Grenze International Journal of Engineering and Technology, Jan Issue

Smart Mobility Assistive Device for Paretic People

Chaitra Upadhya[1], Neethi Shetty[2], Pragya Singh[3], S Raghavendra Rao[4] and Kola Sampangi Sambaiah[5]
[1-5]Department of Electrical and Electronics Engineering, PES University, Bengaluru, India
Email: sambaiahks@pes.edu (corresponding author)

***Abstract*— For individuals who are physically challenged, there are currently plenty of smart gadgets available. Existing technology does have several significant disadvantages, such as the cost and accessibility to an average person. The wheelchairs of today are also heavy and challenging to physically transport from one place to another. The efficacy of contemporary wheelchairs equipped with advanced robotic technology in improving the overall well-being of those with disabilities is hindered by their exorbitant price, technical constraints, and safety concerns. To address the aforementioned issue, the present research study proposes the implementation of a technologically advanced wheelchair controlled using smart gestures. For the elderly and the disabled to move around, wheelchairs and similar assistive devices are required. However, because it requires help from others to move, hand gesture-controlled wheelchairs can help individuals with physical disabilities by enabling them to move the chair on their own with a few simple gestures. The suggested prototype would be highly beneficial to them since it will allow them to operate the wheelchair with their hand gestures, through which the wheelchair's directions may be changed and be used to navigate. This system can be controlled by a microcontroller (Arduino). It is clear from the findings that the proposed research has designed a wheelchair prototype that is affordable, and gesture controlled.**

***Index Terms*— Assistive device, microcontroller, modern wheelchair, paretic patients, smart gesture control.**

I. INTRODUCTION

About 2.68 million persons, or 2.21% of the population, in India as of the 2011 census are disabled. The WHO estimates that 75 million individuals in the year 2019 regularly use wheelchairs. This is equivalent to 1% of the entire global population. Every rural and urban area of India has seen an increase in the percentage of people with disabilities. A medical condition or accident could have resulted in the handicap, or it could have been inherited. Since they must rely on others for their mobility, it is quite challenging for disabled people to independently fulfil their everyday tasks [1].

Every human life deserves the opportunity to live normally. But due to impairments or various unanticipated circumstances, many of us cannot independently perform everyday duties or move about securely. The inability to do any task or difficulty in performing the same is referred to as a disability. The number of physically impaired individuals is unfortunately increasing. A wheelchair or any assistive device is necessary for people who are

Grenze ID: 01.GIJET.10.1.14

paralyzed, have fatal leg injuries or hemiplegia, or have different sorts of neurological and brain injuries, or have lost their ability to walk or move independently. [2].
By combining this gesture technology with the typical wheelchair, individuals with disabilities can be assisted in a variety of ways to carry out their routine daily duties. The development of an affordable, user-friendly smart wheelchair is essential for assisting paretic individuals from disadvantaged backgrounds. The primary impetus for our research is from our commitment to enhancing the quality of life for those with physical impairments and socio-economic disadvantages. Our proposed solution is simple and cost-effective.
This study describes a smart, affordable wheelchair system that may be operated with simple finger signals and movements. To operate a wheelchair, all users need to do is move their fingers and show the gesture. It has straightforward operations and uses less energy. The suggested solution does not require joystick use or external sensor wire because it detects motion and gestures using an external camera.
The five gestures that are considered in this study are STOP, LEFT, RIGHT, BACKWARD, and FORWARD.
The final section of this work is outlined as follows: a literature review has been conducted to assess the status of research on smart wheelchair, which is described in section II, to identify the research gaps between the existing work. We have outlined our suggested methodology in section III. Requirement and utilization of Hardware and Software is presented in Sections IV, and V, respectively. Section VI contains the results and discussions of the analysis. Section VII contains the features of the proposed model. Section VIII presents conclusion and future scope of the work.

