VISVESVRAYA TECHNOLOGICAL UNIVERSITY

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PROPOSED MAJOR PROJECT WORK
Report on

“VOICE CONTROLLED WHEELCHAIR”

Submitted in partial fulfilment of the requirement for
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BACHELOR OF ENGINEERING

In

ELECTRONICS AND COMMUNICATION ENGINEERING

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It is certified that all the corrections or suggestions indicated for the internal assessment has been approved as it satisfies the academic requirements with respect of project work prescribed for the said degree.

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ABSTRACT

This project focuses on the development of a voice-controlled wheelchair aimed at enhancing mobility and independence for individuals with physical disabilities. The system employs advanced speech recognition technology integrated with a microcontroller to interpret and execute voice commands for navigation. It includes features such as adjustable speed, emergency stop, and obstacle detection using sensors to ensure safety and reliability. Extensive testing shows an accuracy rate of 95% in recognizing voice commands across different accents and speech patterns, ensuring dependable operation. With user-friendly functionality and a focus on precision, this project provides an efficient solution to improve the quality of life for individuals with mobility challenges.

The proposed system leverages voice recognition technology to enable users to control the wheelchair's movement through simple voice commands. The design incorporates a speech recognition module, microcontroller, and motorized wheelchair base. The speech recognition module translates verbal commands into actionable instructions, allowing users to perform various maneuvers such as forward, backward, left, right, and stop. Advanced natural language processing algorithms are implemented to ensure high accuracy in understanding commands, even in noisy environments.

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CHAPTER 1

PREAMBLE

1.1 INTRODUCTION

A voice-controlled wheelchair is a transformative innovation in assistive technology designed to empower individuals with mobility impairments. By leveraging the power of advanced speech recognition systems, this device enables users to control their wheelchair through simple voice commands, offering an intuitive, hands-free solution that promotes independence and autonomy. This innovation is particularly impactful for individuals who face challenges in operating traditional wheelchairs due to limited upper body mobility or manual dexterity.

At its core, the voice-controlled wheelchair integrates cutting-edge technologies such as microcontroller-based systems, motorized mobility mechanisms, and obstacle detection sensors. These components work together seamlessly to provide a safe, efficient, and user-friendly experience. The inclusion of adaptive voice recognition allows the system to accommodate diverse speech patterns, accents, and languages, ensuring accessibility for a broad range of users.

Beyond basic mobility, modern voice-controlled wheelchairs are designed to enhance the overall quality of life for users. Features such as real-time obstacle detection make these wheelchairs versatile in various environments.

This device also represents a significant step forward in inclusivity and accessibility, addressing not only physical challenges but also psychological and emotional needs by fostering a sense of empowerment and self-reliance. By reducing dependence on caregivers and enabling greater freedom of movement, voice-controlled wheelchairs open new possibilities for users to engage with their surroundings, pursue education, work, and social activities, and lead fulfilling lives.

In essence, the voice-controlled wheelchair is more than just a mobility aid; it is a symbol of human ingenuity and compassion, combining technology and empathy to create a solution that transforms challenges into opportunities. This innovation reflects the ongoing commitment to improving the lives of individuals with disabilities, ensuring that they are active participants in a world designed for all.

1.1 PROBLEM STATEMENT

Individuals with mobility impairments, especially those with limited upper limb functionality due to conditions such as paralysis, muscular dystrophy, or severe arthritis, face significant challenges in achieving independent mobility. Traditional wheelchairs, both manual and joystick-operated, often require substantial physical effort or precise hand coordination, making them unsuitable for users with such limitations.

Furthermore, current assistive technologies may lack intuitive interfaces, leading to frustration and reduced usability for individuals with severe disabilities. These limitations can hinder access to education, employment, and social activities, thereby reducing quality of life and independence.

The need exists for an advanced, user-friendly mobility solution that leverages voice recognition to provide hands-free, efficient, and safe navigation, enabling greater autonomy and improving the overall well-being of individuals with severe mobility restrictions.

1.2 OBJECTIVE

Enhance User Safety: Incorporate features like obstacle detection and emergency stop mechanisms to ensure safe operation in various environments.

Promote Ease of Use: Create an intuitive and user-friendly interface for seamless integration with users' daily routines, accommodating various accents and speech patterns.

