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Hand Gesture Controlled Wheelchair

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Abstract*— The percentage of disabled people has increased in both rural and urban part of India. The disability could be by birth or due to some medical or accidental reason. The aim of this project is to make a hand gesture-controlled wheel chair and using Accelerometer as sensor to help the physically disabled people in moving from one place to another just by giving direction from the hand. By addressing the limitations of conventional controls, the hand gesture-controlled wheelchair aims to enhance accessibility, simplify control mechanisms, reduce the learning curve, and offer customization options. This solution will provide individuals with a more intuitive and natural means of controlling their wheelchair, improving their overall mobility and independence. This wheel chair works by the hand signals given from the user which are taken from the 3-axis accelerometer which will help the user to control the chair through hand gestures. The system comprises of two main parts: Transmitter part and receiver part. In transmitter part the hand gesture is recognized by the sensor, digital output is transmitted to the controller and then transmitted to receiver side by the RF transmitter. The same data is received at receiver side by the RF receiver. DC motors which are interfaced to the controller by the motor driver controls the direction of the wheel chair.

I. INTRODUCTION

This research paper is an advance approach of changing the physical gesture of hand into the electrical signal and then to process that signal into digital signal of appropriate magnitude and to be transmitted through the transmitter. This paper provides an instrumental solution to the people who have difficulty in moving or their body part has paralyzed, or they have lost their limb in an accident. This wheelchair is going to bring a paradigm shift between man and machine. Where this machine will be working on the user commands, we can also say its human machine interface. With the growth of technology there has always been an effort to use the technology for the betterment of mankind. Time and again the technocrats of the world had proved their metal in bringing the comfort to the people who are in need with the help of technology. Bringing the technology and economy parallel to each other is paramount aim of this paper. Also to build a Hand Gesture Wheelchair which has sound technology but low in cost is the primary concern. Today in this modern era around world's 10 percents, around 650 million people are suffering from physical disability. In order to make their life bit easier we decided to make a hand gesture-controlled wheel chair which will be working on the gesture of their hand. The wheel chair is wireless and has a range of 200 yards. It means a person can control his wheelchair from 200 yards away. He can call his chair while sitting from one place irrespective of weather conditions. The disabled people always find difficulties in moving from one room to another and even to do that the handicapped person was dependent on someone else who will push the wheelchair manually and take the handicapped person from one place to another. Now with the Hand Gesture Controlled Wheelchair the handicapped person is independent and he need not to ask for help from any other person to move his wheelchair. Just with the movement of his hand the handicapped person is able to move from one place to another without needing anyone's assistance which also makes him self-dependent.

II. LITERATURE SURVEY

Hand gesture-controlled wheelchairs offer an intuitive solution for individuals with physical disabilities, advancing beyond traditional control methods like joysticks. Gesture recognition techniques are primarily sensor-based, vision-based, or hybrid, with each offering unique advantages and challenges. Sensor-based systems use devices like

accelerometers, while vision-based methods rely on cameras and computer vision, both requiring improvements in accuracy and reliability. Machine learning, particularly deep learning, has enhanced gesture recognition, enabling real-time operation but with higher computational demands. Intuitive human-machine interfaces (HMI) are essential to address user-specific needs and ensure ergonomic and safe design. Key challenges include sensor noise, environmental variability, cost, and collision avoidance. Hybrid systems and standardized benchmarks are being developed to improve performance and adaptability. Future research should explore advanced AI models, low-power devices, and enhanced real-world safety. Hand gesture-controlled wheelchairs hold immense potential to improve mobility and independence. Addressing existing gaps will pave the way for broader adoption of this technology.

