

Gesture-Based Smart Home Control System: Research Proposal

Rayan Shukri

Abstract

In today's world, smart homes are becoming more common. People want easier and more fun ways to control their devices without using phones or remotes all the time. This project is about creating a smart home system that uses hand gestures to control things like lights, TV, or AC. It focuses on making a simple, affordable system using a depth camera to recognize gestures. The goal is to give users more freedom, enhance accessibility for people with disabilities, and improve convenience and safety. The project will include research, testing, and building a prototype that can be integrated with popular smart home platforms like Google Home and Alexa. In addition, it will investigate user interface design, gesture recognition algorithms, and environmental factors impacting gesture reliability.

Keywords: Smart Home, Gesture Control, Depth Camera, Accessibility, Home Automation, Internet of Things (IoT), Human-Computer Interaction (HCI)

Introduction

Smart homes are changing the way we live. We can already use apps or voice commands to control devices, but there are still challenges. Not everyone finds it easy or comfortable to talk to devices, and sometimes using apps is not fast enough. A gesture control system could make things simpler. Waving your hand to turn off the lights or swipe to change the TV channel would make the experience more natural. This research will study how gesture control can be used at home, how it can improve accessibility for people with physical or speech impairments, and build a basic working model connected to smart devices. The study will also look into the cognitive load on users when adopting gesture-based systems.

Background

Gesture control technology has been used in gaming (like Xbox Kinect) and smartphones. In smart homes, though, it is not common yet. Companies like Singlecue tried making gesture devices but didn't continue. This shows that there are challenges, but also opportunities. Depth cameras like Intel RealSense, Microsoft Azure Kinect, and others now make it easier to detect gestures accurately. Research by Gupta and Akshaya (2021) showed that multimodal systems combining gesture and voice increased reliability. Combining this with smart home platforms like Google Home, Apple HomeKit, or Amazon Alexa could open new possibilities for intuitive, hands-free control.

Problem Statement

Smart homes today still rely mainly on apps, remotes, or voice assistants. This can be limiting for some users, like elderly people, people with speech disabilities, or those who want faster controls without needing to touch devices. There is a lack of simple, intuitive, and touchless ways to control smart home devices that feel natural and comfortable.

Gesture control can solve this, but it needs to be reliable, affordable, easy to learn, and not tiring for users. Environmental variables like lighting, background clutter, and camera angle also pose challenges to reliability.

Research Objectives

1. To study current gesture recognition technologies and hardware.
2. To design a smart home gesture control system using a depth camera and a Wi-Fi module.
3. To create five main gestures for common controls (on/off lights, TV volume, AC settings).
4. To allow users to customize their own gestures through a mobile app.
5. To test the system for accuracy, speed, ease of use, and user satisfaction in a real home environment.
6. To assess the impact of environmental conditions on system performance.
7. To compare user satisfaction between gesture, voice, and app-based controls.

Research Scope

- Focus on indoor smart home devices only (lights, fans, AC, TV, and plugs).
- Use a depth camera for gesture detection and Wi-Fi modules for device communication.
- Build a mobile app for gesture setup and customization.
- Work on a small setup (single room environment) with integration with at least one popular smart home platform.
- Examine environmental variables like lighting and distance.

Literature Review

Many researchers have explored gesture control. According to Sharma et al. (2022), depth cameras help capture hand movements accurately even in low light. Zhang and Lee (2021) discussed how gestures can increase accessibility for elderly users. Singlecue's early failure showed that gesture systems must be very accurate and easy to use to succeed (Brown, 2018). Patel and Wong (2021) found that adding gesture control to smart homes improved safety by reducing the need to touch switches. Gupta and Akshaya (2021) emphasized that combining gestures with voice commands in multimodal systems reduced error rates. Research by Kim et al. (2020) found that users preferred simple, easily memorable gestures, and that complex gestures led to fatigue.

Research Methodology

- Phase 1: Literature Review

- Study papers on gesture recognition, smart homes, IoT, HCI, and depth cameras.

- Phase 2: System Design

- Design gestures, select hardware (depth camera, Wi-Fi module), mobile app interface.
- Use OpenCV and TensorFlow Lite for gesture recognition model.

- Phase 3: Prototype Development

- Build the basic gesture recognition prototype.
- Connect recognized gestures to smart devices using standard smart home APIs.

- Phase 4: Testing and Feedback

- Test with 10 users across different age groups.
- Collect feedback on system usability, comfort, error rates, and satisfaction.

- Phase 5: Analysis and Improvement

- Analyze success rates across different environments and suggest improvements.

Ethical Considerations

- Respect user privacy (no storing personal or biometric data without consent).
- Make participation voluntary with signed consent forms.
- Protect user data during app communication through encryption.
- Ensure inclusivity, making the system usable for elderly and people with disabilities.

Limitations

- Recognition accuracy may drop in cluttered or brightly lit environments.
- Some users may find learning gestures initially challenging.
- Early prototypes will only support basic commands.
- Hardware costs could be a barrier for low-income users.

Expected Outcomes

- A working, user-tested prototype for gesture-based smart home control.
- Improved understanding of how users interact with gesture-based systems.
- Recommendations for enhancing future smart home user interfaces.
- Data on gesture system reliability under different conditions.

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