Solar Based Gesture Control Wheel Chair

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***Abstract*— A solar-based gesture control wheelchair is an eco-friendly mobility aid that is powered by solar panels and uses gesture control technology to operate. This type of wheelchair has several advantages, including being cost-effective, lightweight, and low maintenance. However, it also has some disadvantages, such as being weather-dependent, having a limited range, and requiring a longer charging time. Solar-based gesture control wheelchairs have various applications in different settings, including homes, hospitals, outdoor events, tourist attractions, and transportation. Overall, this type of wheelchair has the potential to improve the quality of life of people with disabilities and limited mobility while promoting environmental sustainability.**

***Keywords*— ESP32, MPU6050, BMS, IDE, BO.**

I. INTRODUCTION

The purpose of a Solar Based Gesture Control Wheelchair project could be to create a wheelchair that is powered by solar energy and can be controlled using hand gestures or other intuitive inputs. This type of wheelchair could provide a more sustainable and eco-friendly alternative to traditional wheelchairs, which rely on battery power or electricity from the grid. By incorporating gesture control technology, the wheelchair could offer greater mobility and independence to individuals with disabilities or limited mobility[3]. It could allow them to navigate through their environment more easily and with greater precision, without the need for physical controls or buttons. Overall, the goal of the Solar Based Gesture Control Wheelchair system would be to improve the quality of life and mobility for individuals with disabilities while promoting sustainability and reducing environmental impact.

There are several problems that researchers and engineers are investigating to improve the functionality and effectiveness of solar-based gesture control wheelchairs. Some of these include Power storage and efficiency are major challenge is to ensure that the solar panels can capture and store enough energy to power the wheelchair for extended periods, especially in areas with limited sunlight. Researchers are exploring ways to improve solar panel efficiency and battery technology to maximize energy storage. Gesture recognition is another challenge is developing accurate and reliable gesture recognition technology that can interpret the user's movements and translate them into wheelchair movements[1]. This requires sophisticated sensors and algorithms that can distinguish between intentional gestures and unintentional movements. User experience and accessibility is a critical aspect of the project is to ensure that the wheelchair is easy to use and accessible to individuals with different levels of mobility and disabilities. This includes designing a comfortable and ergonomic chair, intuitive controls, and adaptable software that can be customized to meet individual needs. The wheelchair must be durable and reliable enough to withstand different environmental conditions, including extreme temperatures and weather conditions. It must also be able to operate safely and effectively for extended periods without requiring frequent maintenance or repairs[4]. Finally, the wheelchair must be cost-effective and scalable so that it can be manufactured and distributed to a broader market. This requires finding ways to reduce production costs and optimize the supply chain to ensure affordability and accessibility for all users.

Solar-based gesture control wheelchairs are important for several reasons are improved mobility and independence. By incorporating gesture control technology, individuals with disabilities or limited mobility can operate the wheelchair more easily and with greater precision, allowing them to navigate through their environment and perform daily tasks with greater independence[6]. Gesture control and eco-friendly Solar-based

wheelchair technology can reduce reliance on traditional sources of energy, such as batteries or grid electricity, and promote sustainability by harnessing solar energy. This can also reduce the carbon footprint associated with wheelchair use. Accessibility is the wheelchair's intuitive and adaptable software can be customized to meet individual needs and ensure accessibility for individuals with different levels of mobility and disabilities[3]. Solar-based gesture control wheelchair technology represents a significant advancement in wheelchair technology, pushing the boundaries of what is possible and inspiring further innovation and development in the field. Over time, solar-based wheelchair technology can be more cost-effective compared to traditional wheelchairs, as it eliminates the need for battery replacements or charging from the grid[6].

