MATEC Web of Conferences **392**, 01061 (2024) https://doi.org/10.1051/matecconf/202439201061
ICMED 2024

Smart Glove or Sign Language and AI-Driven Wheelchair Navigation

Kalpana Akkineni[1*], *Thodeti* Mounika[1], *Malgari* Pooja[1], *T Bhanu Prasad* Reddy[1], *K Sandeep* Reddy[1], *G*. Ramesh[2], *Gaurav* Gupta[3]

[1]Department of Electronics and Communication Engineering, KG Reddy College of [2]Engineering and Technology, Hyderabad, Telangana, India-501504
[2]Department of CSE, GRIET, Hyderabad, Telangana, India
[3]Lovely Professional University, Phagwara, Punjab, India.

Abstract. Gesture gloves are a promising solution for individuals who struggle with both mobility and communication. These gloves' sensor technology helps with nonverbal communication as well as mobility, which is especially beneficial for people who have trouble pushing manual wheelchairs[2]. The goal of gesture gloves, a notable development in assistive technology, is to empower people with disabilities by improving mobility and enabling effective communication through natural hand and finger movements[1]. The use of AI-controlled wheelchairs and smart gloves together raises the bar for assistive technology even higher. The smart glove uses flex sensors to read finger movements and translate them into messages for people who can't effectively use sign language. The AI-controlled wheelchair simultaneously reacts to recognized gestures, removing the need for assistance from a person and providing an unprecedented degree of independence. For people with disabilities, this gesture-based communication and wheelchair control system offers a comprehensive and game-changing solution that seamlessly integrates into their everyday lives.

1 Introduction

According to the Indian Institute of Paralysis, there is a considerable proportion of paralyzed individuals in India—roughly 12,000 to 15,000 cases for every 10 million people. People who struggle with speech problems and paralysis face obstacles in their daily lives, making it difficult for them to communicate and be independent.[1] Their limited mobility in public places makes their lives more difficult. A more inclusive society must prioritize accessibility, attitude shifts, and support. Conventional techniques such as family support, hand-pulled carts, and gestures were typical coping strategies. The use of wheelchairs and more recent technologies skills smart gloves has completely changed communication and mobility [2]. Sensor-equipped smart gloves convert hand gestures into text or spoken words and wirelessly connect to wheelchairs to improve control. Over time, the gloves' brain

* Corresponding author: kalpana.akkineni@kgr.ac.in

analyzes data and adjusts to the movements of its users [6] [7]. These adaptable and user-friendly smart gloves present a promising option for people with speech impairments and paralysis [8].

1.1 Problem Statement

A significant portion of the population in India suffers from paralysis, according to a report published by the Indian Institute of Paralysis. That is, 12,000 to 15,000 people out of every 10 million are thought to be paralyzed [3]. Accessing educational and employment opportunities are one of the major daily challenges faced by individuals with non-verbal and mobility disabilities. Insufficient communication and mobility can make it more difficult for them to pursue an education or find profitable work, which exacerbates social and economic inequality.
Furthermore, stigmatization and discrimination are frequently brought about by a lack of knowledge and comprehension in society, further marginalizing those who suffer from paralysis and other related disabilities.

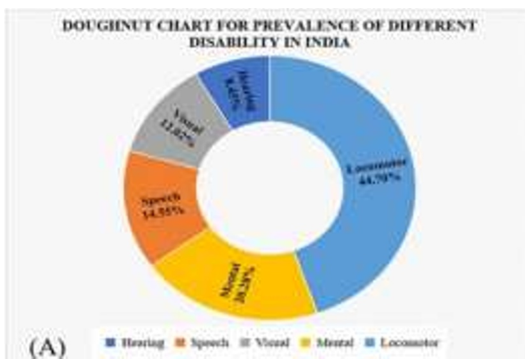

Fig .1. Pie chart of disability people in India

1.2 Problem Scoping

Our goal is to assist people who have trouble speaking and have restricted movement. Our goal is to develop solutions that improve their mobility and communication experiences.[4] These solutions will include better mobility aids, more sophisticated communication tools, and proactive advocacy for increased accessibility. Our goal is to break down barriers and promote greater accessibility so that people who struggle with limited verbal communication and mobility issues can feel more empowered. We aim to foster inclusive environments, encourage social inclusion, and improve people's quality of life in general through our advocacy initiatives [5]. Our ultimate goal is to create significant solutions that allow people to move freely and communicate effectively.

