IJAER/ March-April 2024/Volume-13/Issue-2 ISSN: 2278-9677

International Journal of Arts & Education Research

(Peer-Reviewed, Open Access, Fully Refereed International Journal) Impact Factor:7.06

Hand Gesture Control Smart Wheelchair

Prof. Swati Aswale[1], Parth Chavan[2], Sanket Patil[3], Abhishek Kashid[4]

Professor, Department of Electronics and Telecommunication Engineering, Akurdi, Pune, India[1]

Students, Department of Electronics and Telecommunication Engineering, Akurdi, Pune, India[2 3 4]

Abstract

The "Hand Gesture-Controlled Wheelchair for Disabled Individuals" project introduces a revolutionary solution to empower those with physical disabilities, facilitating enhanced mobility and independence. By incorporating cutting-edge technology and innovation, this endeavour enables users to effortlessly control a wheelchair through intuitive hand gestures. Aiming to bridge the accessibility gap, this project centres on the integration of accelerometer sensors discreetly placed on the user's hand. At its core, a Raspberry Pi serves as the project's central hub, hosting a sophisticated gesture recognition algorithm. This algorithm interprets accelerometer data with precision, translating it into real-time commands for the wheelchair, including forward, backward, turning, and stopping. A user-friendly interface empowers individuals to customize gesture profiles and sensitivity settings to match their unique needs. The project prioritizes safety, integrating obstacle detection capabilities and an emergency stop feature. Rigorous testing and user feedback refinement ensure the system's reliability and accuracy. In essence, the "Hand Gesture-Controlled Wheelchair for Disabled Individuals" project embodies the principles of assistive technology and inclusivity. It holds the potential to transform lives by granting greater autonomy and enhancing the quality of life for individuals with mobility challenges.

Keywords: *Accelerometer, Arduino Nano, Radio frequency transceiver, Raspberry pi*

1. Introduction

In a world where mobility is a fundamental human right, we recognize the challenges faced by individuals with disabilities or health-related limitations. Disabilities can range from paralysis to neural and brain injuries, affecting an individual's ability to move independently. The demand for mobility assistance devices like wheelchairs is on the rise, with over 75 million people worldwide in need of these devices. While manual wheelchairs have served their purpose, they may not be suitable for individuals with severe disabilities. The Hand Gesture Controlled Wheelchair project addresses the pressing need for more accessible and user-centric mobility solutions for individuals with disabilities.

2. Literature review

2.1 Smart Voice and Gesture Controlled Wheelchair Khande and Rajapurkar (2022) introduce a novel approach in assistive technology with their development of a hand gesture-controlled wheelchair system integrated with voice commands. This innovative system offers individuals with physical disabilities a more intuitive means of mobility control, leveraging both hand gestures and voice commands to navigate their surroundings effectively. By combining these modalities, the system enhances user autonomy and ease of operation, thereby potentially improving the overall quality of life for wheelchair users.

2.2 Gesture-based Smart Wheelchair for Assisting Physically Challenged People (ICCCI 2021):
Sarnali Basak, Fariha Faruque Nandiny, S. M. Mazharul Hoque Chowdhury, and Al Amin Biswas introduce a groundbreaking gesture-controlled smart wheelchair system in their paper presented at the ICCCI 2021 conference. This innovative system is

specifically designed to assist disabled individuals in controlling their mobility, offering a novel solution to enhance their independence and quality of life. By utilizing gesture recognition technology, users can intuitively navigate the wheelchair through hand movements, providing a hands-free alternative to traditional joystick-controlled wheelchairs. The integration of gesture control into the wheelchair system represents a significant advancement in assistive technology, catering to the diverse needs of physically challenged individuals and promoting greater accessibility and inclusivity in mobility solutions.

2.3 Wireless Gesture Control Wheelchair (IJRTE):

Shanelle Fernandes, Rushia Fernandes, and Jessica Kakkanad present a pioneering study in the International Journal of Recent Technology and Engineering, unveiling a cost-effective wireless gesture-based wheelchair tailored for individuals with limited arm strength. The research introduces a novel approach to wheelchair control, leveraging hand gestures captured via a glove-mounted Arduino Lilypad and accelerometer. This innovative system offers users increased independence and autonomy by circumventing the constraints associated with traditional joystick-oriented solutions. By harnessing wireless gesture control technology, the wheelchair system provides a seamless and intuitive means of navigation, empowering users to navigate their surroundings with ease and efficiency. This research represents a significant advancement in assistive technology, promising enhanced accessibility and improved quality of life for individuals with mobility impairments.