Design and prototype are the first step to design and develop a prototype of the solar-based gesture control wheelchair. This would involve identifying the necessary components, such as solar panels, sensors, and controls, and integrating them into a functional design. The wheelchair must be able to recognize and interpret the user's gestures accurately to move in the desired direction. This would require the integration of gesture recognition technology such as cameras, sensors, or machine learning algorithms[4]. The solar panels must be integrated into the design to capture and store solar energy to power the wheelchair. This would require optimizing the energy storage system, such as the battery capacity and power management, to ensure the wheelchair has enough power to operate throughout the day. The wheelchair must have an easy-to-use interface that allows the user to control the wheelchair with gestures or other input methods. The interface must be accessible to people with different levels of mobility and disabilities. Once the wheelchair is designed and developed, it must be tested and refined to ensure it works reliably and effectively in different environments and with different users. This would involve user testing to ensure the wheelchair meets the needs of the user and is safe to use. Manufacturing and distribution of the wheelchair design is finalized, it can be manufactured and distributed to users. This would involve optimizing the manufacturing process to ensure the wheelchair is affordable and accessible to people with different resources.

The criteria for the success of a study on solar-based gesture control wheelchair would depend on the specific objectives and research questions of the study. However, some potential criteria for success are Functionality. The solar-based gesture control wheelchair should be functional, meeting the needs of users and effectively utilizing gesture recognition and solar power technology. The wheelchair should be accessible to people with different levels of mobility and disabilities, and the gesture recognition technology should be adaptable to different users' needs. The solar-based gesture control wheelchair should be energy-efficient, effectively capturing and storing solar energy to power the wheelchair. The solar-based gesture control wheelchair should promote sustainability, reducing reliance on traditional sources of energy and minimizing the carbon footprint associated with wheelchair use[6]. The wheelchair should be safe to use, and the gesture recognition technology should be accurate and reliable to prevent accidents. User experience should have a positive experience using the solar-based gesture control wheelchair, finding it easy to use, comfortable, and effective. The solar-based gesture control wheelchair should be cost-effective compared to traditional wheelchairs over the long-term, promoting affordability and accessibility to people with different resources[6].

II. LITRATURE SURVEY

- P. T, M. MK, A. Kattimani, G. R and A. Kalshetty, "Development of Head Motion Controlled Wheelchair," [1]2021 International Conference on Design Innovations for 3Cs Compute Communicate Control (ICDI3C), Bangalore, India. For older and physically challenged people, mobility aid is essential. The purpose of this research is to create a wheelchair that is steerable with head movements. Quadriplegics who can move their heads but not their hands or legs could gain from using this system. The impaired person may swivel their head to steer this wheelchair in any direction. Tilt sensors and diode logic have enabled the creation of a head motion controlled wheelchair. The system's prototype has been constructed, and it functions satisfactorily. The proposed wheelchair is created for less money than conventional joystick-controlled wheelchairs.
- Pathan, Shadman Mahmood Khan et al: “Wireless Head Gesture Controlled Robotic Wheelchair for Physically Disabled Persons.” Journal of Sensor Technology 10, no. 04 (2020): 47–59. doi:10.4236/JST.2020.104004 [2]. This work makes the assumption that a robotic wheelchair can use sensors and intelligence to perform tasks like navigation, obstacle detection, etc. The building of a cap-controlled wheelchair was the first phase of the project, which was used to test and validate the gesture operation. The next step was to create a real-time wheelchair that could switch between joystick and head gesture control modes in accordance with the needs of the user. An MPU6050 sensor, a joystick module, an RF module, a battery, a dc motor, a toggle switch, and an Arduino make up the wheelchair. The MPU6050 monitors head movement and sends a signal to the microcontroller when it does.
- Kulkarni, Sapna and N et al: “Real Time Automatic Gesture Controlled Based Wireless Wheelchair for disabled people” (June 22, 2022) [3].Six million individuals worldwide are crippled and depend on wheelchairs for mobility, according to study. The wheel directors need to be moved and remotely maintained before anything else. "Joystick-controlled wheelchairs" were created to help with this. However, these joystick-controlled wheelchairs proved challenging to use in everyday situations. The usage of joysticks became more sensitive as a result of the tight fastens and joysticks' unidirectional use, particularly in the situation of people who have been rendered dead. We created a "signal-controlled wheelchair" that can be moved with a slight hand motion in order to overcome these difficulties. This can be used in a controlled manner and with two hands to approach the stoner.

