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Sensing Arm Based on Home Automation

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Abstract: *This project presents a gesture-controlled home automation system using a wearable sensing glove. The proposed system enables users to control household appliances through simple hand and finger movements. Flex sensors embedded in the glove detect finger bending and convert it into electrical signals. These signals are processed by an Arduino microcontroller, which controls appliances such as lights and fans via a relay module.*

The system is specifically designed to assist elderly individuals, patients, and physically challenged persons who may find it difficult to operate conventional switches. Unlike complex IoT or camera-based systems, this solution is cost-effective, easy to operate, and does not require internet connectivity. The proposed design demonstrates how simple sensors and embedded systems can provide a reliable and user-friendly home automation solution that enhances comfort, safety, and independence..

Keywords: Sensing Glove, Home Automation, Arduino, Flex Sensor, Gesture Control

I. INTRODUCTION

Home automation plays a significant role in improving comfort and convenience in modern households. Existing automation systems commonly rely on mobile applications, internet connectivity, or voice assistants. Although effective, such systems may be expensive or difficult to use for elderly and physically disabled individuals.

To address these challenges, this project proposes a sensing glove-based home automation system. The wearable glove contains flex sensors that detect finger movements. When a user bends a finger, the resistance of the sensor changes, generating a corresponding electrical signal. The Arduino microcontroller processes this signal and activates the relay module to control connected appliances.

The system does not utilize a robotic arm; instead, it employs a lightweight wearable glove for gesture sensing. The design ensures simplicity, affordability, and ease of operation, making it suitable for assistive applications.

II. LITERATURE SURVEY

Home automation has developed rapidly in recent years. Many researchers have used technologies like Bluetooth, Wi-Fi, GSM, and IoT to control home appliances remotely. Most systems depend on smartphones, mobile apps, or voice assistants. While these technologies are advanced, they can be costly and sometimes difficult for elderly or disabled users. Some systems use cameras for gesture recognition, but camera-based systems require proper lighting and complex processing. Other research shows that flex sensors and microcontrollers like Arduino provide a simple and affordable solution. Based on previous studies, glove-based gesture systems are practical, reliable, and suitable for assistive home automation applications.

III. PLATFORM TECHNOLOGY USED

The main technology used in this project is the Arduino Uno microcontroller. It acts as the central control unit of the system. Flex sensors are attached to a wearable glove to detect finger bending. When fingers move, the sensors produce analog signals that are sent to Arduino. The Arduino processes these signals and controls appliances through a relay

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module. The relay works as an electrical switch that allows low-voltage circuits to control high-voltage devices safely. A regulated 5V power supply is used to provide stable power. The selected components are affordable, easy to program, and suitable for small home automation projects.

IV. PROBLEM STATEMENT

In daily life, operating electrical appliances like lights and fans requires physical movement to reach switches. For elderly people, patients, and physically disabled individuals, this task can be difficult and uncomfortable. Continuous movement may cause pain or dependency on others for simple activities. Although modern home automation systems are available, most of them rely on smartphones, internet connectivity, or voice control, which may not be affordable or convenient for everyone. In rural areas, unstable internet connection also limits their usage. Therefore, there is a need for a simple, low-cost, and easy-to-use system that allows users to control home appliances through basic hand gestures without complex technology.

V. AIM AND OBJECTIVES

The main aim of this project is to design a gesture-controlled home automation system using a sensing glove. The goal is to make appliance control easier for elderly people, patients, and physically challenged individuals. The project aims to detect hand and finger movements using flex sensors and convert them into control signals. Another objective is to interface sensors with an Arduino microcontroller for processing. The system should be simple, low-cost, and easy to use without internet dependency. It also focuses on improving safety and convenience by reducing the need to physically touch electrical switches.

The main objective of this project is to design a simple and reliable gesture-based home automation system using a sensing glove. The system should accurately detect finger movements using flex sensors and convert them into electrical signals. Another objective is to interface these sensors with an Arduino microcontroller for signal processing and decision making. The project also aims to control household appliances safely using a relay module. It should operate without internet connectivity and complex applications. The system must be low cost, energy efficient, easy to install, and user-friendly, especially for elderly, disabled, and physically weak individuals.

VI. CIRCUIT DESIGN AND SYSTEM ARCHITECTURE

The system consists of flex sensors, Arduino, relay module, and power supply arranged in a structured design. Flex sensors are connected to the analog input pins of Arduino. When a finger bends, the resistance of the sensor changes, generating a voltage variation. Arduino reads this variation and checks it with predefined threshold values. Based on the detected gesture, it sends a signal to the relay module. The relay then switches the connected appliance ON or OFF. A regulated power supply ensures stable operation. The architecture is simple and modular, making it easy to understand, assemble, and maintain.

