
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:

- Raspberry Pi (central controller)
- Temperature sensors
- Servo drives for physical control
- Android-based smartphone
- Networking and auxiliary modules

Software Stack:

- Home Assistant OS
- Alice voice assistant
- Telegram chatbot interface
- Mobile app (Home Assistant)

System Architecture Overview

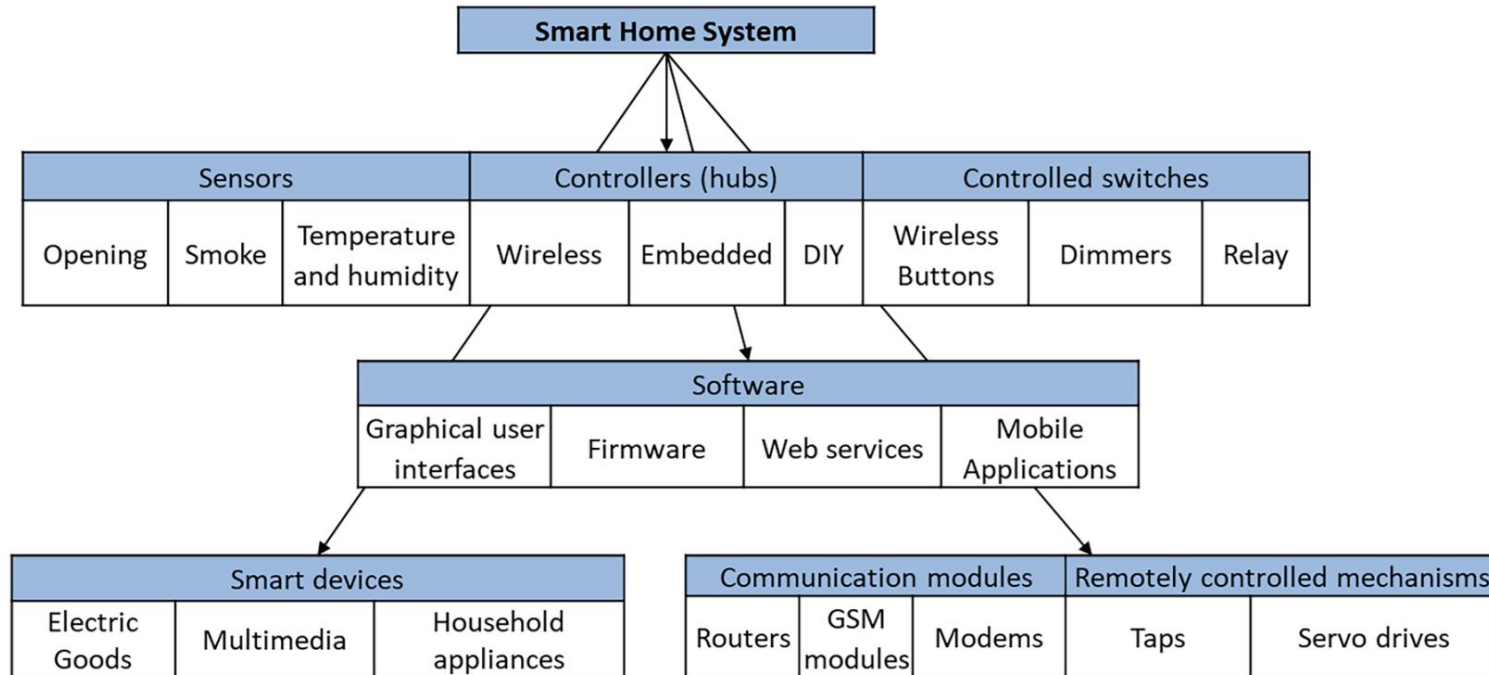





Fig. 1. Smart Home system components.