- Mrs. Surabhi Tankkar-Sawant, Miss.Sayali Kajare ,Mr.Ashfaque Ansari , Mr.Mujammilali Kazi ,Mr.Pranav Rane published “wireless hand gesture controlled wheelchair”[4].The wheelchair is fully capable of carrying the load up to 110Kgand moving in accordance to the gesture given by the person who is using the wheel chair. Certain improvisation and improvement can be done to make the wheelchair more reachable to those whose whole body is paralyzed. Certain eyes gesture or brain signals reader can be imparted on the wheelchair system so as to make it better. The proposed model makes the wheel chair a lot easier to assemble and simple in the use, in addition the cost of manufacturing also reduced to large extent. Also, with the use of RF technology the wheel chair can be controlled remotely from near about 10 to 20 meters of a distance.
- P. Upender, P.A. Harsha Vardhini, “A HAND GESTURE BASED WHEELCHAIR FOR PHYSICALLY HANDICAPPED PERSON WITH EMERGENCY ALERT SYSTEM.”[5]. They created a device that enables disabled people to control the motion of their wheelchairs with hand gestures. By using different body movements, such as eye look, leg movement, or head movement appropriately, improvements can be accomplished. Using a switch, the switching process for the accelerometer or touch pad mode selection is segregated. This increases the wheelchair's effectiveness while bringing down the system's price and size. The suggested wheelchair has a wide range of uses, including in hospitals, nursing homes, and airports. In the future, voice monitoring will assist the impaired person in identifying obstacles by acknowledging alarm signals and modifying the power section slightly to increase speed and estimate the delay for action to be taken to enhance the speed of the wheelchair dc motors can be replaced by servo motors.
- Jainam j. sanghvi, Maulik y. shah, Jay k. fofaria proposed the “SOLAR ELECTRIC WHEELCHAIR WITH A FOLDABLE PANEL.”[6]. The solar electric wheelchair with a foldable panel provides freedom to physically challenged people. The solar panel allows users to store solar energy in the battery during the daytime and use it for their mobility. With the help of all the components like motor, steering mechanism, joystick, etc. allows sufficient mobility to the users. Separate motors are used to take a turn on a straight path. The proposed design is the extension of previously made Solar Wheelchairs with certain advancements and certain. Their solar electric wheelchair has a foldable solar panel that allows it to fold and settle at a safe place providing safety to the solar panel. The foldable panel can easily be cleaned after folding it, thus increasing its efficiency and lifetime. This solar wheelchair is economical and efficient. The prime benefit of our solar wheelchair is that, it provides safety to solar panels, and is eco as well as userfriendly in nature.

III. SYSTEM DESIGN

Fig. 1 shows the block diagram of solar based gesture control wheel chair. The solar panels must be placed in a location that maximizes their exposure to sunlight while also not interfering with the user's comfort or mobility. Typically, the solar panels are mounted on the top of the wheelchair frame or integrated into the sides of the frame. The battery capacity should be sufficient to provide the required power to the wheelchair, while also being compact and light weight.

Due of their great energy density, lithium-ion batteries are frequently utilized for this purpose. The selection of gesture control sensors is critical to ensure that users can effectively control the wheelchair using hand gestures[6]. In most cases, human motions are detected by sensors like accelerometer sensors. The wheelchair frame should be designed to be lightweight, durable, and comfortable for the user. The frame should also be able to accommodate the solar panels, battery, and gesture control sensors without jeopardizing its structural soundness. The control system should be designed to process the data from the gesture control sensors and translate it into wheelchair movements[5].

BO motors (also known as BO DC motors) are a type of direct current (DC) motor that is commonly used in robotics, automation, and other applications that require precise control of speed and position. The term "BO" stands for "Brushless Outrunner." BO motors are brushless, meaning they do not have the carbon brushes that are commonly found in other types of DC motors. Instead, BO motors have a stationary winding that surrounds a rotating permanent magnet, which creates a magnetic field that rotates around the motor's axis. This rotation creates torque that drives the motor's output shaft. A motor driver is an electronic circuit or device that controls the direction, and other parameters of an electric motor[3]. Motor drivers are commonly used in robotics, automation, and other applications that require precise control of motor performance. Motor drivers typically consist of three main components: a microcontroller or other control circuit, a power circuit, and a driver circuit. In order to move the wheelchair in all direction these BO motors used. The movement of those wheels are shown in Table 1.

