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HAND GESTURE CONTROLLED WHEEL CHAIR

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Abstract

The project for controlling wheelchairs through gestures offers a complete solution to enhance the mobility and independence of individuals with limited motor abilities using an intuitive gesture control system. This system incorporates essential elements, such as an Arduino Nano microcontroller, MPU (Motion Processing Unit), NRF wireless communication module, 775 DC motors, and a motor driver, to allow for smooth and responsive wheelchair operation.

- **Core System Components:**

The central component of the system is the Arduino Nano microcontroller, responsible for interpreting and executing user gestures effectively.

An MPU sensor accurately captures real-time hand movements, with the data processed by the Arduino Nano to recognize predefined gestures using advanced algorithms.

- **Wireless Communication Integration:**

The NRF module facilitates wireless communication between the user's gesture control device and the wheelchair's control system to ensure rapid and reliable transmission of gesture commands.

- **Propulsion System Details:**

The wheelchair's propulsion system is powered by robust 775 DC motors, managed through a motor driver connected to the Arduino Nano. This setup allows for dynamic speed and direction control, enabling smooth acceleration, deceleration, and maneuverability across different terrains.

1. INTRODUCTION

History of Wheelchair Development:

Wheelchair with a footrest was originally created in 1565 by King Phillip II of Spain. In 1783, John Dawson introduced a tricycle wheelchair known as the bath chair after the town of Bath. This innovation became highly popular during the 19th century with its two large wheels and one small wheel setup.

Subsequent developments between 1867 and 1875 included the addition of new hollow rubber wheels on the existing metal rims, along with the incorporation of small front caster and rear push wheels. In 1881, the manual self-propelled wheelchairs were introduced.

Evolution of Wheelchair Types:

Over time, various types of wheelchairs have been designed to enhance control and usability, including attendant-propelled wheelchairs, motorized wheelchairs, mobility scooters, single arm drive wheelchairs, and reclining wheelchairs, among others.

Innovative Design:

A new concept has emerged to create an advanced wheelchair that offers improved control and affordability for individuals with disabilities. The proposed design involves a hand-glove controlled wheelchair where the user's hand movements dictate the wheelchair's motion. By utilizing sensors such as a flex sensor and gyroscope, the wheelchair can move forwards, backwards, right, or left based on the user's gestures. The hand-glove transmits signals to a receiver located under the seat, influencing the wheels' movement through a motor's signal. This design aims to simplify wheelchair operation by aligning it with natural hand movements for greater comfort and efficiency across different terrains.

Technology Integration for Enhanced User Experience:

Unlike traditional wheelchairs with limited functionality, bulkiness, and flexibility constraints, the hand-glove controlled wheelchair leverages human gestures to synchronize with the wheelchair's actions, enabling ease of use on various terrains without causing fatigue or cardiovascular strain. By incorporating a mems accelerometer instead of a PC, the design reduces complexity and size, allowing for fingertip placement on users. Additionally, RF transmission enhances long-range communication and eliminates wired connections, facilitating seamless operation and communication between the wheelchair and user.

Human-Machine Interface and Cost-Effective Innovation:

The hand gesture-controlled wheelchair represents a significant milestone in human-machine interaction, where user commands direct the machine's operations via a user-friendly interface. The integration of advanced technology and cost-effective solutions aims to address the needs of the growing population of individuals with physical disabilities worldwide. This innovation strives to make life easier for those in need by providing an efficient and affordable mobility solution through hand gesture recognition technology.

2. LITERATURE SURVEY

G.Bourhis and K.Moumen in a published paper show that a number of guidance systems are currently available in the market to ensure comfortable navigation for a physically challenged person. The systems developed are highly competitive in bringing change to old traditional systems [1].

Mahipal Manda and B Shankar Babu developed a wheelchair using MEMS technology, can be integrated to develop a useful wheelchair control system using hand movements. Powered wheelchair with high navigational intelligence can be counted as one of the big steps towards integration of physically challenged [2].

Rakhi A. Kalanthri and D. K. Chitra demonstrated in their work that the wheelchair can be controlled in four directions by tilting the acceleration sensor. Ultrasonic sensors are used to control the movement of the wheelchair, avoiding the possibility of collisions with objects until the user is able to take over some of the responsibility of steering. It simply calculates the degree of inclination and decides which direction to move [3].

A study by Kannan Megalingam, Srikanth, and Raj shows that a combination of touch screen and Bluetooth technology allows disabled people to swipe across the screen to control movement. Apart from this, even in situations where the disabled cannot move their arms, a second person can control the movement instead of pushing the wheelchair [4].

The concept developed by Shreedeep Gangopadhyay ensures that it works completely independently without any wires or restrictions. The ability to avoid obstacles is kept within certain limits from the wheelchair. The wheelchair is configured to turn in a different direction if it detects obstacles while moving [5]..

