	3 Devices	145kwh
Speaker	2 Devices	89kwh

Thanks

Any Question