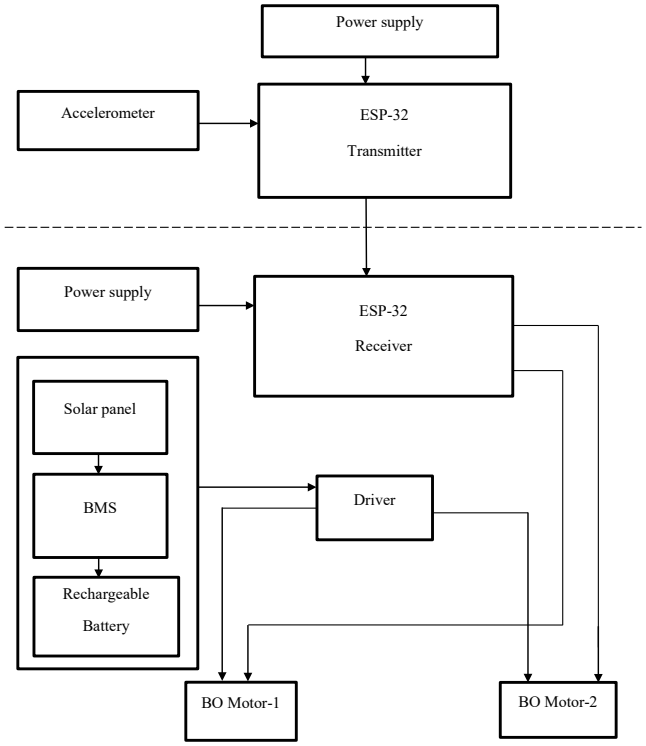

Fig 1: Block diagram of solar based gesture control wheel chair

The BMS monitors the temperature of the battery cells and takes action to prevent overheating or freezing. The BMS monitors the battery voltage and takes action to prevent overcharging or deep discharge of the battery cells. The BMS monitors the battery's health over time and provides information on the battery's capacity and remaining life. Overall, a BMS is an essential component of any battery-powered device or vehicle. It guarantees the battery's effective and safe operation. An electrical current can be used to repeatedly recharge a certain kind of battery called a rechargeable battery. Unlike disposable batteries, which are designed for single use and must be discarded after their charge is depleted, rechargeable batteries can be recharged and used again, making them more environmentally friendly and cost-effective over time. Rechargeable batteries are extensively utilized in a wide range of applications, from small electronics like cell phones and laptops to larger devices like electric vehicles and backup power systems. Nickel-Cadmium (NiCad) batteries were one of the first rechargeable battery technologies developed. They are reliable and have a high energy density, but they contain toxic cadmium and have a relatively short lifespan. NiMH batteries are similar to NiCad batteries but use a different chemistry that does not contain toxic materials. They have a higher capacity and longer lifespan than NiCad batteries but are less efficient at high discharge rates.

Li-ion battery are most efficient and commonly used battery. They have a high energy density, low self-discharge rate, and a long lifespan. Li-ion batteries are used in a wide range of applications, including cell phones, laptops, electric vehicles, and power tools. In future we may employ lead-acid batteries. in applications that require high power output, such as backup power systems and starter batteries for cars. They are heavy and have a relatively short lifespan compared to other rechargeable battery technologies. Rechargeable batteries are typically charged using a charger that is designed for the specific battery chemistry and voltage. In order to avoid the overcharging and damaging of batteries need to follow the datasheet of particular component. With proper use and maintenance, rechargeable batteries can provide reliable and long-lasting[6].

IV. SYSTEM IMPLEMENTATION

The table 1 shows the direction control table of model prototype.