2.4 Modal Analysis of MEMS Capacitive Accelerometer (TEMSMET 2023):

In their research presented at the IEEE TEMSMET conference, Komalakumari, Namrata Dcruz, Bindu A Thomas, and G. Narayanaswamy delve into the modal analysis of MEMS capacitive accelerometers. Their study provides valuable insights into the dynamic behaviour of these sensors, crucial for improving their precision and reliability. By gaining a comprehensive understanding of the accelerometer's modal characteristics, researchers can optimize its performance for specific applications, thereby advancing the capabilities of motion sensing technology in various fields, including assistive devices.

3.Proposed System

3.1 Transmitter

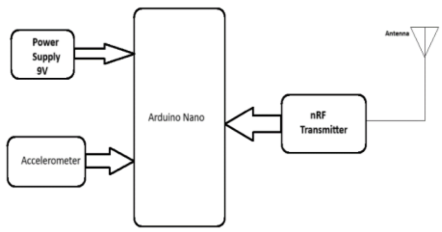
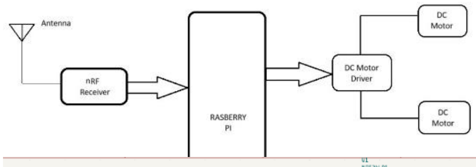


Fig. 1 Block Diagram of Transmitter

An accelerometer integrated into a glove worn by the user senses hand gestures and movements. This accelerometer, connected to an Arduino Nano, provides real-time data on the gestures made by the user's hand. The Arduino Nano reads this data and interprets the hand gestures into specific commands, such as "move forward," "turn left," or "turn right." These commands are derived from predefined gestures and mapped accordingly in the Arduino Nano's code. Once the gestures are interpreted into commands, they are wirelessly transmitted to the receiver using an NRF24L01 wireless transmitter module connected to the Arduino Nano. The NRF24L01 module encodes the commands into data

packets, which are then transmitted to the receiver. This wireless transmission enables seamless communication between the transmitter (the glove with Arduino Nano) and the receiver (the Raspberry Pi).

3.2 Receiver



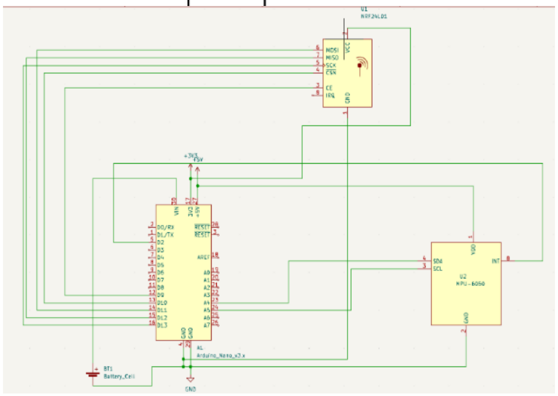


Fig. 2 Circuit Diagram of Transmitter

On the receiver side, a Raspberry Pi equipped with an NRF24L01 wireless receiver module receives the transmitted commands from the transmitter. The Raspberry Pi decodes these commands from the received data packets. It then interprets the commands, understanding the intended movements based on the gestures captured by the accelerometer and translated by the Arduino Nano. Using the interpreted commands, the Raspberry Pi controls the motors of the wheelchair. It sends signals to the motor drivers, which manage the movement of the wheelchair accordingly. For instance, if the interpreted command is "move forward," the Raspberry Pi activates the appropriate motor drivers to propel the wheelchair forward. This control mechanism ensures that the wheelchair moves in the desired direction and speed as dictated by the user's hand gestures, thus facilitating intuitive and responsive movement.