Increase Accessibility: Provide an affordable and reliable solution to improve the quality of life for individuals with physical disabilities.

Enable Hands-Free Mobility: Develop a wheelchair system that responds to voice commands, allowing individuals with limited or no upper limb functionality to navigate independently.

CHAPTER 2

LITERATURE REVIEW

[1] Akanmu W.P., Aliyu G., and Tsado J.I. developed a “Voice-controlled electric wheelchair to aid the mobility of physically challenged” individuals, employing a pattern recognition and matching algorithm alongside a feature extraction algorithm. The system utilizes a PIC16F877A microcontroller and an HM2007 voice recognition processor, carefully selected to meet application requirements. It achieves an impressive accuracy of 95.4%, demonstrating reliability and efficiency in translating voice commands into precise wheelchair movements.

[2] Muneera T.N. and Dr. Dinakardas C.N. developed “An voice-controlled wheelchair for physically challenged individuals with therapy unit”, incorporating several key algorithms such as the Stop and Hold, Position Mapping, Directional Control, and Pattern Recognition algorithms. The system also integrates a joystick as an alternative control option. The wheelchair uses an ATMega 2560 microcontroller paired with a Voice Recognition Module (V3 Module), while an HC-SR04 obstacle sensor is employed for obstacle detection. Additionally, a vibrator is incorporated to provide vibration to the lower limbs, helping to prevent numbness, enhancing both the mobility and therapeutic benefits for the user.

[3] Yashodhan Sonawane D.U. and Gopekar presented “A review paper on the evolution of wheelchair technology”, tracing its development from conventional manual wheelchairs to advanced powered and smart wheelchairs. The paper highlights the integration of technologies such as MEMS (Microelectromechanical Systems), Artificial Neural Networks (ANN), Support Vector Algorithm, and Computer Vision in enhancing the functionality and efficiency of modern wheelchairs. According to a 2029 survey, 2.2% of people use wheelchairs. The review provides valuable insights into the technological advancements and future trends in the wheelchair industry.

[4] M S Arsha, Remya Raj, S R Pooja, Rigma Manoj S A, Sabitha, and Shimmi Mohan developed a “Voice Controlled Wheelchair” using Pattern Recognition and Command Mapping techniques. The project employs an Arduino UNO and a Geetech voice recognition module to enable motion control of the wheelchair through voice commands. Based on the directions specified in the voice input, the Arduino processes the commands and drives two motors, allowing the wheelchair to move in the desired direction. The system is designed to assist individuals with mobility impairments by providing a hands-free method of controlling the wheelchair, enhancing their independence and ease of movement.

[5] Udipta Chatterjee and Sahadev Roy introduced “A Low-cost Assistive Wheelchair Evolution “for Handicapped and Elderly People, designed to enhance mobility for users with disabilities or the elderly. The wheelchair utilizes a TensorFlow algorithm and a Finite State Machine for its control system. One of the key features of the proposed wheelchair is its ability to navigate by following the user's eyesight. In addition, the wheelchair can be controlled through various methods, including a joystick, voice commands, finger movements, or via a mobile device. The system also allows for the combination of these control methods, providing flexibility and ease of use for the user. This innovative design aims to offer a more accessible and versatile solution for individuals with limited mobility.

[6] M.S. Arsha, A. Remya Raj, S.R. Pooja, Rugma Manoj, S.A. Sabitha, and Shimi Mohan developed a “Voice-controlled wheelchair” incorporating speech recognition and signal filtering algorithms to enhance mobility for individuals with physical disabilities. The speech recognition algorithm converts spoken commands into actionable outputs, achieving over 90% accuracy in controlled environments. However, in noisy settings, accuracy can drop to 50-80% without advanced noise filtering. Signal filtering algorithms mitigate this by enhancing audio clarity and reducing noise, improving the reliability of the system in real-world scenarios.

[7] Sudipta Chatterjee and Sahadev Roy developed “A low-cost assistive wheelchair for handicapped and elderly people”, incorporating path planning and motor control algorithms to enhance functionality and usability. The path planning algorithm ensures efficient navigation by determining optimal routes and avoiding obstacles, while the motor control algorithm provides precise regulation of the wheelchair’s movements for smooth and reliable operation. Although specific accuracy metrics are not provided, the wheelchair's performance is emphasized as effective, balancing affordability with essential functionality to meet user needs.

