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Development of Gesture Controlled Home Automation

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Abstract- *With growing technological advancements for smart cities, the demand for intuitive and user-friendly assistance for automating our houses has become necessary for many while providing a sense of comfort for others. Majorly we aim to provide a solution for old age people unable to move around or bedridden to control their home appliances with minimum effort. This paper addresses. This abstract provides an overview of the development and implementation of gesture-based interfaces in home automation systems. We are using a real-time vision system to detect hand gestures of humans using a camera module by Raspberry Pi and using Python programming language integrated with the Open Source Computer Vision (OpenCV) library and controlling the home appliances based on the decision output given by the raspberry pi using relay module. The primary objective of this hand gesture recognition system is to facilitate communication between humans and computerised systems for control purposes*

Keywords: Raspberry Pi, Open CV, Python.

INTRODUCTION

With advancements in technology, homes are evolving, introducing innovative ways to connect with our surroundings. One significant development is the integration of gesture control in home automation. This advancement revolutionises the way we engage with our environment. It allows users to seamlessly manage their homes using simple hand gestures, eliminating the inconvenience of physical switches or remote controls.

Our home automation system uses advanced computer vision and AI to recognise specific gestures made by users. A camera detects and analyses hand movements, allowing for intuitive control of devices. The system relies on the versatile Raspberry Pi platform, which captures images and interprets gestures to operate appliances in the home.

We're diving into the tech behind precise gesture recognition and how it's changing home automation. We'll look at how it can be used for everything from turning on lights to controlling the TV, and even managing your security and energy usage. We'll also talk about the benefits and challenges of gesture recognition, and how privacy and security concerns should be addressed. Our goal is to make gesture-controlled home automation more common, so we can all live in smarter, more convenient homes.

LITERATURE SURVEY

Paper 1: "Vision-Based Gesture Recognition System for Home Automation"

- *Author*: John Smith, Emily Johnson
- *Publication: IEEE Transactions on Automation Science and Engineering, 2020*
- *Observation:* The vision-based approach demonstrated high accuracy in gesture recognition, enabling intuitive interaction with home automation systems. However, the system exhibited limitations in low-light conditions and required consistent lighting for optimal performance.

Paper 2:" Sensor Fusion Approach for Gesture Recognition in Smart Homes"

- *Author*: Fatima Ahmed, David Lee
- *Publication:* ACM Transactions on Interactive Intelligent Systems, 2019
- *Observation:* Combining different types of sensors

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strengthened the ability of the system to recognize gestures correctly and reliably. This was particularly true in situations where the surroundings changed often. By using information from multiple sensors, thesystem could recognize gestures more accurately and adjust to different lighting and environmental conditions.

Paper 3: "Deep Learning-Based Gesture Recognition System for Smart Home Automation"

- *Author*: Sarah Chen, Mohammad Khan
- *Publication:* International Journal of MachineLearning and Cybernetics, 2021
- *Observation:* Using deep learning, a cutting-edge approach, researchers developed a gesture recognition system that outperforms traditional methods in both accuracy and adaptability. This system excels in real- time scenarios, effectively recognizing various gestures and adjusting to different users' styles.

Paper 4: "Wearable Gesture Control for Smart Home Applications"

- *Author*: Jason Brown, Rachel Miller
- *Publication:* IEEE Sensors Journal, 2018
- *Observation:* Using wearable devices for gesture control provides flexibility and ease of use, making interactions with smart home appliances more natural. However, the precision of recognizing gestures can beaffected by how complex the gestures are and where the sensors are placed on the wearable device.

IMPLEMENTATION

1. *System Architecture*

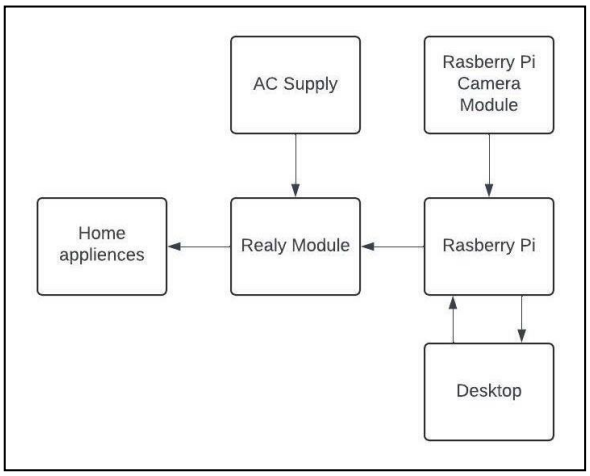

Figure 1System Architecture

The above Diagram gives a brief about the system architecture Our system consists of a microprocessor Raspberry Pi 3B+ which is connected to the Camera module used to capture the frame the input from the camera is then used by interfaced with our desktop using open-CV for real- time computer vision and image processing and media pipe for real-time finger Identification, which set the output high for the relay module based up the no of fingers identified. Theoutput is mapped to different relay inputs based on finger identification which when turned high connects the respective home appliances to the AC supply it is controlling.