2 Literature Study

The Literature Review reveals various systems developed to work as sign language translators and wheelchair controllers. Ashish S. Nikal and Aarti G. Ambedkar have developed a sign language translator as the process involves capturing live stream images via webcam, applying noise removal and brightness adjustment through preprocessing, and employing a convexity algorithm for hand contour extraction. Utilizing a 2.40 GHz Intel® CoreTM processor, the proposed algorithm successfully detects finger gestures for precise

number recognition.[1] Abhishek B. Jani Nishith A. Kotak and Anil K. Roy have proposed a wearable device, a smart glove, interpreting American Sign Language (ASL) gestures. Equipped with flex sensors, an accelerometer, and a gyroscope, it utilizes Dynamic Time Warping and Nearest Mapping Algorithms for real-time recognition. After training and processing, the system achieves over 96.5% accuracy in recognizing ASL gestures.[2]
Vigneswaran, Shifa Fathima, Vijaysagarv, and Sree Anshika have proposed a system that translates gestures of mute individuals into voice signals and vice versa using flex sensors and accelerometers. For safety, in emergencies, the system automatically sends gesture information as a text message to their friends or relatives. The design includes Raspberry Pi, sensors, and internet connectivity for effective communication.[3] Manasi Agrawal, Ruturaj Aina Pure, Shrestha Agrawal, Simran Bhosale, and Dr Sharmista Desai have developed a sign language dataset and trained two models. One model used a basic structure (CNN), while the other borrowed knowledge from a pre-trained model (Inception V3). We compared their performance on subsets and analysed the accuracy and loss graphs to see which one worked better.[4]Umang Garg, Kamal Kumar Ghanshala, R.C. Joshi, and Rahul Chauhan have proposed that wheelchairs for Quadriplegia patients have three modes. In the first, the wheelchair moves based on hand gestures detected by an accelerometer. The second mode allows local transmission of messages through hand gestures, while the third mode involves global data transmission to a cloud service for alerts.[5]Jigme Wangchuk Mishanga and Tejanita Singh Chinghai have proposed that wheelchairs for quadriplegic patients use head gestures detected by an accelerometer and gyroscope. The wheelchair's locomotion is controlled based on tailored head movement thresholds. It also incorporates ultrasonic sensors for obstacle avoidance. The system features three modes: standard movement, local information transmission via gestures, and global data transmission to the cloud for alerts.[6]
Bediuzzaman Sebum, Jahida Islam, and Muhammad Aminur Rahman have proposed a system involving a robot wheelchair controlled by hand gestures. The sender, equipped with Arduino, infrared sensors, and Bluetooth, registers gestures and sends signals to the receiver on the wheelchair. The receiver, managed by Arduino and motor drivers, interprets the signals and moves the wheelchair accordingly.[7]Shan

elle Fernandes, Rushia Fernandes, and Jessica Kakkanad have developed a wheelchair design that allows easy control through wrist gestures using a simple hand gesture recognition algorithm. It recognizes five movements (forward, reverse, left, right, stop). The design is user-friendly for the elderly and includes GPS for global location tracking and Bluetooth for remote assistance control.[8].

3 Methodology

When designing the Gesture Gloves for Conversation and Movements, we kept the user at the forefront of our design process[5]. It is a continuous, iterative process that takes the needs and preferences of individuals with disabilities into particular account. To completely understand the specific needs of the user community, caregivers, and professionals with whom we have close relationships are formed. User input is crucial to our development process [6] because it allows us to enhance the gloves' performance and functionality. The technology is ensured to keep up with the evolving needs of its users by going through this iterative cycle. Our objective is tocreate a product that empowers individuals with disabilities by furnishing them with enhanced mobility andcommunication, thereby augmenting their general quality of life, by emphasizing user-centred design and incorporating input at every stage place [7].