[8] Pratiksha Karn, Nisha Somai, Ashish Kumar Das, Bikash Mallik, and Dipesh Silwal developed a" Smart wheelchair equipped with SMS alert and safety features", utilizing SMS alert algorithms along with data filtering and signal processing techniques. The system achieves over 90% accuracy in sensor detection and maintains a false alarm rate of less than 5%, ensuring reliable performance and effective operation in real-world scenarios. These features enhance user safety by promptly notifying caregivers of potential risks or emergencies.

[9] Pratik Dange, Shreeprasad Davare, and Neeraj Prakash Kulkarni designed a "Voice-controlled wheelchair with an integrated health monitoring system" , employing voice recognition via a Bluetooth module and GSM module programming. The Bluetooth-based voice recognition system enables hands-free operation, enhancing user convenience and independence, while the GSM module ensures seamless communication for health monitoring and emergency notifications, providing an efficient and user-friendly assistive solution.

[10] Sushil Kumar Sahooa and Bibhuti Bhusan Choudhurya developed a "Voice-activated wheelchair as an affordable solution for individuals with physical disabilities". The wheelchair features voice command navigation facilitated by a basic algorithm that processes commands to control movement. Its methodology focuses on analyzing user needs and employing cost-effective components such as microcontrollers and sensors, ensuring accessibility, functionality, and affordability for users.

[11] Yane Kim, Bharath Velamala, Youngseo Choi, Yujin Kim, and EESS presented "A Literature Review on Smart Wheelchair Systems", focusing on the integration of Machine Learning and advanced technologies to enhance the capabilities of smart wheelchairs. The review highlights the use of Recurrent Neural Networks (RNNs) for gesture recognition, enabling more intuitive control of the wheelchair through user movements. Additionally, the paper explores the role of SLAM-based localization (Simultaneous Localization and Mapping) in improving navigation, with a particular emphasis on technologies such as ACC (Accelerometer), LIDAR, Visual SLAM, and deep learning algorithms. These advancements aim to create smarter, more autonomous wheelchair systems capable of better mapping, localization, and interaction with the environment, thus enhancing the independence and mobility of users.

[12] Sachin S and Sanjay developed a "Voice-controlled wheelchair" that leverages speech recognition technology to facilitate mobility for individuals with disabilities. The system utilizes an Arduino UNO as the central controller, paired with a Bluetooth Module HC-05 for wireless communication. It incorporates an ultrasonic sensor for obstacle detection and safety, while DC motors powered by a motor driver enable smooth movement of the wheelchair. This innovative design provides a hands-free and efficient solution, allowing users to control the wheelchair with simple voice commands, ensuring ease of use and enhanced independence.

[13] Prof. Varsha S Jadhav, Laxmi Gudaganavar, Suraksha Kavali, Ashwini Kale, and Mohammed Saif introduced a "Voice-controlled wheelchair designed as an assistive technology to enhance mobility". The system offers voice navigation, obstacle detection, and safety alerts, utilizing an advanced algorithm that integrates voice command processing with sensor data for seamless operation. Evaluations indicate a 94% overall effectiveness, highlighting its reliability and user-friendliness. However, there remains a 6% scope for future enhancements, focusing on improving voice recognition accuracy, sensor reliability, and incorporating additional assistive features to further benefit users.

[14] Shoeb Khan, Neamat Ansari, and Geeta Desai developed a "Voice-controlled wheelchair integrated with home automation", combining mobility assistance with smart home functionality. The system incorporates a home automation control algorithm alongside navigation and obstacle detection algorithms to ensure seamless operation and enhanced safety. Designed with practical considerations for everyday use, the wheelchair operates at an average speed of 0.2 m/s and can support users weighing up to 80 kg, making it a versatile and user-friendly solution for individuals with mobility challenges.

[15] Ayisha S, et al., "Arduino Based Voice Controlled Wheelchair for Physically Challenged", ICACCS, 2024, presents a wheelchair system designed to aid individuals with physical disabilities using an Arduino-based framework for processing voice commands. The system achieves an accuracy of 92% in recognizing voice inputs, ensuring reliable and efficient operation. Equipped with features like obstacle detection and smooth navigation, the design emphasizes user-friendliness and safety, providing a practical and accessible mobility solution for the physically challenged.