Fig. 3 Block Diagram of Receiver

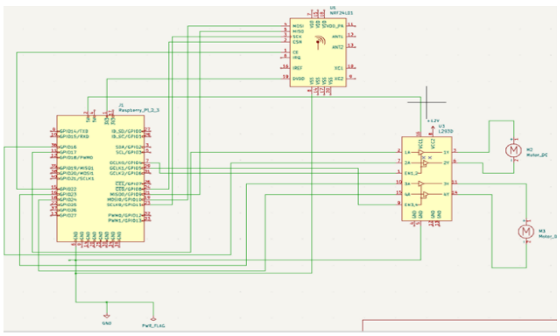


Fig. 4 Circuit Diagram of Receiver

4. Results

Accelerometer with Arduino

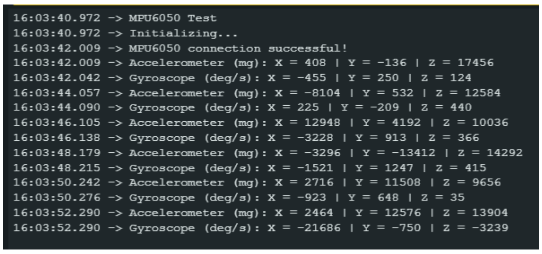


Fig. 5 MPU output on Serial monitor

An accelerometer, in conjunction with an Arduino microcontroller, serves to identify variations in motion or subtle vibrations. The image depicts the testing of the MPU (Motion Processing Unit) within the Arduino IDE. The MPU, interfaced with an Arduino microcontroller board, is configured to capture motion data such as acceleration and gyroscope readings. In the image, the MPU's output data is showcased through the Serial Monitor window, displaying numerical values corresponding to the measured motion parameters. The MPU testing involves verifying the accuracy and reliability of motion data captured by the MPU under different conditions. Researchers may manipulate the MPU's settings or subject it to various motion scenarios to evaluate its performance. The image serves as a visual representation of the MPU testing process, demonstrating the integration of the MPU with the Arduino IDE for motion sensing applications. This testing phase is crucial for assessing the MPU's suitability for specific use cases and refining its functionality to meet desired performance standards.

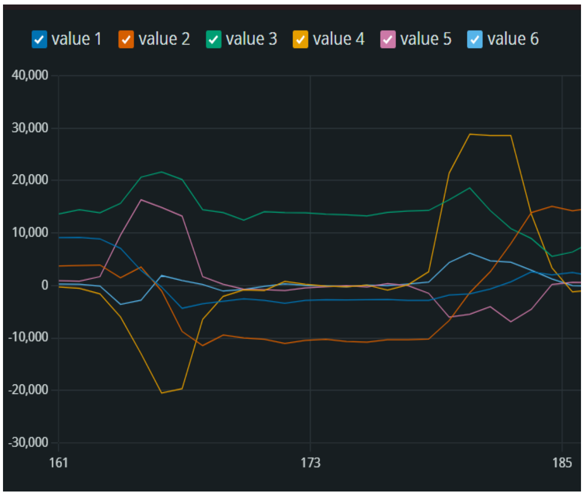


Fig. 6 MPU Output on Serial Plotter

The image showcases the graphical representation of MPU data using the Serial Plotter tool within the Arduino IDE. The MPU, connected to an Arduino microcontroller board, captures motion data such as acceleration and gyroscope readings. The graph illustrates changes in motion dynamics over time, providing a visual depiction of the MPU's performance. Researchers can observe trends, fluctuations, and patterns in the motion data, enabling them to assess the MPU's accuracy and responsiveness to different motion scenarios. The Serial Plotter serves as a valuable visualization tool, enhancing the analysis of MPU data and aiding in the evaluation of its functionality for motion sensing applications. This graphical representation complements numerical data displayed in the Serial Monitor, offering researchers a comprehensive view of the MPU's behaviour during testing.

Fig. 7 Wheelchair Model

The image depicts a schematic representation of the wheelchair model developed as part of this research. The model integrates advanced technologies including a Raspberry Pi microcontroller, NRF24L01 wireless communication module, L293D motor driver, and two motors. The Raspberry Pi serves as the central control unit, orchestrating the operation of the wheelchair through wireless communication with the NRF24L01 module. The NRF24L01 module facilitates seamless transmission of commands from the handheld controller to the wheelchair, enabling intuitive control and manoeuvrability. Additionally, the L293D motor driver interfaces with the Raspberry Pi to regulate the motion of the wheelchair's two motors, ensuring precise and responsive movement. This wheelchair model is designed to provide enhanced mobility assistance for individuals with disabilities, showcasing the integration of cutting-edge technologies to improve accessibility and independence.

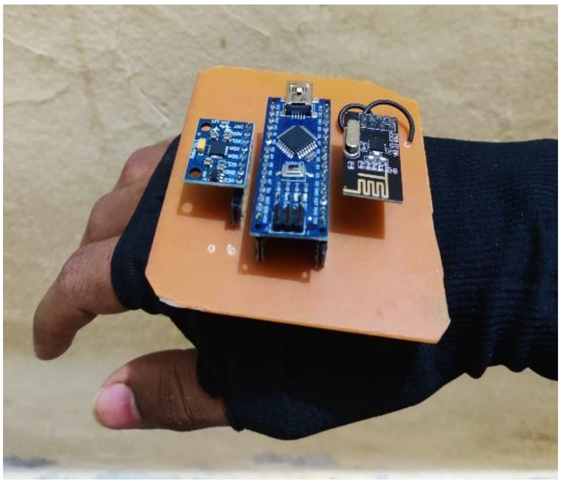


Fig. 8 Gesture Controller

The transmitter, comprising an integrated PCB hosting an MPU (Motion Processing Unit), NRF transmitter module, and Arduino Nano, is depicted. This setup enables gesture recognition through the MPU, wireless transmission via the NRF module, and data processing by the Arduino Nano. The compact design facilitates seamless integration into a glove for intuitive control and transmission of hand gestures for further processing.