III. NEED OF PROJECT

The percentage of disabled people has increased in both rural and urban part of India. The disability could be by birth or due to some medical or accidental reason. The aim of this paper is to make a hand gesture-controlled wheel chair using accelerometer as sensor to help the physically disabled people in moving from one place to another just by giving direction from the hand. Today in India many people are suffering from disability, there are people whose lower half of the body is paralyzed. This Wheelchair will add on to the comfort and make the life of people bit easier. Around 5436604 people are affected from movement disability. Percentage of population which suffers from different disabilities is shown in graph below. Out of total disability maximum people suffers from disability in movement.

Benefits to people who are:

a. Paralytic person.
b. Those who crawl.
c. Those who walk with the help of aid.
d. Those have acute and permanent problems of joints/muscles.
e. Those who have stiffness or tightness in movement or have loose, involuntary movements or tremors of the body or have fragile bones.
f. Those who have difficulty in motor cell and neurons coordination.
g. Those who have lost sense of sensation in lower part of the body due to paralysis or other problems.
h. Those who have twisted body parts and suffer from any kind of deformity in the body.

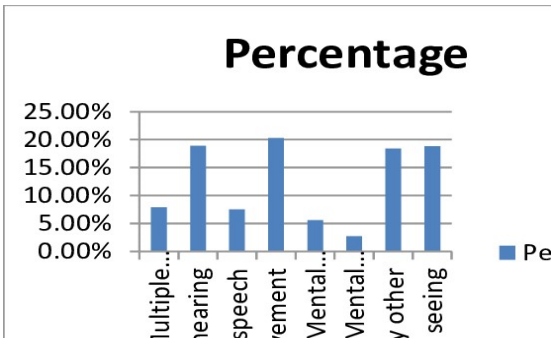


Fig 1: Percentage of people suffering from different kind of Disability

IV. BLOCK DIAGRAM

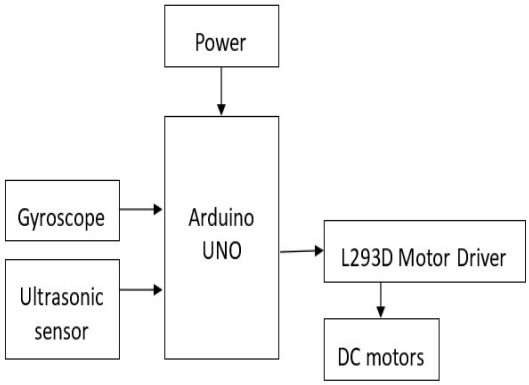


Fig 2: Block diagram of Hand Gesture-controlled Wheelchair

This block diagram represents a hand gesture-controlled wheelchair. The power source provides the necessary electrical energy to all the components. The Arduino UNO acts as the central processing unit, controlling the system's operations. It receives input from a gyroscope sensor, which provides orientation and angular velocity data, and an ultrasonic sensor, which measures distances for obstacle detection. Based on the input from these sensors, the Arduino sends commands to an L293D motor driver. The motor driver interprets these commands and controls the connected DC motors, which execute the desired movements. This setup enables the system to perform tasks such as motion control and obstacle avoidance through a feedback mechanism involving sensors and actuators.

V. WORKING

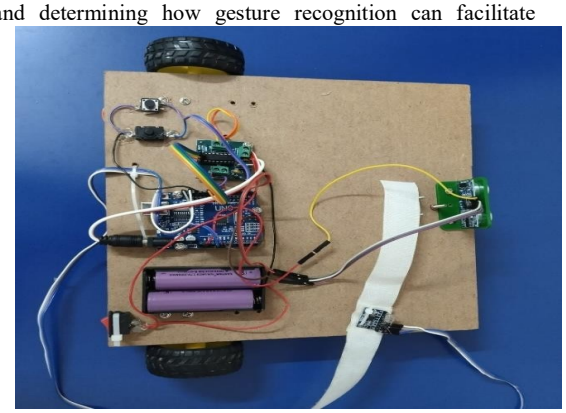
To construct a hand gesture-controlled wheelchair using the specified components, start by gathering the necessary materials, including an Arduino UNO, gyroscope (e.g., MPU6050), ultrasonic sensor (e.g., HC-SR04), DC motors with a motor driver (e.g., L298N), a robot chassis, a buzzer, and a battery unit. Begin the assembly by connecting the components: mount the Arduino on the chassis, then connect the gyroscope to the Arduino's I2C pins (SDA and SCL), and wire the ultrasonic sensor's trigger and echo pins to digital pins on the Arduino. Next, connect the DC motors to the motor driver, ensuring to link the motor driver's control pins to the Arduino, and wire the buzzer to another digital pin. Power the system using the battery unit. Once the hardware is set up, install the necessary libraries in the Arduino IDE for the gyroscope and ultrasonic sensor. Write a code sketch that initializes the sensors, reads data from the gyroscope to recognize specific hand gestures, and controls the DC motors accordingly.