The operation of the various components of the smart gloves is explained in the image above. What if a glove was designed to understand specific sign language? [6] This is the method to follow: First, gather the subsequent elements: Flexible finger sensors (flex sensors), an accelerometer for tiny movements, an HC-05 Bluetooth device, an LCD for a small screen, an Arduino microcontroller for the glove, and a 12V DC power supply are all included. To detect when a finger bends, attach the flex sensors to each one now. Connect them to the Arduino's CPU using jumper wires. Use a converter, if necessary, to enhance the sensors' ability to communicate with the brain. Before turning everything on, make sure the 12V power source is suitable for the parts. To detect when a finger bends, attach the flex sensors to each one now. Connect them to the Arduino's CPU using jumper wires. Use a converter, if necessary, to enhance the sensors' ability to communicate with the brain. Before turning everything on, make sure the 12V power source is suitable for the parts. Connect the Bluetooth device and accelerometer of the brain. Enable Bluetooth connectivity between the glove and other devices.Enable Bluetooth connectivity between the glove and other devices. Create a sign language decoding app for your phone or computer to identify these signals. A tiny screen can be attached to the glove to show messages or indicators. Like two friends holding hands, everything has to fit together harmoniously. Now, affix the flex sensors to each finger to detect when it bends. Jumper wires are used to connect them to the Arduino's CPU. If necessary, use a converter to improve the sensors' capacity to communicate with the brain. Verify that the 12V power source is appropriate for the parts before turning everything on. Associate the brain's accelerometer with the Bluetooth gadget. To connect the glove to other devices via Bluetooth, turn on the feature.To connect the glove to other devices via Bluetooth, turn on the feature. To recognize these signals, develop a sign language decoding application for your computer or phone. The glove can have a tiny screen attached to it to display indicators or messages. Everything needs to work together harmoniously, like two friends holding hands

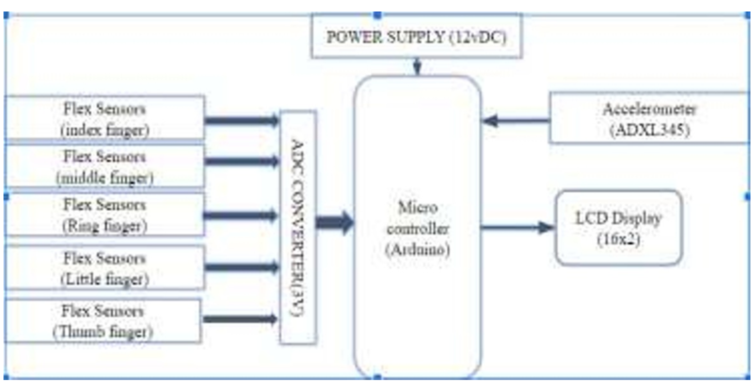

Fig.2. Block Diagram for the smart glove

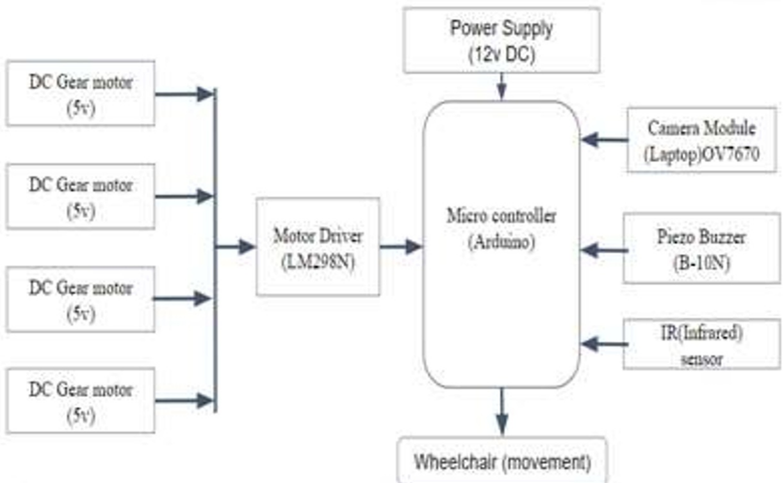

Fig. 3. Block Diagram for AI wheelchair

The figure above provides an explanation of the AI wheelchair. Imagine designing a wheelchair that you can maneuver with your hands! This is what you can do with an Arduino, a camera, and a few other parts. First, mount a small motor to each wheelchair wheel, then use a motor driver and an Arduino to control the motors. As a result, the wheelchair moves. The wheelchair is then visible thanks to a camera mounted on it. Connect the camera and Arduino together. Now that the camera has picked up on your hand gestures, create a unique code that the Arduino can recognize. For example, if you wave your hand in a left direction, the wheelchair will turn left. To help the wheelchair steer clear of obstacles, equip it with sensors. Connect these sensors to the Arduino. If the wheelchair's sensors pick up an object nearby, it will stop or steer differently. You can also connect a buzzer to the Arduino and have it beep if there is something that the wheelchair needs to warn you about. To power everything, use a 12V battery, and make sure the voltage is right for each part. Test the wheelchair in a safe area to make sure it moves how you want it to and stays clear of obstacles. Adding a remote control or a display that shows what the wheelchair "sees" will make it even more intimate.