II. Literature Review

The features and safety of smart wheelchair technology continue to be improved by researchers and engineers. Recent years have seen development of several intelligent mobility systems which use different control methods [2]. For the current research article review of several relevant publications are being referred to provide an efficient and better response. By pointing out a lack of research, this part helped to propose an alternative solution for the existing objective.
Rajeshree Khande et al. have designed the Smart Voice and Gesture Controlled Wheelchair [1]. The proposed model in this study will have improved accuracy because they used The Voice Recognition Module-V3, which can recognize any seven vocal commands at once from a collection of 80 instructions. Muhammad Sheikh Sadi et al. have designed the Finger-Gesture Controlled Wheelchair with Enabling IoT [2]. In this study, a clever, reasonably priced wheelchair system is described. It may be controlled using basic finger signals and motions. Therefore, there is no need to use joysticks or any additional sensor circuits in the proposed system for detecting movement and gestures using a simple RGB camera of 1 mega pixel with 30 fps at USB cable connection. Sarnali Basak et al. have designed the Gesture-based Smart Wheelchair for Physically Challenged People [3]. The proposed research work is about a gesture-based smart wheelchair system that can recognize hand movement using gestures or 3D hand movement detection technologies.
Amar Paljeet Cheema et al. proposed a fully wireless electric wheelchair with quadriplegia individuals and home automation using IoT. To simulate the motion of full handsfree electric wheelchair, an accelerometer sensor, a cell phone RF transceiver, a Handoff module, and an Arduino microcontroller are integrated [4]. The three main parts of the proposed framework are the speed increase sensor, the RF (radio recurrence) transmitter, and the RF (radio recurrence) collector. A literature review on smart wheelchair has presented by Kedar Sukerkar et al. in [5]. The fact that an electric wheelchair contains a computer and multiple sensors is the only distinction between a smart wheelchair and one without. Intelligent wheelchairs are easy to use and provide the user with outstanding safety. The current state of the art and possible research directions are covered in this essay. Muzhal Ghaffar et al. has developed an Assistive Smart Home Environment using Head Gestures and EEG Eye Blink Control Systems [6]. To develop a system to allow users to operate room lighting, air circulation, security lock management and wheelchair navigation, the study uses an approach based on head tilt movement and sets of blinking eyes. R.R. Bhambare et al. have presented smart wheelchair control using voice and gesture control. The authors have developed an intelligent wheelchair control system that can detect hand gestures and voice commands for the purpose of helping people with disabilities. It is a wheelchair that just requires simple hands and verbal gestures to operate [7].
Mubdi-Ul Alam Sajid et al have designed an intelligent wheelchair for handicapped people that functions based on body movement. The semi-autonomous wheelchair that allows the user to maneuver it however they see fit is the main topic of this study. With the help of this wheelchair, a crippled person with limited mobility and freedom can move around [8]. Advances in Smart Wheelchair Technology and the brief history of wheelchair prototype designs and the most recent advancements in intelligent wheelchair technology are presented in [9]. A Smart

Autonomous Wheelchair was developed to enhance self-driving wheelchair utilizes computer vision technology to facilitate forward movement and perhaps replace conventional control mechanisms such as head joysticks, sip-and-puff controls, chin joysticks, and thought-controlled wheelchairs [10].

III. Proposed Methodology

By designing the motion control wheelchair with the use of hand gestures, the authors of this paper put forth a useful and affordable solution. The chair can be controlled by hand gestures such as the thumbs up for the FRONT, the palm hand to STOP, the peace sign for the LEFT, the OK hand for the RIGHT, and the thumbs down for the BACK. Additionally, these inputs can be modified based on the user's preferences. Fig 1 represents schematic of hand gesture unit. Fig 2 shows the hand-gestures integrated to the chassis. Fig 3 illustrates the block diagram of smart wheelchair. The aim was to create a wheelchair that was both inexpensive and equipped with all the features required for individuals with disabilities to use it and go about their everyday lives without any difficulties.

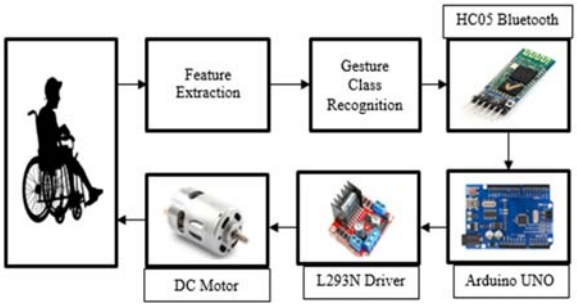

Fig. 1. Schematic Representation of the Hand Gesture Unit.

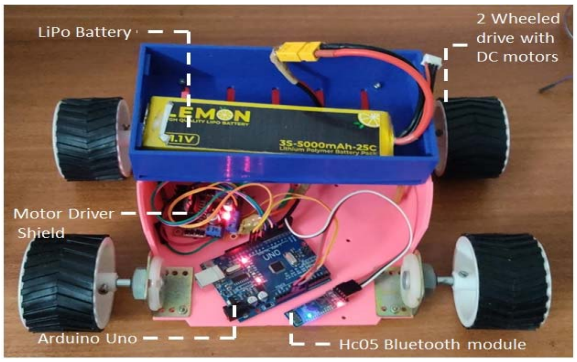

Fig. 2. Integration of Hand Gestures to Chassis.