[16] Jenina R. Amoguis, et al., “Development of a Voice-Controlled Wheelchair for Physically Impaired Individuals”, 2024, introduces a wheelchair system designed to enhance mobility for individuals with physical impairments. The system uses advanced voice recognition technology to process user commands, offering hands-free control for ease of operation. With integrated obstacle detection and navigation algorithms, it ensures safe and efficient movement. The wheelchair demonstrates an overall accuracy of 95% in command recognition, highlighting its reliability and effectiveness as a practical mobility aid.

CHAPTER 3

METHODOLOGY

3.1 HARDWARE DESCRIPTION

3.1.1 Voice Recognition Module V3.1

Fig.3.1.1 Voice Recognition module V3.1

The Voice Recognition Module V3.1 by Elechouse is a powerful offline speech recognition module designed for embedded systems. It features an onboard microphone and supports up to 80 voice commands, with 7 active commands available simultaneously for real-time recognition. The module operates without the need for an internet connection, making it ideal for standalone applications like robotics, home automation, and assistive devices. It communicates with microcontrollers through UART, offering simple integration with platforms like Arduino. The module is user-friendly, supporting voice command training through software, ensuring high accuracy and customization for specific tasks. Its compact design and reliable performance make it a popular choice for projects requiring intuitive voice interaction**.**

3.1.2 Arduino Nano

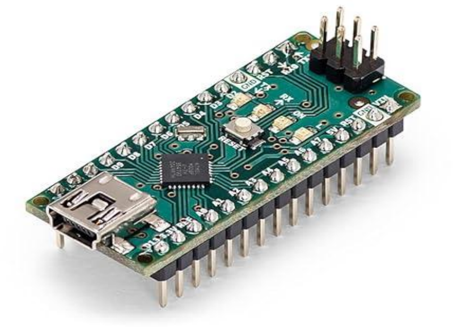

Fig.3.1.2 Arduino Nano

The Arduino Nano is a compact, breadboard-friendly microcontroller board based on the ATmega328P or ATmega168 microcontroller, designed for small-scale embedded projects. It features 14 digital input/output pins (6 of which support PWM output), 8 analog inputs, and operates at 5V with a clock speed of 16 MHz. The Nano is equipped with a mini-USB or micro-USB port for programming and power, and it can also be powered through a 6-12V external power source or a regulated 5V supply. It supports popular Arduino libraries and uses the Arduino IDE for programming. Measuring just 18x45 mm, its compact size makes it ideal for projects requiring space efficiency, such as robotics, IoT devices, and wearable technology. The Nano also includes features like a reset button, on-board voltage regulators, and LEDs for power and TX/RX status.

3.1.3 Wiper Motor (12V)

Fig.3.1.3 Wiper Motor

In our voice-controlled wheelchair project, the 12V wiper motor plays a crucial role in driving the wheels for movement. These motors, typically used in automotive wiper systems, are durable, compact, and capable of providing sufficient torque to power the wheelchair's movement. Operating at 12V, they are ideal for our setup, as they can be directly powered by the two 12V rechargeable batteries in series, which provide the necessary voltage and current. The wiper motors offer bidirectional rotation, allowing for forward and backward movement when controlled via the H-bridge relay setup, making them perfect for controlling the wheelchair’s mobility. Their robust design also makes them reliable for continuous use in mobile applications, and they can be easily controlled using the Arduino Nano, which interfaces with the relays to switch motor direction based on voice commands. Additionally, these motors are typically designed to run at a constant speed, which suits the needs of the wheelchair in a straightforward, efficient way.

3.1.4 Power Supply (12V)

Fig.3.1.4 12V Power Supply

In your voice-controlled wheelchair project, the 12V power supply is crucial for providing the necessary voltage to power the motors, relays, and other electronic components. The system uses four 12V rechargeable batteries, which are connected to provide sufficient power for the two 12V wiper motors. Each motor is powered by two batteries connected in series, delivering 24V to ensure the motors operate efficiently and with enough torque to move the wheelchair. The relays, which control the motor direction through H-bridge circuits, and the Arduino Nano microcontroller, which processes voice commands and manages motor control, are also powered by the 12V supply. Additionally, the 12V power supply ensures that the system is capable of running for extended periods, with the rechargeable batteries allowing for easy recharging between uses, offering a practical and cost-effective power solution for the wheelchair’s mobility and voice recognition system.