5. Conclusion

In conclusion, our Hand Gesture Control Wheelchair project represents a significant advancement in assistive technology. By harnessing the capabilities of accelerometers, Raspberry Pi, and RF communication, we've created an intuitive, cost-effective solution that enhances mobility and independence for individuals with disabilities. This innovative approach not only simplifies wheelchair control through natural hand gestures but also prioritizes user-centric design and safety. As we continue to refine and expand this technology, we aim to empower users and promote inclusivity, making mobility more accessible and dignified for all.

6. Acknowledgement

We extend our sincere appreciation to our esteemed project guide, Mrs. Swati Aswale, for her invaluable guidance, support, and expertise throughout the duration of this research project. Her mentorship has been instrumental in shaping our understanding and approach. We would also like to express our gratitude to our diligent group members, Parth Anil Chavan, Sanket Patil, and Abhishek Kashid, for their unwavering commitment, collaboration, and contributions to every phase of the project. Their dedication and teamwork have been pivotal in achieving our research objectives. Furthermore, we extend our heartfelt thanks to Shinearc Technologies for their generous support and provision of equipment, which was indispensable for the successful execution of our research endeavour. This research would not have been possible without the collective effort and support of all those involved, and we are deeply grateful for their contributions.

7. References

[1] Mahipal Manda, B Shankar Babu, M Abhishek and J Srikanth ―Hand Gestures Controlled Wheel Chair‖ Journal of Emerging Technologies and Innovative Research (JETIR) September 2018, Volume 5, Issue 9, page no.642-647,2018.

[2] Shanelle Fernandes, Rushia Fernandes, Jessica Kakkanad, "Wireless Gesture Control Wheelchair", International Journal of Recent Technology and Engineering (IJRTE) ISSN: 2277-3878, Volume-9 Issue-2, July 2020

[3] V Sridevi,P. Ishwarya, P. Surya Chandra, N. Suresh Kumar, "Automated Gesture Based Wireless Wheelchair Control by Means of Accelerometer", International Journal of Engineering and Advanced Technology (IJEAT) ISSN: 2249 – 8958, Volume-9 Issue-1, October 2019

[4] F. F. Alkhalid and B. K. Oleiwi, "Smart Autonomous Wheelchair Controlled by Voice Commands-Aided by Tracking System," In Iraqi Journal of Computers, Communication and Control & Systems Engineering, Vol. 19, No. 1, pp. 82-87, 2019.

[5] Z. Fan, L. Meng, T. Q. Chen, J. Li, and I. M. Mitchell, "Learning Motion Predictors for Smart Wheelchair Using Autoregressive Sparse Gaussian Process," In 2018 IEEE International Conference on Robotics and Automation (ICRA), pp. 713-718, 2018.

[6] Y. Asai; R. Enomoto, Y. Ueda, D. Iwai, K. Sato, "Virtual Hand Representation and Motion Control for Smart Wheelchair with Touch- Based Extended Hand Projection," In IEEJ Transactions on Electronics, Information and Systems, Vol. 139, No. 5, pp. 662-669, 2019.

[7] Ababneh, M., et al. "Gesture Controlled Mobile Robotic Arm for Elderly and Wheelchair People Assistance Using Kinect Sensor." 2018 15th International Multi-Conference on Systems, Signals & Devices (SSD). IEEE, 2018

[8] Megalingam, Rajesh Kannan, et al. "Wireless gesture-controlled wheelchair." 2017 4th International Conference on Advanced Computing and Communication Systems (ICACCS). IEEE, 2017.

[9] A.Ray Chaudhuria, S. Severia, M.A. Erimisa, L.A. Francisb and A.Witvrouwa, "SiGe MEMS Accelerometers combining a large bandwidth with a High capactivie Sensitivity, 2012.

[10] Heung Seok Kang, Kang-Hee Lee, Dong-Youk Yang, Byoung Hee You, In-Hyouk Song, "Micro-accelerometer Based on Vertically Movable Gate Field effect Transistor", 2015 "