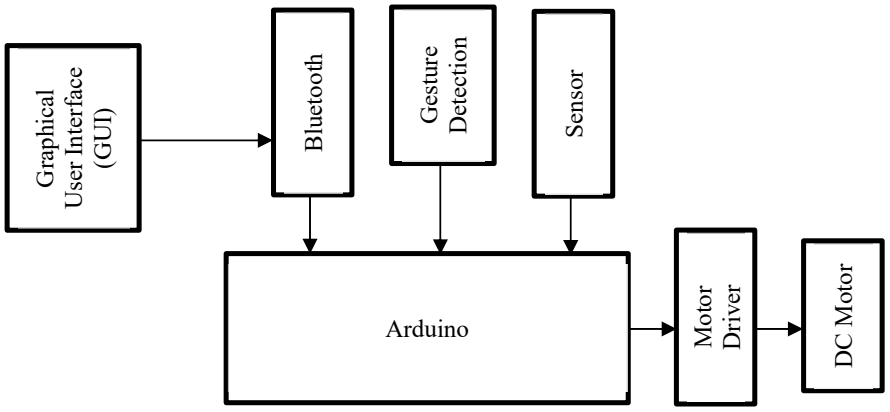

Fig. 3. Block Diagram of Smart Wheelchair

IV. HARDWARE

Gesture control allows disabled patients to control their navigation and movement. Two DC motors, a motor driver shield, a webcam (for capturing) image, rechargeable LiPo battery (12V) for power supply, and a hc05 Bluetooth module (for communication) are included in the configuration of the system to achieve the defined functionality and requirements.
The motor driver shield employs a triple high current half-H driver. The L293N motor driver shield is designed to provide bidirectional driving currents of up to 1 A.

V. SOFTWARE

For this system, Arduino Integrated Development Environment (IDE) was used for programming. It offers a range of built-in capabilities, including series menus for streamlined programming and sequential verification, among other features. The program implemented on IDE has transferred to Arduino Uno (Hardware Board).
The code is based on the following Python libraries for gesture recognition:

- *cv2 package*: The official open-source OpenCV "cv2" module for Python offers computer vision functionality.
- *NumPy package*: The package has a high degree of versatility in its ability to handle arrays. In addition to providing tools for manipulating these arrays, the software also includes a high-performance object for handling multidimensional arrays and tools for dealing with such arrays. It is an essential Python module for scientific computing.

VI. RESULT

The objective was to control wheelchair movement for paretic people through hand gestures. Fig 4 shows direction based on the gestures from the user. Table 1 shows the functionalities of the defined gesture class. The key features of the proposed system are as follows:

- The proposed paradigm is appropriate for persons with physical constraints as well as those who are unable to converse.
- The suggested solution decreases cost and complexity by utilizing Arduino uno, which requires no extra hardware support and is affordable as well as easy to program.
- Image processing is used for Hand Gesture Recognition.

VII. CONCLUSION AND FUTURE DIRECTIONS

In this research article, a cost-effective gesture-controlled smart wheelchair system is suggested. For wheelchair users with physical limitations, this system guarantees safe travel and easy navigation. Basic safety features like obstacle detection and fall detection can be added, along with an emergency messaging system that notifies both the user and the caregiver. It is still difficult to detect the hand region in dimly lit rooms and with varying colour schemes, particularly for skin tones that don't change is still challenging. This study's scope can be expanded in the future to address this issue. In order to enhance the efficacy of the model, additional research must be conducted. The smart wheelchair will become an indispensable necessity in the future. There is considerable opportunity to develop sensors and mobile robots in smart wheelchairs. The evolution of these things may have a significant effect on the cost factor. The success of smart wheelchair systems also depends on the development of hardware and software. To improve current problems with wheelchair systems, the work on feedback and evaluations could also provide useful new ideas.

TABLE 1: FUNCTIONAL TABLE.

