HEALTH MONITORING AND SMART GLOVE ENABLED WHEELCHAIR NAVIGATION SYSTEM

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Abstract
Mobility impairments have a significant effect on the independence and quality of life of people with disabilities. This project introduces a smart glove-controlled wheelchair system that utilizes hand gesture recognition, real-time health monitoring, and obstacle detection to improve mobility and safety. The system is designed around an integrated Arduino microcontroller, which facilitates smooth and accurate navigation through intuitive hand gestures. The smart glove features an accelerometer to monitor hand movement with ease, with minimal physical engagement required for effective wheelchair control. Real-time healthcare monitoring capabilities through Heart Rate (HR) and SpO_2 sensors offer regular physiological checks to ensure user protection. An ultrasonic sensor has been included for the detection of obstacles in proximity, avoiding any collisions and a safe navigation journey. Further, Bluetooth technology also enables wireless communication, which means remote control and feedback systems for enhanced accessibility and convenience for users. By integrating wearable technology and intelligent automation, this system largely improves mobility support while focusing on safety and health monitoring. The gesture control system provides a user-friendly alternative to joystick-based or voice-controlled systems, thus proving to be a good option for people with varying physical abilities.

Keywords: Gesture Recognition, Accelerometer, Heart Rate, SpO_2, Navigation, Ultrasonic Sensor, Bluetooth Technology, Arduino

1. INTRODUCTION

Mobility options have advanced remarkably, but legacy wheelchair control mechanisms continue to remain difficult for disabled persons. This restriction makes necessary more natural, easy-to-use, and convenient alternatives that appeal to users of diverse motor capability, enabling greater autonomy and quality of life. The intricacies of coping with daily tasks call for novel methodologies that not only enhance independence but also consider users' safety and ease.

This project overcomes these challenges by proposing a groundbreaking smart glove-based wheelchair control system. By integrating gesture-based navigation, real-time health monitoring, and advanced obstacle detection, the system offers individuals a seamless and accessible experience. With accessibility and autonomy in mind, this solution empowers independence and redefines assistive mobility for people with disabilities.

Such solutions are in greater need due to the increasing global focus on creating inclusive technologies that bridge the gap for people with disabilities. Conventional mobility aids fail to provide the flexibility and user-oriented design necessary to address varied needs. The present project evolves a step further in filling the gaps and providing a solution to empower individuals to participate more fearlessly in their lives.

The result of this effort is a user-friendly, economical mobility aid that balances safety, independence, and real-time health information. By combining innovative capabilities with an emphasis on user well-being, this system not only increases mobility but also raises the bar for assistive technologies, changing the way people with disabilities interact with their environment.

2. PROPOSED SYSTEM

The new system presents a novel smart glove-based wheelchair control system that is designed to revolutionize mobility for people with disabilities. Through the application of gesture recognition technology, the system enables the user to move with ease about their environment using only hand gestures, removing the inconvenience associated with the use of the conventional joystick or voice-controlled system. The fusion of real-time health monitoring guarantees continuous monitoring of essential parameters for the purposes of safety and welfare during operation.

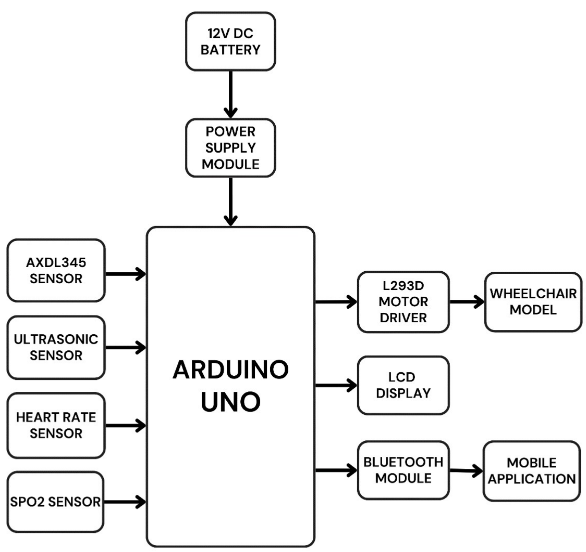

Figure 1. Block Diagram

For greater mobility, the system utilizes obstacle detection technology, which guarantees collision-free movement and allows users to enjoy safety and comfort. Wireless communication through Bluetooth is incorporated, providing greater strength in linking the wheelchair with the smart glove, with the benefits of comfort and ease of use, even for users with minimal physical strength.

The Block Diagram of the proposed system in Fig. 1 illustrates the architecture of the system, providing a clear overview of how the various components, including the gesture recognition module, health monitoring sensors, ultrasonic sensors, and Bluetooth module, interact to deliver seamless functionality and enhance user experience. This accessible, affordable, and ergonomic system emphasizes accessibility and usability and encourages independence. The system recommended here establishes a new benchmark for assistive mobility technology by balancing innovative features, safety, and accessibility, thereby enhancing the overall quality of life for people with disabilities.