TABLE 1:Direction control table

Direction of movement	Wheel - 1	Wheel-2
⇦	Displace backward	Displace forward
⇨	Displace forward	Displace backward
⇧	Displace forward	Displace forward
⇩	Displace backward	Displace backward

A. ESP32 microcontroller

ESP32 is one of the microcontroller 802.11b/g/n integrated with802.11b/g/n Wi-Fi and dual mode Bluetooth its means it supports both Bluetooth 4.0 (BLE) and Bluetooth Classic (BT). It is a low-cost, low-power system so it has more advantages to implement the projects. ESP Ressif Systems and Shanghai-based Chinese company created/invented and developed this ESP32 microcontroller, which is produced by TSMC using their 40 nm process. Sometimes it connects the network of its own. It provides power supply is of about 5V through USB. The ESP32 is good option for peer-to-peer connection without the need of an access point supports wi-fi Direct as well.

B. MPU6050 accelerometer

The MPU6050 is a popular 6-axis accelerometer and gyroscope sensor module that combines both acceleration and rotation sensing on a single chip. It is often used in various electronic projects, robotics, and drones. The MPU6050 can measure acceleration in three axes (X, Y, and Z) and rotation rate in three axes (roll, pitch, and yaw). It communicates with the microcontroller using I2C communication protocol. To use the MPU6050, you will need to interface it with a microcontroller, such as an Arduino, ESP-32 & Raspberry Pi, using I2C communication. The MPU6050 has a built-in temperature sensor as well, which can be used to measure the temperature of the surrounding environment[1].

C. BMS(Battery Management System)

BMS stands for Battery Management System, which is an electronic system that manages and monitors the performance of a battery. A BMS ensures the optimal use of the battery,

protects it from damage, and extends its lifespan. It typically includes a microcontroller, sensors, and communication interfaces, and can be used in various applications, including electric vehicles, solar energy systems, and portable electronics [6].

D. Solar panel

A sun panel, commonly called a photovoltaic (PV) panel, is a system that makes use of daylight to create electricity. Silicon, a semiconductor material that can turn sunlight into electricity, is often used to create solar panels. When sunlight strikes the solar cell, it dislodges silicon atom electrons, resulting in an electron flow or current. Electrical devices can be powered by this current, which can also be stored in batteries for later use.This solar panel consists of 17 cells .It is having the capacity of 140mA/hr and in order to charge of 7.4V, the solar panel has to be kept for sunny for 3 hours. Each cell in solar panel has the output of 0.4V and for 17 cells it would be 7.4V [6].

E. Driver circuit

A driver circuit, in the context of electronics, refers to a circuit that controls and regulates the operation of a specific component or device. It ensures that the component receives the appropriate voltage, current, or signals required for its proper functioning. Driver circuits are commonly used in various applications, including motors, LEDs, transistors, relays, and more[5].

F. Rechargeable batteries

A 3.7V rechargeable battery is a type of lithium-ion battery that has a nominal voltage of 3.7 volts. These batteries are commonly used in portable electronic devices such as smartphones, tablets, digital cameras, and other similar devices. The 3.7V rating refers to the nominal voltage of the battery, which is the average voltage that the battery outputs during its normal operating range. However, the actual voltage of a fully charged 3.7V battery can range from 4.2V to 3.0V depending on the specific battery chemistry and its state of charge.

G. BO motors

These are the DC motors with 100 RPM, these helps to move the ROBOT model in the required directions. They can operate at voltage ranging from 3.3 to 9v; by changing the polarity direction of the motors could be controlled.

H. Jumper wires

These are things are going to use in the project for connection purpose, This can get to see 3 types of wires like male to male, male to female and female to female. Using them we can establish connection between different components easily without need of soldering.

V. SOFTWARE REQUIREMENTS

Arduino IDE (Integrated Development Environment) is an open-source software used to write, compile and upload code to Arduino boards. It is a user-friendly platform that is based on the Processing programming language and uses a simplified version of C++ syntax. The IDE includes a code editor, a compiler, a linker, and an uploader, all in one interface. It provides various libraries and examples that can be used to quickly prototype and develop projects with Arduino boards. The Arduino IDE is compatible with different operating systems including Windows, Mac OS, and Linux, and it supports a wide range of Arduino boards and other microcontrollers based on Atmel AVR and ARM processors.