3.3 Flow chart for AI Wheelchair

The operation of AI-driven wheelchairs is explained in detail in the diagram above. First, set up the camera so that it can capture the hand gestures. The next step in capturing the gestures is to record the user's hand movements using the camera. The recorded hand gesture data is then processed to extract relevant information. The next step compares the processed data with predefined hand gestures.[3] There are currently two choices: yes and no. In the event that YES, once the hand gestures have been recognized or matched, proceed to the following action. Give the controller the necessary data, and the wheelchair will begin to move immediately based on the gestures that are identified. If the condition is NO and the gestures are not matched or recognized, the process will start over at the first step. We have to use the camera to capture the user's hand gestures before we can record them. We have to do the same things again [2][8]].
When you make gestures, the wheelchair will stop to see if there are any more obstructions in its path. There are two prerequisites. If the response is in the affirmative, both yes and no the wheelchair will stop automatically and sound an alert with a buzzer if there is no

 https://doi.org/10.1051/matecconf/202439201061

condition. If the wheelchair moves further based on recognized gestures, the process will come to an end.[6][7]

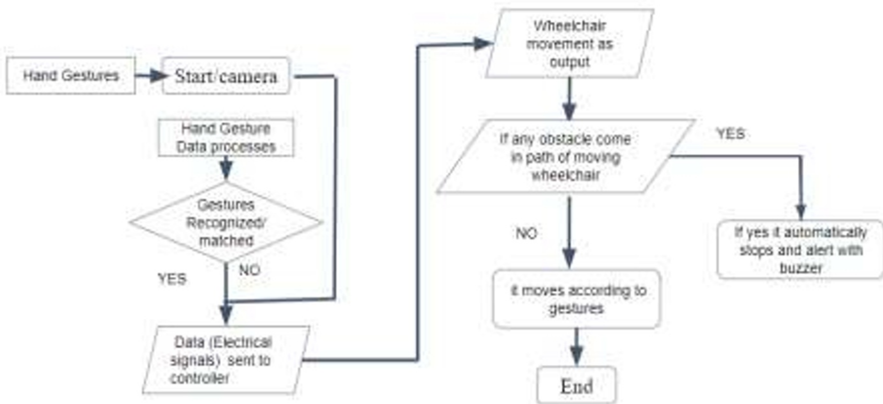

Fig. 4. Flow chart for AI wheelchair

3.4 Flow chart for the smart glove

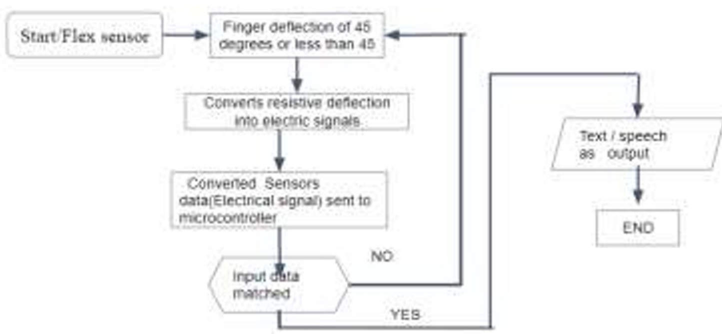

Fig.5. Flow chart for the smart glove

Information about smart gloves can be found in the flowchart above. Flex sensors are first incorporated into the procedure. These sensors measure and identify finger deflection, which is subsequently processed and transformed into electrical signals. After processing, an electrical signal representing the amount of finger movement angle (above 45 degrees) is produced from the finger deflection data. After that, a microcontroller receives the electrical signals for further processing and analysis. There are two requirements for the next phase: yes and no. The microcontroller outputs text or speech and terminates the process when the input matches and the decision is made in the affirmative. The procedure repeats itself from the flex sensor introduction when the input does not match. When the input does not match, the procedure repeats itself, starting the cycle anew with the addition of the flex sensors, and ends with the completion of the process as a whole.