HAND/PALM MOVEMENT	FUNCTION	ACTION
Thumbs-up	front ()	Chassis moves forward
Thumbs-down	back ()	Chassis moves backward
Raised Hand	stop ()	Chassis stops
Peace sign	left ()	Chassis moves left
OK sign	right ()	Chassis moves right

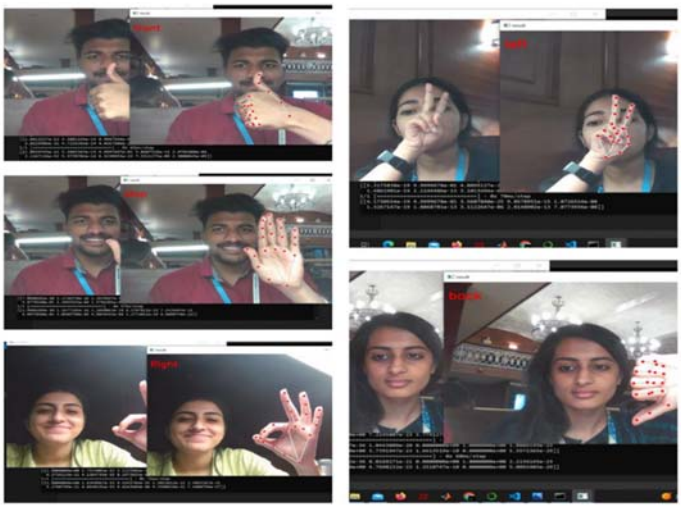

Fig. 4. Directions by Hand Gesture for the Wheelchair.

ACKNOWLEDGEMENT

All the authors would like to thank PES University, Bangalore for providing the necessary infrastructure and supporting the current research.

REFERENCES

[1] R. Khande and S. Rajapurkar, "Smart Voice and Gesture Controlled Wheel Chair," 2022 6th International Conference on Trends in Electronics and Informatics (ICOEI), Tirunelveli, India, 2022, pp. 413-417, doi: 10.1109/ICOEI53556.2022.9777223.

[2] Sadi, M.S.; Alotaibi, M.;Islam, M.R.; Islam, M.S.; Alhmiedat,T.; Bassfar, "Z.Finger-Gesture Controlled Wheelchair with Enabling IoT. Sensors 2022, 22, 8716. https://doi.org/10.3390/s22228716

[3] S. Basak, F. F. Nandiny, S. M. M. H. Chowdhury and A. A. Biswas, "Gesture-based Smart Wheelchair for Assisting Physically Challenged People," 2021 International Conference on Computer Communication and Informatics (ICCCI), Coimbatore, India, 2021, pp. 1-6, doi: 10.1109/ICCCI50826.2021.9402632.

[4] A. P. Cheema, M. K. Naik, C. Gopinadh, M. Kumar and B. Bhavani, "A Complete hands-free electric powered wheelchair for Quadriplegic Individuals and Home automation using IoT," 2022 International Conference on Advances in Computing, Communication and Applied Informatics (ACCAI), Chennai, India, 2022, pp. 1-4, doi: 10.1109/ACCAI53970.2022.9752589.

[5] Sukerkar, Kedar & Suratwala, Darshitkumar & Saravade, Anil & Patil, Jairaj & D'britto, Rovina. (2018), "Smart Wheelchair: A Literature Review". International Journal of Informatics and Communication Technology (IJ-ICT). 7. 63. 10.11591/ijict.v7i2.pp63-66.

[6] M. Ghaffar, S. R. Sheikh, N. Naseer and F. Ahmed, "Assistive Smart Home Environment using Head Gestures and EEG Eye Blink Control Schemes," 2021 International Conference on Artificial Intelligence and Mechatronics Systems (AIMS), Bandung, Indonesia, 2021, pp. 1-6, doi: 10.1109/AIMS52415.2021.9466031.

[7] Prof. R.R. Bhambare, Akash P. Ghaiwate, Kishor B. Jadhav, Hitesh K. Patil. (Vol-3 Issue-2 2017) "Smart Wheelchair Control Using Voice and Gesture Control" International Journal of Advance Research and Innovative Ideas in Education(IJARIIE-ISSN(O)-2395-4396).

[8] M. -U. A. Sajid, M. F. Mahmud, I. Rahaman, S. Shahriar and M. N. Rahman, "Design of An Intelligent Wheelchair for Handicap People Conducting by Body Movement," 2020 11th International Conference on Computing, Communication and Networking Technologies (ICCCNT), Kharagpur, India, 2020, pp. 1-5, doi: 10.1109/ICCCNT49239.2020.9225663

[9] S. Desai, S. S. Mantha and V. M. Phalle, "Advances in smart wheelchair technology," 2017 International Conference on Nascent Technologies in Engineering (ICNTE), Vashi, India, 2017, pp. 1-7, doi: 10.1109/ICNTE.2017.7947914.

[10] R. Alkhatib, A. Swaidan, J. Marzouk, M. Sabbah, S. Berjaoui and M. O.Diab, "Smart Autonomous Wheelchair," 2019 3rd International Conference on Bio-engineering for Smart Technologies (BioSMART), Paris, France, 2019, pp. 1-5, doi: 10.1109/BIOSMART.2019.8734264.