VI. RESULTS

The snapshots of model prototype is shown in the fig 2, 3, 4 and 5. With the help of a transmitter that is attached to the hand band in this project, we can control the wheelchair. Wearing the gloves, the user can steer the wheelchair in all four directions—forward, backward, left, and right.

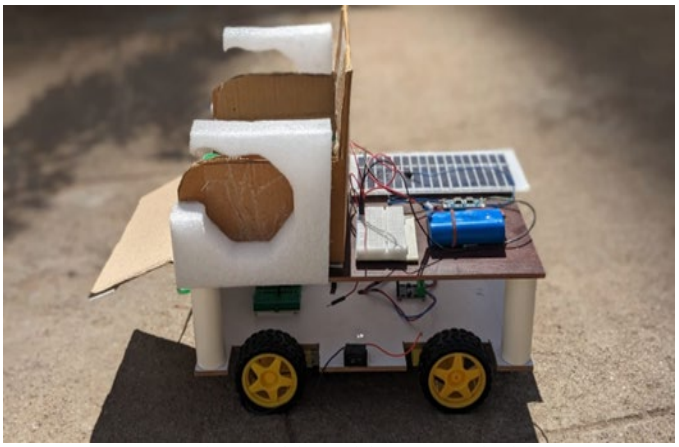

Fig 2: Side view of the model prototype wheelchair

Fig 3:Front view of the model prototype wheelchair

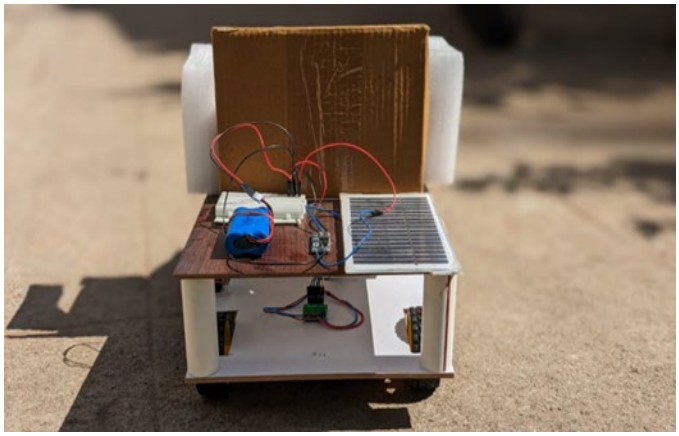

Fig 4: Back side view of the model prototype wheelchair with solar panel

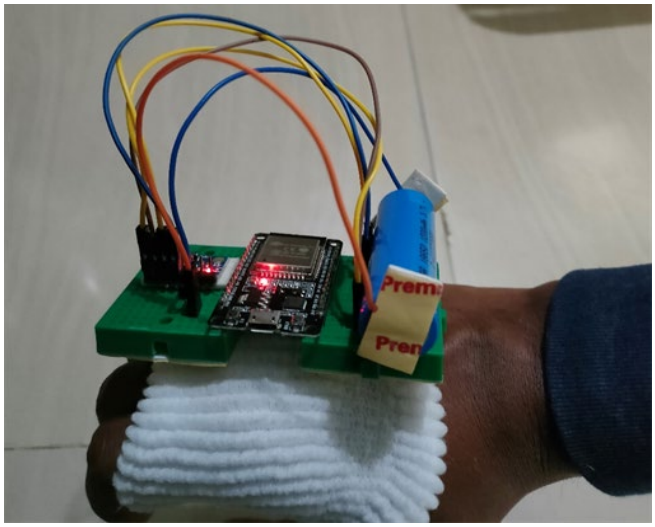

Fig 5: Transmitter model prototype gloves fitted with sensor that detect the hand movements

In Fig 5 a person operating a wheelchair using hand band that enable gesture-based control. The band are fitted with sensors that detect the wearer's hand movements, translating them into commands for the wheelchair movement[2].