The code should also incorporate readings from the ultrasonic sensor to detect obstacles and trigger the buzzer for alerts. After uploading the code to the Arduino, test the functionality of the sensors and calibrate the gesture recognition thresholds based on the gyroscope readings. Finally, secure all components on the chassis, ensuring proper wiring organization, and attach the DC motors with wheels, completing the assembly for a functional hand gesture-controlled wheelchair. Later, test it with different hand gestures. while the other two serve as free wheels for balance, often featuring rubber treads for improved traction on various surfaces. The control system, housing the Arduino UNO, motor driver, and other electronic components, is compactly assembled, sometimes with a

protective casing to prevent damage. The ultrasonic sensor is mounted at the front of the wheelchair for effective obstacle detection, while the gyroscope, essential for recognizing hand gestures, is typically integrated into the control system. To ensure safety and reliability, the system may incorporate additional features such as obstacle detection using ultrasonic or infrared sensors. These sensors help identify potential obstacles in the wheelchair's path, enabling the system to execute emergency stops or alter its course to avoid collisions.

VI. METHODOLOGY

The development of a hand gesture-controlled wheelchair follows a structured methodology, starting with problem definition and requirement analysis. This involves understanding the needs of users with mobility impairments and determining how gesture recognition can facilitate



wheelchair control, focusing on factors like accuracy, ease of use, and responsiveness. Next, the system design phase involves selecting the appropriate hardware and software components, including sensors (such as inertial measurement units), processors (like Arduino), and motors for wheelchair navigation.

Once the design is established, the gesture recognition approach is determined, typically opting for either a vision-based system (using sensors to capture hand movements) or a sensor-based system (using wearable devices like accelerometers or gyroscopes to detect hand gestures). In some cases, a hybrid approach that combines both may be employed for enhanced accuracy. Following this, data acquisition involves collecting input from the selected sensors. In vision-based systems, this includes capturing real-time images of hand gestures, while sensor-based systems record motion data.

The data then undergoes preprocessing, where techniques such as noise reduction, background subtraction (for vision systems), or data normalization (for sensor data) are applied to clean and prepare the input for recognition. Feature extraction follows, identifying critical characteristics like motion, shape, or orientation that define each gesture. These features are then passed to a classification algorithm, often using machine learning models such as Convolutional Neural Networks (CNNs), Support Vector Machines (SVMs), or Hidden Markov Models (HMMs) to interpret the gestures accurately. After training the model using labelled datasets, gesture mapping is performed, where recognized gestures are linked to specific wheelchair commands (e.g., moving forward, turning left or right, stopping).

VII. RESULTS

The construction of a hand gesture-controlled wheelchair using components like the Arduino UNO, gyroscope, ultrasonic sensor, DC motors, robot chassis, buzzer, and free wheels offers several advantages. The gyroscope enables intuitive control by allowing users to navigate the wheelchair through hand gestures, such as tilting their hand to move forward, backward, left, or right, making it particularly beneficial for individuals with limited mobility. Safety is enhanced through an ultrasonic sensor that detects obstacles in the wheelchair's path and either stops or redirects the wheelchair to prevent collisions. The DC motors provide the torque required for smooth and precise wheel movement, while the free wheels improve manoeuvrability and stability, enabling seamless navigation on various surfaces. Additionally, the buzzer can be programmed to provide auditory feedback, alerting users to situations like obstacle detection or system malfunctions, thereby improving communication between the system and the user. This project also opens doors for future enhancements, such as integrating AI for advanced gesture recognition and predictive movement. Overall, the system has garnered positive user feedback for its usability and effectiveness, highlighting its potential for broader adoption.