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

Lorem ipsum dolor sit
amet, consectetur

Log In

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



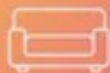
Welcome Home,
Marry Janeson

20:08
North City, NC

☁ 24°C

Rooms

Living Room



Bathroom



Kitchen



Device



Air Conditioner
AC Brand



Bulb Lamp
LED LAMP



Smart TV



Wifi Router



Air Conditioner



TURN OFF



timer



Fan



Cool



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

30°C

17 Nov 2021

Kaliurang, Yogyakarta

Precipitation

18%

Humidity

69%

Wind

8 Km/h

My Device

See All

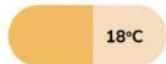
Air Conditioner



ON



Swipe to set temperature



18°C

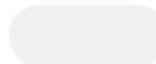
Smart Lamp



OFF



Swipe to set brightness



Smart TV



OFF



Swipe to set channel



Home

Refrigerator



OFF



Swipe to set temperature



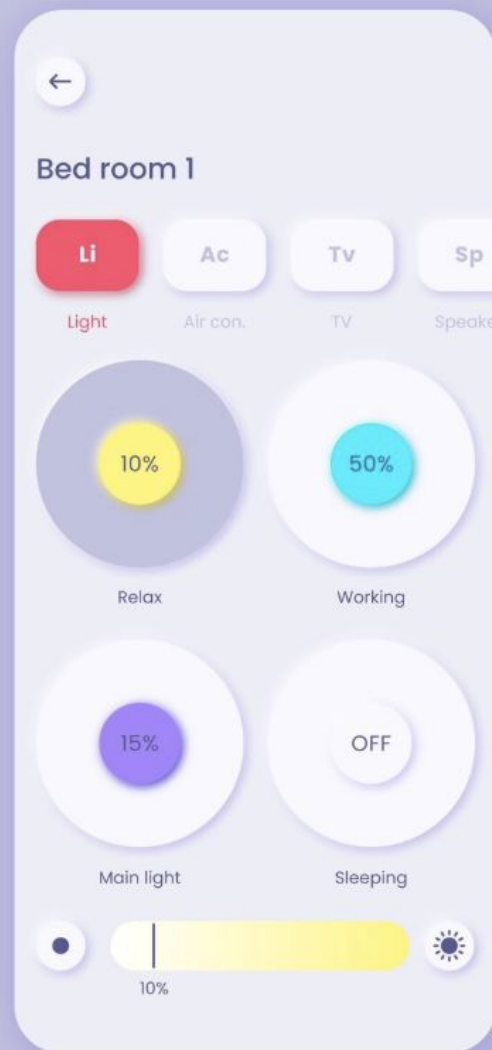
Profile

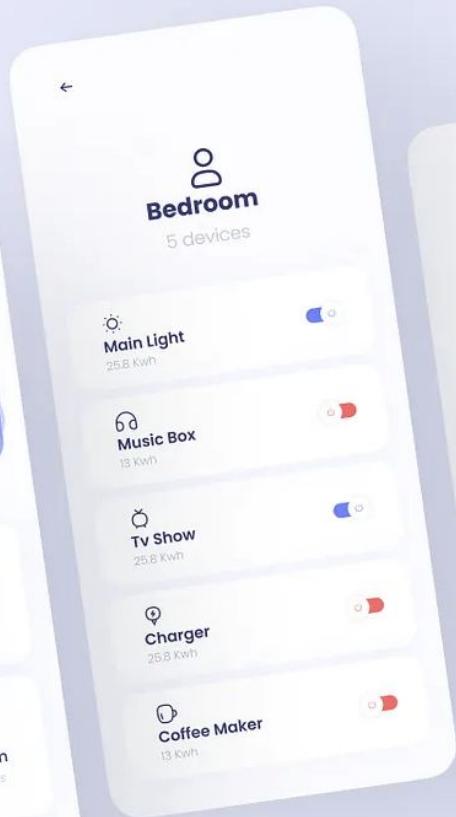
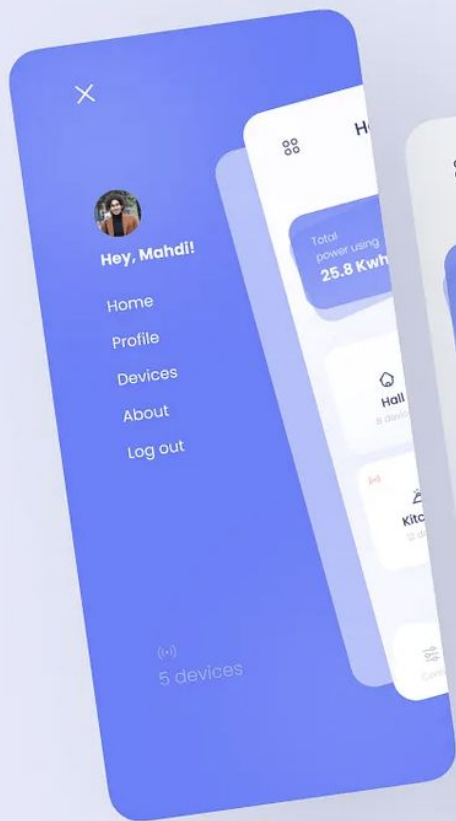