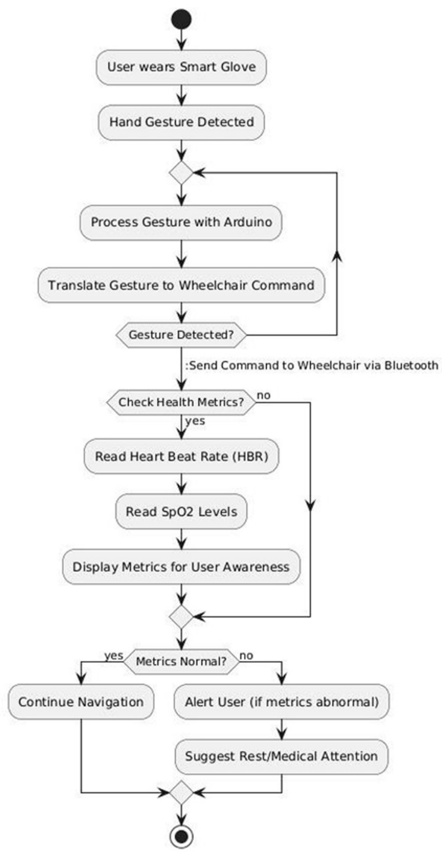

Figure 2. Flowchart

3. HARDWARE DESCRIPTION

The system employs the following components:

1. **Accelerometer**: Facilitates gesture identification through the sense of hand movement and converting the same into associated commands for a wheelchair to achieve comfortable movement.

2. **Arduino Microcontroller**: It is the processing unit, executing the gesture instructions and making sure the wheelchair carries out the same smoothly.

3. **Bluetooth Module**: Provides wireless connectivity between the wheelchair and smart glove to facilitate ease of use and user accessibility.

4. **Pulse Oximeter Sensor**: Tracks the important health indicators, such as SpO_2 and heart rate levels, for real-time health information to ensure safety and comfort.

5. **Ultrasonic Sensor**: Detects any obstacles in front of the wheelchair to avoid bumping, for safe and assured movement.

6. **Motor Driver Module**: Responsible for driving the movement of the wheelchair—forward, backward, left, and right—according to user commands.

7. **LCD Display**: Displays essential information, including health data and obstacle warning, enabling users and caregivers to check conditions at ease.

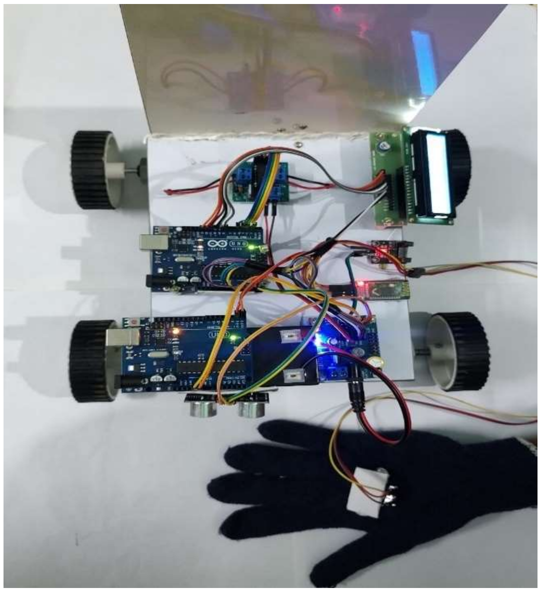

Figure 3. Hardware Implementation

4. RESULT AND OUTPUT

Figure 4, which displays the real-time SpO_2 levels and heart rate measurements on the LCD screen, provides a clear demonstration of the system's functionality. These results highlight the effectiveness of the wheelchair in monitoring vital health parameters and ensuring user safety. The integration of sensors and modules, including the SpO_2 and Heart Rate sensors, ultrasonic sensor, Arduino microcontroller, and Bluetooth module, has culminated in a reliable system for tracking health metrics and enabling safe navigation. Despite minor delays in data updates, the system has proven to be dependable and capable of enhancing mobility, independence, and well-being for individuals with disabilities.

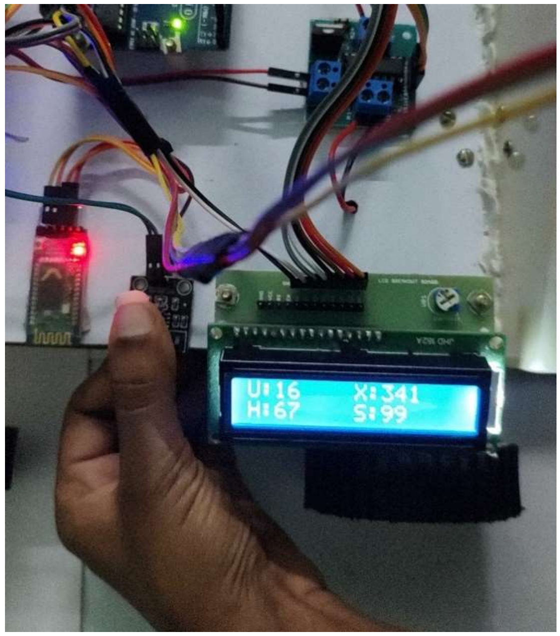

Figure 4. Health Monitoring and Obstacle Detection

TILT DIRECTION	TILT RANGE: X (IN ANALOG VALUES)	WHEELCHAIR MOVEMENT
Neutral (No Movement)	309 – 316	Stop
Forward Tilt	> 316	Move Forward
Backward Tilt	355 – 365	Move Backward
Left Tilt	268 – 274	Turn Left
Right Tilt	396 – 410	Turn Right

Table 1. Accelerometric Tilt Range

Table 1 showcases the tilt directions, corresponding analog value ranges, and their resulting wheelchair movements. It illustrates how specific hand gestures translate into precise wheelchair navigation. This design emphasizes intuitive control, ensuring accessibility for users with varied physical abilities.

5. CONCLUSION

The smart glove-controlled wheelchair system merges gesture recognition, real-time health monitoring, and obstacle detection effectively to provide an accessible, safe, and user-friendly mobility option. With the use of Bluetooth communication and ergonomic design, the system facilitates independence and improves the quality of life among people with disabilities. This project raises the bar in assistive technology through its innovative and inclusive strategy.

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