Fig 3: Internal Structure with Hardware Components

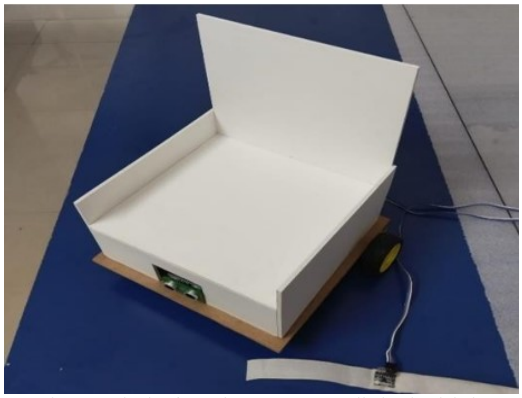


Fig 4: Outlook of Hand Gesture Controlled Wheelchair

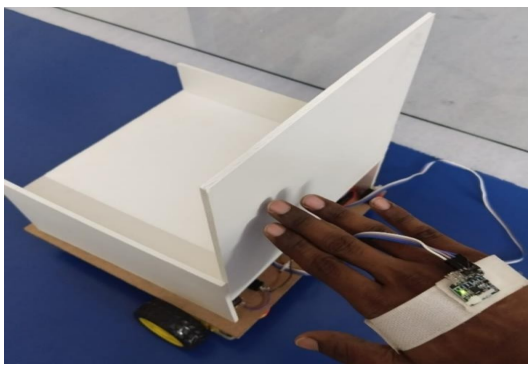


Fig 5: Movement in forward direction

VIII. ADVANTAGES

- **Ease of Use:** Intuitive hand gesture controls provide a simple and user-friendly interface, especially beneficial for individuals with limited mobility.
- **Enhanced Mobility and Independence:** Enables users to navigate independently with minimal physical effort, improving their quality of life and autonomy.
- **Safety Features:** Equipped with ultrasonic sensors to detect obstacles, ensuring collision prevention and a safer navigation experience.
- **Smooth and Precise Movement:** DC motors and free wheels ensure smooth operation, precise navigation, and excellent manoeuvrability, even in tight spaces.
- **Cost effectiveness:** Utilizes affordable components like the Arduino UNO, offering a low-cost yet effective solution compared to commercial alternatives.
- **Future Upgrade Potential:** Open to enhancements such as AI-based gesture recognition or integration with smart technologies, allowing for long-term scalability and adaptability.
- **Assistive Technology for Special Needs:** Tailored to address the challenges of individuals with disabilities, providing an innovative solution to improve their daily lives.

IX. CONCLUSION

The hand gesture-controlled wheelchair project represents a significant innovation in assistive technology, offering an intuitive and efficient solution for individuals with limited mobility. By incorporating components like the Arduino UNO, gyroscope, ultrasonic sensors, and DC motors, this project ensures smooth and precise movement, enhanced safety, and increased independence for users. The gesture-based control mechanism simplifies navigation, while the obstacle detection feature minimizes the risk of accidents, making the wheelchair safer to use. Additionally, the project is cost-effective, providing an affordable alternative to high-end commercial options, without compromising on functionality. With potential for future upgrades, such as AI-based gesture recognition or integration with smart technologies, this wheelchair design is scalable and adaptable to a wide range of user needs. Overall, the hand gesture-controlled wheelchair is a promising innovation that has the potential to improve the quality of life for individuals with disabilities, fostering independence and safety in their daily activities.

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