4. Result and Discussion

Fig. 6. Results AI-power wheel chair navigation system with a smart glove for sign language interpretation

In this study, we presented a pioneering system that integrates a smart glove for sign language interpretation with an AI-powered wheelchair navigation system.[11] The aim was to elevate communication and mobility for individuals dealing with speech and motor impairments. The smart glove demonstrated its effectiveness by translating sign language gestures into either text or speech, facilitating seamless communication. Moreover, the AI-driven wheelchair navigation system enabled users to control their wheelchairs naturally through gestures [11].The outcomes highlight a promising advancement in meeting the communication and mobility requirements of individuals with speech and motor challenges. Putting together a smart glove for sign language and an AI-powered wheelchair has the potential to make a big difference in the lives of people with disabilities [8]. This system helps with both talking and moving around, giving users more independence [12]

5 Conclusion

In conclusion, the introduced system, uniting a smart glove for sign language interpretation with an AI-driven wheelchair navigation system, holds tremendous promise for enhancing the lives of individuals facing challenges in speech and motor abilities. By seamlessly translating sign language gestures into text or speech, the smart glove facilitates effectives the communication. Simultaneously, the AI-driven wheelchair navigation system empowers users to navigate their wheelchairs naturally through gestures, addressing both communication and mobility hurdles

References

1. Haider, M. A. Mehdi, A. Amin, and K. Nisar, "A Hand Gesture Recognition based Communication System for Mute people," 2020 IEEE 23rd International Multitopic Conference (INMIC), Bahawalpur, Pakistan, 2020, pp. 1-6, Doi:
2. S. Vanaja, R. Preetha and S. Sudha, "Hand Gesture Recognition for Deaf and Dumb Using CNN Technique," 2021 6th International Conference on Communication and Electronics Systems (ICCES), Coimbatore, India, 2021, pp. 1-4, Doi: 10.1109/ICCES51350.2021.9489209.

3. A. B. Jani, N. A. Kotak, and A. K. Roy, "Sensor-Based Hand Gesture Recognition System for English Alphabets Used in Sign Language of Deaf-Mute People," 2018 IEEE SENSORS, New Delhi, India, 2018, pp. 1-4, Doi: 10.1109/ICSENS.2018.8589574.
4. A. S. Nikam and A. G. Ambekar, "Sign language recognition using image-based hand gesture recognition techniques," 2016 Online International Conference on Green Engineering and Technologies (IC-GET), Coimbatore, India, 2016, pp. 1-5, Doi: 10.1109/GET.2016.7916786.
5. M. Agrawal, R. Ainapure, S. Agrawal, S. Bhosale and S. Desai, "Models for Hand Gesture Recognition using Deep Learning," 2020 IEEE 5th International Conference on Computing Communication and Automation (ICCCA), Greater Noida, India, 2020, pp. 589-594, Doi: 10.1109/ICCCA49541.2020.9250846.
6. S. Vanaja, R. Preetha and S. Sudha, "Hand Gesture Recognition for Deaf and Dumb Using CNN Technique," 2021 6th International Conference on Communication and Electronics Systems (ICCES), Coimbatore, India, 2021, pp. 1-4, Doi: 10.1109/ICCES51350.2021.9489209.
7. S. Vigneshwaran, M. Shifa Fathima, V. Vijay Sagar and R. Sree Arshika, "Hand Gesture Recognition and Voice Conversion System for Dumb People," 2019 5th International Conference on Advanced Computing & Communication Systems (ICACCS), Coimbatore, India,2019, pp. 762-765, Doi: 10.1109/ICACCS.2019.8728538.
8. N. S. Soni, M. S. Nag mode and R. D. Komati, "Online hand gesture recognition & classification for deaf & dumb," 2016 International Conference on Inventive Computation Technologies (ICICT), Coimbatore, India, 2016, pp. 1-4, Doi: 10.1109/INVENTIVE.2016.7830112.
9. S. Nit aware and A. Badge, "Hand Gesture Recognition to Facilitate Tasks for the Disabled," 2022 Second International Conference on Artificial Intelligence and Smart Energy (ICAIS), Coimbatore, India, 2022, pp. 949-953, Doi: 10.1109/ICAIS53314.2022.9743056.
10. A. R. Manika Avar and S. B. Shiro, "Gesture Controlled Assistive Device for Deaf, Dumb and Blind People Using Raspberry-Pi," 2022 International Conference on Smart Technologies and Systems for Next Generation Computing (ICSTSN), Villupuram, India, 2022, pp. 1-5, Doi: 10.1109/ICSTSN53084.2022.9761314.
11. .https://encryptedtbn0.gstatic.com/images?q=tbn:ANd9GcTyv58WQuIO1N9FlEOPOCGKcCtVKTi-1Lv6uAyqtJgxAw&s
12. .https://encrypted-tbn0.gstatic.com/images?q=tbn:ANd9GcSoJbJWpmvsDmcDL0Y-pdzXXQ0hiYYvzPeX3w&usqp=CAU