VII. CONCLUSION

In conclusion, a solar-based gesture control wheelchair can be an innovative and useful solution for people with mobility impairments. The use of solar power as the primary source of energy can make the wheelchair more sustainable and eco-friendly, while the integration of gesture control technology can improve the user experience and make the wheelchair easier to operate. The design and development of such a system would involve the use of an ESP32 microcontroller, battery management system, and BO motors for driving the wheelchair. The user's gestures would be detected by a gesture sensor, and the microcontroller would translate these gestures into control signals for the motors. One of the main benefits of a solar-based gesture control wheelchair is its independence from external power sources, making it ideal for use in remote areas or locations where access to electricity is limited. Overall, a solar-based gesture control wheelchair has the potential to improve the quality of life for people with mobility impairments, providing a sustainable and user-friendly solution for their mobility needs. However, further research and development are needed to optimize the design and address any challenges that may arise during the implementation of such a system.

VIII. FUTURE WORK

The future work of solar-based gesture control wheelchairs could focus on the following areas:

- **Improving efficiency**: Research could be conducted to improve the efficiency of solar panels and the overall energy consumption of the wheelchair, which could increase the range and reduce the charging time.
- **Enhancing durability**: New materials and technologies could be explored to improve the durability and reliability of solar panels and other mechanical parts of the wheelchair, enhancing its suitability for prolonged use.
- **Integration with AI**: Artificial intelligence (AI) could be integrated into the gesture control system of the wheelchair to enhance its functionality and adaptability to different environments and users.
- **Customization**: Personalized customization options could be developed to accommodate the unique needs and preferences of individual users, such as seat height, backrest angle, and control sensitivity.
- **Accessibility**: The wheelchair could be further developed to enhance accessibility, such as adding voice commands and visual cues for users with limited hand mobility or vision impairment.

Overall, the future work of solar-based gesture control wheelchairs could focus on advancing the technology to improve its functionality, durability, and accessibility, making it a more effective and sustainable mobility aid for people with disabilities and limited mobility.

REFERENCES

[1] P. T, M. MK, A. Kattimani, G. R and A. Kalshetty, "DEVELOPMENT OF HEAD MOTION CONTROLLED WHEELCHAIR," 2021 International Conference on Design Innovations for 3Cs Compute Communicate Control (ICDI3C), Bangalore, India, 2021, pp. 41-44, doi: 10.1109/ICDI3C53598.2021.00017.

[2] Pathan, Shadman Mahmood Khan, Wasif Ahmed, Masud Rana, Shahjalal Tasin, Faisul Islam, and Anika Sultana. "WIRELESS HEAD GESTURE CONTROLLED ROBOTIC WHEELCHAIR FOR PHYSICALLY DISABLED PERSONS." Journal of Sensor Technology 10, no. 04 (2020): 47–59 doi:10.4236/JST.2020.104004.

[3] Kulkarni, Sapna N, Kranti, and Bhat, Rohit and V., Abhishek, "REAL TIME AUTOMATIC GESTURE CONTROLLED BASED WIRELESS WHEELCHAIR FOR DISABLED PEOPLE" (June 22, 2022). Proceedings of the International Conference on Innovative Computing & Communication (ICICC) 2022.

[4] Mrs. Surabhi Tankkar-Sawant, Miss.Sayali Kajare ,Mr.Ashfaque Ansari , Mr.Mujammilali Kazi ,Mr.Pranav Rane., "WIRELESS HAND GESTURE CONTROLLED WHEELCHAIR", 2018 IJCRT | Volume 6, Issue:2 April 2018 | ISSN: 2320-2882.

[5] P. Upender, P.A. Harsha Vardhini, "A HAND GESTURE BASED WHEELCHAIR FOR PHYSICALLY HANDICAPPED PERSON WITH EMERGENCY ALERT SYSTEM.", 2020 International Conference on Recent Trends on Electronics, Information, Communication & Technology (RTEICT), DOI: 10.1109/RTEICT49044.2020.9315575

[6] Jainam J. Sanghvi, Maulik Y. Shah, Jay K. Fofaria.,"SOLAR ELECTRIC WHEELCHAIR WITH A FOLDABLE PANEL", 2021 IJRD | Volume 6, Issue:8 August 2021 | ISSN: 2455-7838.