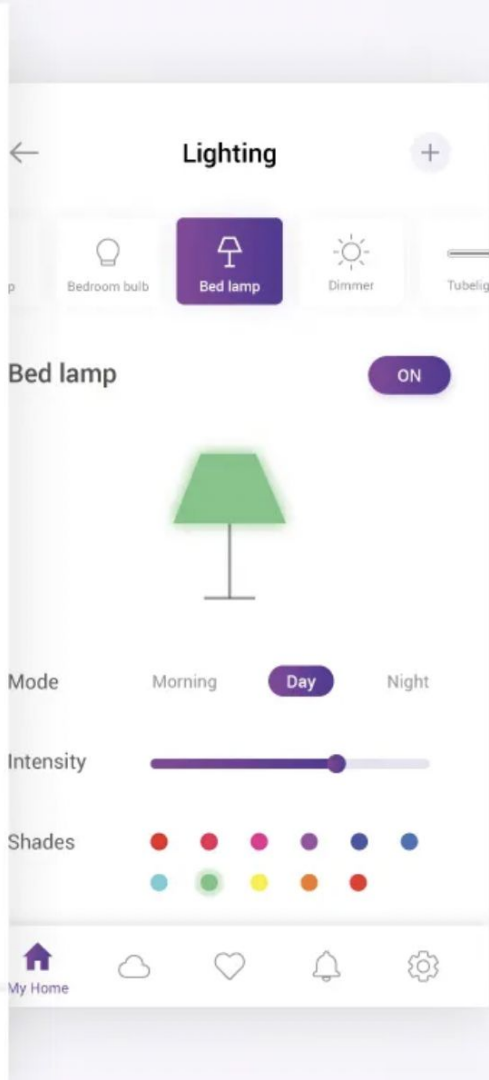
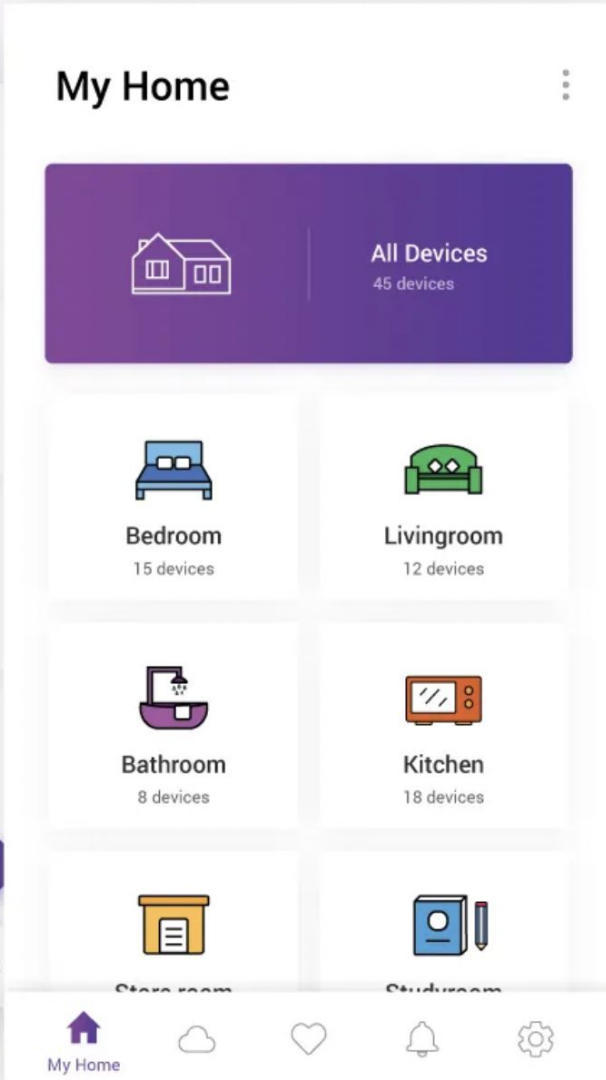
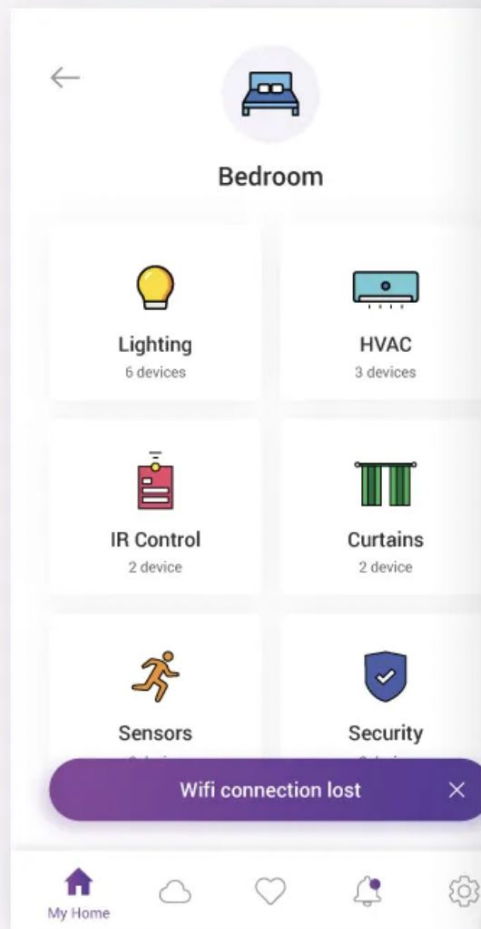
Succeed

