GESTURE CONTROLLED WHEELCHAIR AND HOME AUTOMATION USING BLUETOOTH

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Abstract

This paper proposes an assistive technology solution that enables individuals with physical disabilities to navigate a motorized wheelchair and control basic home appliances through intuitive hand gestures. The system utilizes a MEMS accelerometer to detect directional hand movements, which are processed by an Arduino-based transmitter and transmitted wirelessly via Bluetooth. On the receiving end, a Raspberry Pi Pico microcontroller decodes the gestures and executes corresponding actions such as wheelchair movement (forward, backward, left, right) and appliance control (lights, fan) using a relay module. The integration of Bluetooth communication ensures wireless operation, enhancing user convenience and mobility within a defined range. This project demonstrates a practical and affordable solution to improve the autonomy and quality of life for the physically challenged community.

1. Introduction Advancements in embedded systems and wireless communication have opened new possibilities in assistive technologies. Physically challenged individuals often face difficulties in mobility and accessing home appliances. Traditional wheelchairs lack intelligent control, and voice-activated systems may not be viable for all users. This paper introduces a gesture-based control mechanism integrated with smart home features using a Raspberry Pi Pico, Bluetooth communication, and MEMS sensors.

2. Literature Review Existing assistive mobility solutions include joystick-controlled wheelchairs and voice-controlled automation. However, these systems may be expensive or unreliable in noisy environments. Gesture control using MEMS sensors provides a cost-effective, user-friendly, and noise-immune alternative. Several research efforts have demonstrated gesture-based control systems, but integration with home automation remains limited.

3. System Architecture

3.1 Transmitter Side:

- **MEMS Accelerometer (MPU6050):** Detects tilt and orientation.
- **Microcontroller (Arduino Nano):** Converts gesture data into control signals.
- **Bluetooth Module (HC-05):** Transmits commands wirelessly.

3.2 Receiver Side:

- **Microcontroller (Raspberry Pi Pico):** Receives Bluetooth signals, processes commands.
- **Motor Driver (L298N):** Drives the wheelchair motors.

- **Relay Module:** Controls home appliances.
- **Power Supply:** 12V DC battery for motors and 5V for microcontrollers.

4. Implementation The system detects gestures through an accelerometer worn on the user's hand. Movements are mapped to specific commands: forward, backward, left, right, and stop. These signals are transmitted via Bluetooth and interpreted by the Raspberry Pi Pico. The Pico then activates the motor driver for wheelchair navigation or switches appliances on/off through relay circuits.

5. Results and Testing The prototype was tested in a controlled environment. Gesture recognition accuracy was above 90%. The wheelchair responded promptly to movement commands. Appliance control through relay switching was effective with negligible delay. The Bluetooth range was tested up to 10 meters.

6. Advantages

- Hands-free operation
- Low-cost and scalable
- Real-time control with minimal delay
- Enhances independence for disabled users

7. Limitations

- Limited range of Bluetooth (10 meters)
- May require recalibration for different users
- Not suitable for outdoor uneven terrains

8. Conclusion The proposed system effectively combines gesture control and home automation to offer a robust solution for assistive mobility and remote appliance control. It is cost-effective, easy to use, and significantly improves user autonomy. Future enhancements could include obstacle detection, IoT connectivity, and solar-powered operation.

9. References

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