4. REQUIREMENTS

> Hardware

1. **NRF24L01 Module** The NRF24L01 is a wireless transceiver RF module, where each module can send and receive data. Since it operates on the 2.4 GHz ISM band, the technology is approved for engineering applications in almost all countries. This module can cover 100 meters (200 feet) when operated efficiently, making it suitable for wireless remote-control project.

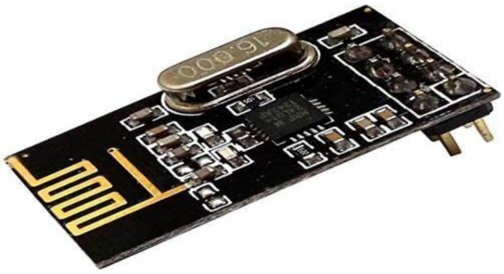

Figure 4.1 NRF24L01 Module

2. **DC MOTORS**: The four DC motors move the wheelchair in all the four directions: forward, reverse, left and right. Two motors (front and rear) on one side, say left side, are connected in parallel. Similarly, the other two motors on the right side of the wheelchair are connected in parallel. So there are four motors for four wheels, with one motor for each wheel

3. **L298N Motor driver** : Operating Supply Voltage up to

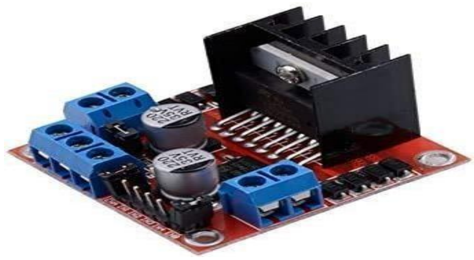

Figure 4.3 L298N Motor driver

46V Total DC current up to 4amp (Each channel can carry up to 2amp) Low Saturation Voltage Over Temperature Protection Logical "0" input voltage up to 1.5 v (High Noise Immunity) PTR connector for easy connection.

4.ACCELEROMETER(ADXL335)-SYMBOL FUNCTION 1 2 3 4 5 An Accelerometer is an electromechanical device that measures acceleration forces. These forces may be static, like the constant force of gravity pulling at your feet, or they could be dynamic caused by moving or vibrating the accelerometer. It is a kind of sensor which record acceleration and gives an analog data while moving in X,Y, Z direction or may be X,Y direction only depending on the type of the sensor. PIN NO Z Records analog data for Z direction Y Records analog data for Y direction X Records analog data for X direction GND Connected to ground for biasing VCC +3.3 volt is applied

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Figure4.4 ACCELEROMETER(ADXL335)

5.**12v ODDO Battery 12V 8Ah**.: the ODDO Battery 12V 8Ah is a versatile and reliable power source suitable for a wide range of applications where a stable, rechargeable, and maintenance-free power supply is required. Proper care and maintenance can help extend the lifespan and performance of the battery

Figure 4.5 PCA9685

6. nRF24 Module (Generic) - The nRF24 module is a wireless communication module based on the Nordic Semiconductor nRF24L01 chip. It operates in the 2.4GHz ISM (Industrial, Scientific, and Medical) band and provides a cost-effective solution for short-range wireless communication in projects such as remote control systems, sensor networks, and telemetry.

Figure 4.6 nRF24 Module

5. Working

Gesture Detection:
Hand movements and gestures by the user are detected by sensors or cameras mounted on the wheelchair.

Data Processing:
Captured data from the sensors or cameras is processed by the onboard microcontroller or computer system.

Gesture Recognition:
Processed data is compared against predefined gesture patterns stored in the system.

Machine Learning Techniques:
System recognizes gestures through machine learning or computer vision techniques.

Command Generation:
Microcontroller generates commands for controlling wheelchair movements based on recognized gestures.
Commands include instructions for forward/backward motion, turning, stopping, and adjusting speed.

Motor Control:
Generated commands are sent to the motor control system, consisting of motor drivers, actuators, and feedback sensors.
Motor drivers translate commands into electrical signals to drive wheelchair motors.

Wheelchair Movement:
Actuators and motors respond to control signals, adjusting the wheelchair's speed and direction.
Wheelchair moves based on user's gestures, like moving forward or turning.

Safety Mechanisms:
Safety mechanisms ensure user's safety and prevent accidents.
Obstacle detection sensors detect nearby obstacles, triggering wheelchair to stop or change direction.

User Feedback:
System provides feedback to confirm user's gestures have been recognized and wheelchair response.
Feedback may be visual, auditory, or tactile depending on user interface design.