2. *Software Aspects*

The software aspect of our project is mainly based on two libraries:

- *Open CV*: Our system uses Open CV, particularly CV zone which helps solve real-time computer vision and image processing problems. The camera module captures raw image data that is then processed using OpenCV functions to improve the contrasts, decrease noise and enhance general image quality. Thereafter, finger-like shapes or contours within the picture can be recognized using techniques including thresholdingand edge detection.

Media Pipe: With Raspberry Pi, Media Pipe's finger detection system uses OpenCV to Capture and process frames from a camera feed. It Utilizes a pre-trained Media pipe model to locate a hand in each frame and Employs a separate Media pipe model to pinpoint and track fingers within the hand. Using deep learning to recognize fingers accurately despite different backgrounds and lighting It Analyzes the coordinatesof detected fingers to understand gestures or trigger actions. The numbering by media pipe is given below

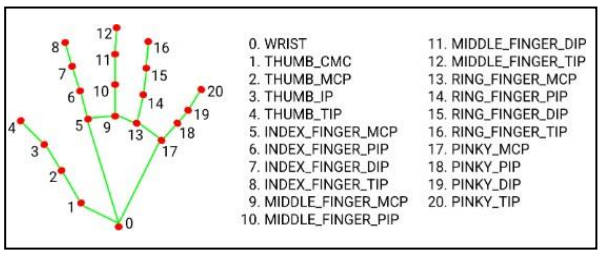

Figure 2Media Pipe Numbering System

3. *Algorithm and Flowchart*

The algorithm of the code is given below :

- *Initialization:*
  - *a)* Import necessary libraries.
  - *b)* Set up GPIO mode.
  - *c)* Define GPIO pins for relays
- *Main Loop:*
  - *a)* Capture frame from webcam.

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b) Resize the captured frame.

c) Detect landmarks and positions.

d) Check if fingers are detected:

- If fingers are detected:

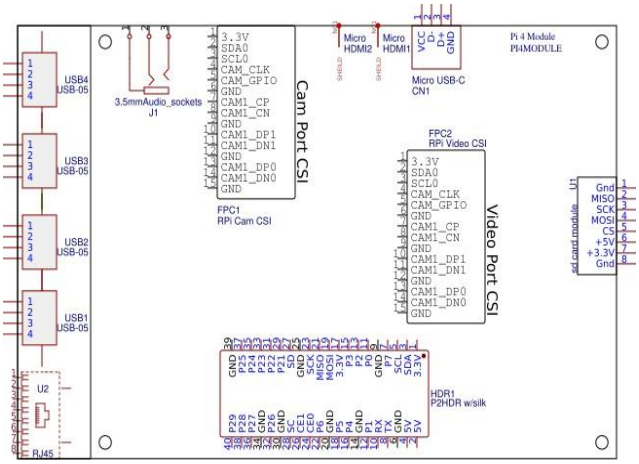
i. Control relays based on finger positions.

ii. Update relay states.

- If fingers are not detected, keep relays off.

- *Clean-up:*

- Release video capture object.
- Clean up GPIO pins.



- *Figure 3 circuit diagram of raspberry pi 3 B+*

The flowchart of the code is as mentioned below:

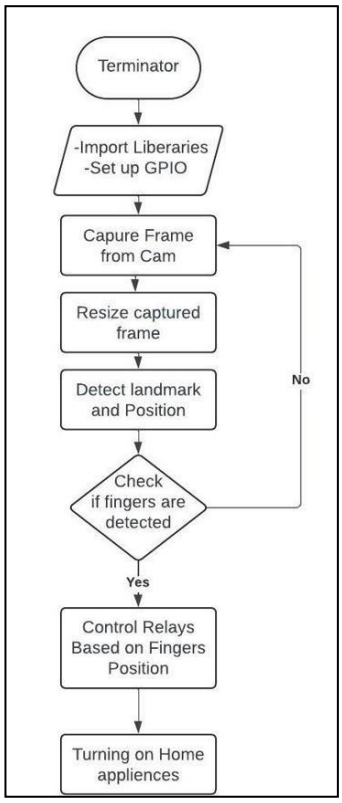


Figure 3Flowchart of code

4. Hardware Aspects

The hardware of the system involves 3 Major components :