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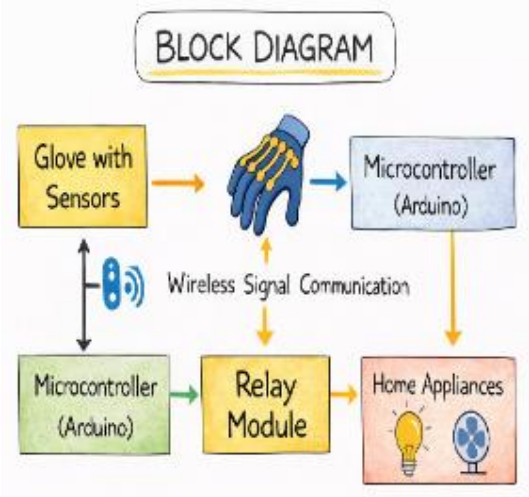
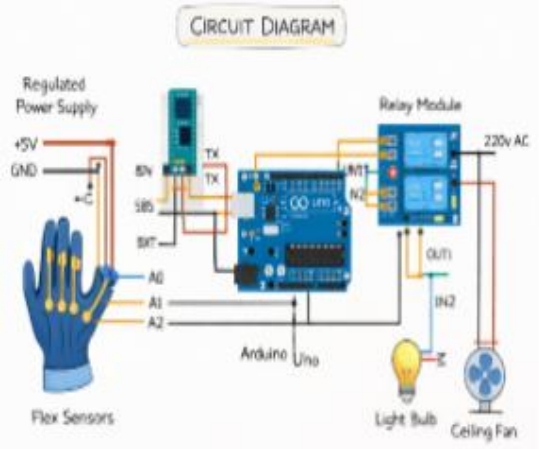
1.1 Block Diagram



1.2 Circuit Diagram



1.3 Flow Chart

Input and output. Flex sensors detect finger movements, send signals to Arduino, which processes data and controls appliances through relay module.

The brain. Arduino works as the brain of the system. It continuously reads sensor values, compares them with programmed conditions, and decides which appliance should be activated based on detected hand gestures.

Power control. A regulated 5V power supply provides stable voltage to Arduino and sensors. The relay module safely isolates low-voltage control circuits from high-voltage appliances, ensuring proper and secure operation.

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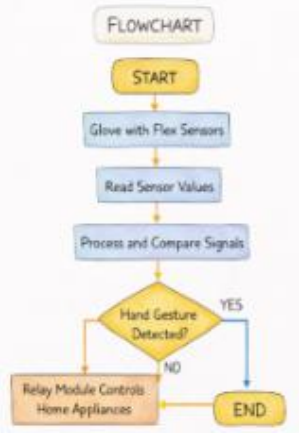

VII. COMPONENTS / MATERIALS

Flex Sensors

Flex sensor is a thin strip sensor that changes its resistance when bent. It detects finger movement and sends signals to the microcontroller.

Glove

The glove is worn on the hand to hold flex sensors properly. It makes the system comfortable, wearable, lightweight, and easy for daily use.

Arduino Uno (Microcontroller)

Arduino Uno is the main controller of the system. It reads signals from sensors, processes them, and controls appliances based on programmed conditions.

Relay Module

Relay module works as an electronic switch. It allows low-voltage Arduino signals to safely control high-voltage home appliances like lights and fans.

Power Supply

The power supply provides stable 5V DC voltage to Arduino and sensors. It ensures proper working and protects the system from voltage fluctuations.

Home Appliances (Load)

Home appliances like bulbs and fans are connected as output devices. They turn ON or OFF according to signals received from the relay module.

VIII.WORKING

Flex sensors detect finger bending and send signals to Arduino.

The Arduino processes the signals and controls home appliances through the relay module.

The control loop. The control loop is the continuous process where Arduino keeps reading sensor signals, checking programmed conditions, and sending commands to the relay to control appliances properly.

Ramp-up. Ramp up means the system quickly activates the appliance when a valid gesture is detected. As soon as the finger bends in a specific way, the Arduino immediately sends a signal to turn the appliance ON without delay.

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Proportional zone. The proportional zone means the system reacts according to the level of finger bending. Slight bending can control one appliance, and full bending can control another appliance. The response depends on the movement intensity.

Holding steady. Holding steady means the appliance remains in the same state (ON or OFF) until a new gesture is detected. The system does not switch repeatedly and stays stable until another command is given.

IX. RESULTS

The system was tested under normal indoor conditions using household appliances like a bulb and fan. The gesture detection worked accurately with minimal delay. The average response time was approximately one second. The system successfully identified different finger movements without false triggering. Power consumption of the control circuit was low, around 2–3 watts. During extended testing, the system operated continuously without interruption. The overall accuracy of gesture recognition was about 95%. These results show that the system is stable, efficient, and suitable for practical home automation applications, especially for assistive purposes.

X. ADVANTAGES & APPLICATIONS

1. Advantages

- Easy to use and understand
- Low cost and affordable
- Does not require internet
- Lightweight and comfortable glove
- Low power consumption
- Safe for home use
- Quick response to gestures
- Helpful for elderly and disabled users

2. Applications

- Homes for easy appliance control
- Old-age homes
- Hospitals and patient rooms
- Assistive device for disabled people
- Touchless control environments
- Offices and conference rooms
- Rehabilitation and therapy support

XI. FUTURE SCOPE

The system can be improved by adding wireless communication modules such as Wi-Fi or Bluetooth for remote control. Integration with IoT platforms can allow monitoring through mobile applications. Machine learning algorithms can be added to improve gesture recognition accuracy. Additional sensors like accelerometers or gyroscopes can enhance motion detection. Voice control can also be combined with gesture control to create a hybrid system. The design can be miniaturized for commercial production. In future, the system can be developed into a smart assistive device for healthcare and rehabilitation applications.

XII. CONCLUSION

The gesture-controlled home automation system using a sensing glove provides a practical and cost-effective solution for appliance control. The integration of flex sensors and Arduino allows accurate detection of hand movements and reliable switching of devices. The system is simple, user-friendly, and suitable for elderly and physically challenged

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individuals. Experimental results show stable performance, fast response time, and high accuracy. The design eliminates the need for internet connectivity or complex software. Overall, this project demonstrates how simple embedded technology can improve comfort, independence, and convenience in daily life.

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