By combining these steps, hand gesture-controlled wheelchairs offer an intuitive, hands-free way for individuals with physical disabilities to navigate their surroundings, enhancing independence and mobility. Refinement of gesture recognition algorithms and control systems improves accuracy and user experience.

6. Result

The result of a hand gesture-controlled wheelchair is improved mobility and independence for individuals with physical disabilities. Here are some key outcomes and benefits of using such a wheelchair:
Enhanced Autonomy: Users can manage the wheelchair using hand signals, eradicating the necessity for physical contact with traditional joystick controllers. This fosters more independence in maneuvering their surroundings.

Heightened Reachability: Hand gesture control presents an accessible substitute for individuals with limited or no limb use, granting them a method to operate the wheelchair effectively.

Natural Operation: Gestures typically mirror instinctive movements, simplifying the learning and usage of the wheelchair without extensive training. This streamlines user experience and lessens the learning curve.

Hands-Free Utilization: Users can operate the wheelchair without the requirement to utilize their hands to operate joysticks or other input mechanisms, allowing them to free up their hands for other tasks or activities.

Enhanced Convenience: The ergonomic layout of hand gesture-controlled wheelchairs, alongside adaptable settings, guarantees a comfortable and personalized user experience, diminishing fatigue and discomfort during prolonged use.

Safety and Reliability: Integration of safety attributes like obstacle detection, collision prevention, and emergency stop functionalities bolsters user safety and lowers the likelihood of accidents or collisions.

Adaptable Nature: The system is adjustable to suit various user preferences, capacities, and environments through personalized gesture mapping, modifiable sensitivity, and other configurations.

Social Integration: By empowering users with increased mobility and independence, hand gesture-controlled wheelchairs promote engagement in social events, interactions, and community involvement, fostering inclusion and well-being.

Continuous Evolution: Persistent research and development in gesture recognition technology and wheelchair design result in ongoing enhancements in accuracy, responsiveness, and user experience, thereby boosting the efficacy of hand gesture-controlled wheelchairs.

Overall, the outcome of a hand gesture-controlled wheelchair has a transformative impact on the lives of individuals with physical disabilities, empowering them to navigate their environment with greater freedom, dignity, and confidence..

7. Conclusion

Hand gesture-controlled wheelchairs signify a noteworthy progress in assistive technology, granting individuals with physical disabilities a fresh feeling of mobility, independence, and empowerment. By utilizing the natural and instinctive movements of hand gestures, these innovative devices enable users to easily navigate their surroundings, free from the constraints of traditional joystick-controlled wheelchairs.

Through incorporating sophisticated gesture recognition systems, sturdy motor control mechanisms, and advanced safety features, hand gesture-controlled wheelchairs offer a comprehensive solution that prioritizes user comfort, safety, and accessibility. The user-friendly operation and customizable settings render these wheelchairs appropriate for individuals with various abilities and preferences, while ongoing research and development fuel continuous enhancements in accuracy, responsiveness, and user experience.

The transformative influence of hand gesture-controlled wheelchairs extends beyond mere mobility, fostering increased independence, social inclusion, and quality of life for users. By dismantling barriers and enabling individuals to participate more fully in day-to-day activities and interactions, these devices assume a critical function in promoting dignity, autonomy, and equality for people with physical disabilities.

As technology progresses and innovates, hand gesture-controlled wheelchairs spotlight the potential of assistive technology to enrich the lives of individuals with disabilities, paving the way for a more inclusive and accessible society. By maintaining cooperation among researchers, engineers, healthcare professionals, and end-users, the future holds even greater potential for advancing the capabilities and accessibility of hand gesture-controlled mobility devices, ultimately enhancing the lives of millions worldwide.

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8. Future scope

Enhanced Gesture Identification:
Ongoing investigations into gesture detection technologies could result in more precise and dependable systems capable of recognizing a wider array of gestures with increased accuracy. Implementing artificial intelligence and machine learning strategies may enable the system to adapt and learn from user interactions, enhancing its performance over time.

Diversified Input Options:
Progressing beyond hand gestures, future wheelchairs might integrate additional input methods like voice commands, facial expressions, or eye movements. This multi-modal approach offers users greater flexibility and control, particularly for individuals with intricate motor disabilities.

Incorporation of Wearable Sensors:
Merging wearable sensors and gadgets, such as intelligent gloves or wristbands, can offer users a more seamless and intuitive means of engaging with the wheelchair. These sensors can recognize subtle hand motions and gestures, amplifying the system's responsiveness and usability.

Utilization of Augmented Reality Interfaces:
Utilizing augmented reality (AR) technology to overlay virtual controls or visual feedback directly onto the user's field of vision enhances the user interface, providing real-time guidance and aid. AR also offers immersive training and rehabilitation experiences to help users enhance their proficiency with gesture-controlled wheelchairs.

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