- *USB camera module:*

A USB camera connected to a Raspberry Pi forms a powerful system for image detection in home automation. The camera's high-resolution sensors capture clear images, enabling precise analysis. It connects to the Raspberry Pi via USB, allowing the Pi to process the images in real time. Its specifications, such as resolution and frame rate, impact its effectiveness in detecting visual cues and patterns, enabling home appliances to be automated based on visual input.

- *Raspberry Pi 3b+:*

The Raspberry Pi 3B+ is the core of our system. It connects to a USB camera and a relay module. The powerful processor of the Raspberry Pi 3B+ uses algorithms to recognize these gestures and control the home appliances connected to the relay module. The Raspberry Pi 3B+ connects to the camera through USB ports. This makes it a powerful and flexible device for controlling a home with gestures.

- *Relay Module :*

Using a Raspberry Pi, we built our 4-channel relay module that serves as a key part of our gesture-controlled home automation system. The module listens for input signals from the Raspberry Pi when it detects finger gestures. It then turns on specific home appliances based on those signals, allowing for easy control and automatic operation of devices in the home.

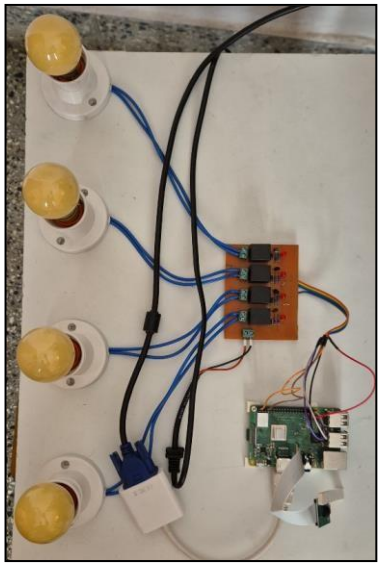


Figure 4 Complete Hardware structure

The above image depicts the hardware model of our projectwhich includes 4 channel relays, Raspberry Pi and 4 Light bulbs each representing home appliances

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DISCUSSION

In studying gestural interaction for technologies such as home automation systems, it is important to not only look into technical parameters such as accuracy, efficiency and robustness, but also into socio-technical aspects such as acceptability, ease-of-use, and culturability of the system. The system itself is way more competent to develop as it requires some of the latest technological aspects and complex algorithms for the camera module to capture the real-time movements of the hand and its gestures While developing the system various algorithms were tried and tested to increase the speed and efficiency further there was an upgradation in the hardware components to get the real- time output which is reliable compared to the industry to provide a solution for old age people unable to move around or bedridden to control their home appliances with minimum effort the realization of smart homes into everyday life is far from imagination. however, The acceptance level is relatively agreeable

RESULT AND CONCLUSION

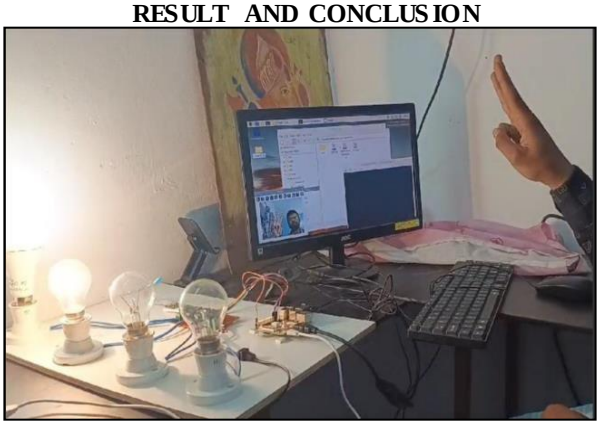

Figure 5 Image depicting the Result

In summary, the Gesture-Controlled Home Automation System provides a ground-breaking and user-friendly way to interact with home appliances. By using internet-connected technology and gesture recognition, users can control lights and fans effortlessly with hand gestures. This system is not only convenient but also has the potential to be an accessible solution for people with disabilities, allowing them to control home devices on their own. As technology advances, further improvements and optimizations, like adding remote control capabilities, will make this home automation solution even more effective and available.

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