3.1.5 Motor Driver(BTS 7960)

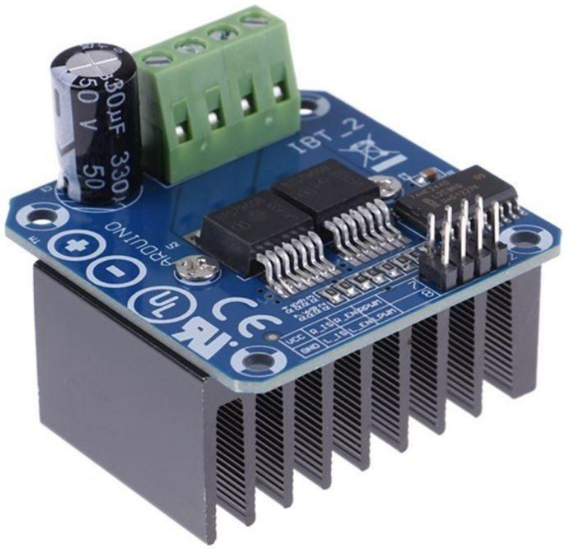

Fig.3.1.6 BTS7960 Motor driver

The BTS7960 motor driver is an essential component in voice-controlled wheelchairs, enabling smooth and efficient DC motor control for movement and direction changes. With a voltage range of 6V to 27V and the ability to handle up to 43A continuous current, it ensures reliable operation for high-torque wheelchair motors. The driver supports PWM signals (up to 25kHz), allowing precise speed control while being compatible with 3.3V and 5V logic, making integration with microcontroller Arduino and voice recognition modules seamless.

For a voice-controlled wheelchair, the BTS7960 receives control signals from a speech recognition module (such as EasyVR, Google Assistant, or offline AI models), which processes voice commands like “move forward,” “turn left,” or “stop”. The driver’s dual half-bridge design enables smooth forward, reverse, and braking operations, ensuring safe and precise movement. Additionally, built-in overcurrent, overtemperature, and undervoltage protection enhances safety, preventing damage due to excessive load or overheating.

By integrating the BTS7960 motor driver into a voice-controlled wheelchair system, users with mobility impairments can experience hands-free navigation, improving independence and accessibility. Its high efficiency and durability make it ideal for assistive mobility solutions, ensuring a smooth and responsive ride.

3.2 SOFTWARE DESCRIPTION

3.2.1 Arduino IDE

Fig.3.2 Arduino IDE

The Arduino IDE (Integrated Development Environment) is an open-source software platform used to write, compile, and upload code to Arduino microcontroller boards.

It features a user-friendly interface with a text editor for writing programs (sketches), a message area for feedback, a text console for error messages, and a toolbar with buttons for common functions like verifying, uploading, and saving code. The IDE uses the C++ programming language with Arduino-specific libraries to simplify complex hardware control tasks. It supports serial communication for debugging and provides a comprehensive library repository for interfacing with sensors, motors, and modules. Compatible with Windows, macOS, and Linux, the Arduino IDE is widely used in embedded systems projects for its simplicity, flexibility, and extensive community support. In this project, the IDE is used to program the Arduino Nano to process voice commands, control relays, and manage obstacle detection logic.