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

OK









Mr.Vitaliy



Energy Saving

November

Device



Today [02.11.21]



23/13°

A sun with a cool



Tomorrow

Rain

20° / 18°



Wednesday

Storm

16° / 10°



Thursday

Rain

17° / 13°



Sunset 6:30 PM

Sunrise 7:21 AM

18° C

Indoor temp

22° C

Outdoor temp

59%

Humidity

10 km/h

Wind



Tequila Shots

Kid Cudi

02:14

04:17

Temperature



10:30 PM

to

02:30 AM

20°

20°

Temperature

69m²

First floor

46m

Time

My device

OFF

Light



2hr 45min

ON

Climate



3hr 15min

ON



AC

1hr 20min

OFF



Sound

4hr 02min



Pro

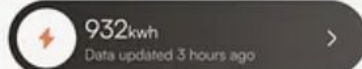
Hi, Nicole

Monitor and control your home



Dining room

Bath



4 Devices
Lamp



2 Devices
Air Purifier



8 Devices
Smart CCTV



3 Devices
Air Conditioner



REMODEL

Air Conditioner



Heat



Cold



Air



Humid

Accounts (3)



Schedule



From
10:00 AM

To
2:00 PM

Get Started

Home Analysis

Monthly

932kwh

Bigger than last month 3%



Per-device Usage (23)



Television
3 Devices

145kwh



Speaker
2 Devices

89kwh

Thanks

Any Question