3.3 WORKING

3.3.1 BLOCK DIAGRAM

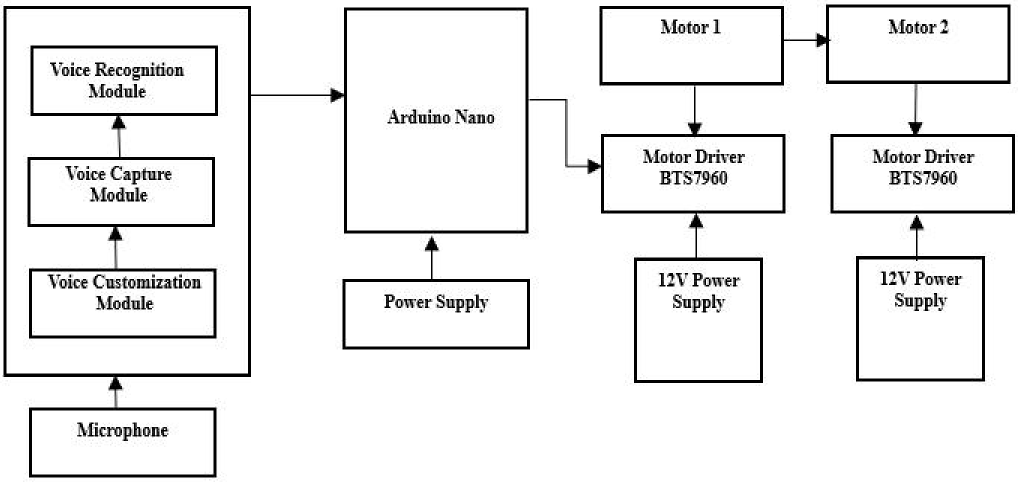

Fig.3.3-Block Diagram of Working of Voice Controlled Wheelchair

The Voice-Controlled Wheelchair operates by processing voice commands provided by the user through a microphone. The Voice Recognition Module (V3.1) is the core component responsible for identifying the user's commands, such as "forward," "reverse," "left," or "right." These commands are captured by the Voice Capture Module, customized via the Voice Customization Module, and sent to the Arduino Nano microcontroller for further action.

The Arduino UNO acts as the central control unit, integrating signals from the voice recognition module. Based on the voice command and sensor data, the Arduino sends control signals to the Motor Speed Control Module and a series of relays (Relay 1–4). These relays regulate the operation of the left and right motors, enabling precise control of the wheelchair's movement and direction.

A 12V Power Supply powers the entire system, including the motors, Arduino, and voice recognition module. The Battery Level Indicator monitors the power status, ensuring the user is aware of the battery condition to avoid sudden power loss. This integration of voice recognition, obstacle detection, and motor control makes the wheelchair responsive, safe, and user-friendly.

3.4 ALGORITHMS USED

3.4.1 Voice Recognition

Algorithm:

Keyword Spotting and Matching

- The Voice Recognition Module V3 processes and recognizes pre-trained voice commands.
- Training involves storing a set of specific voice commands (e.g., "forward," "stop").
- The module uses template-matching techniques such as Dynamic Time Warping (DTW) or other simple pattern recognition algorithms to match incoming audio signals with stored templates.

3.4.2 Signal Processing

- The module extracts features from the speech signal, such as:
- Mel-frequency Cepstral Coefficients (MFCCs): Converts the speech waveform into spectral features.
- Short-Time Energy: Identifies voiced/unvoiced segments of speech.

3.4.3 Communication with Arduino Nano

After recognition, the module sends a command (e.g., "ID1 for Forward") as a serial signal to the Arduino Nano.

Algorithm:

Serial Communication Protocol

The Arduino Nano reads and interprets the serial data using the Software Serial library.

CHAPTER 4

RESULT AND CONCLUSION

4.1 RESULT

The development and deployment of a voice-controlled wheelchair yield significant benefits across multiple dimensions of functionality, accessibility, and user experience. By enabling hands-free operation, the wheelchair empowers individuals with severe physical disabilities, such as paralysis or limited upper limb mobility, to regain autonomy and perform daily tasks independently.

The integration of voice recognition technology ensures intuitive control, allowing users to navigate their surroundings by issuing simple voice commands. This eliminates the need for physical effort, making the wheelchair particularly beneficial for those with conditions like quadriplegia or muscular dystrophy. The system is designed to accommodate various accents and speech patterns, ensuring inclusivity and ease of use for a diverse user base.

Safety features, such as obstacle detection and collision avoidance systems, significantly enhance user confidence and security. These technologies minimize the risk of accidents, enabling safe navigation in both indoor and outdoor environments. Additionally, emergency stop mechanisms provide an added layer of protection, allowing for quick responses in critical situations.

From a technological perspective, the voice-controlled wheelchair showcases the integration of cutting-edge advancements, such as GPS for precise navigation and smart connectivity for seamless interaction with home automation systems. These features transform the wheelchair into a multifunctional tool that adapts to the user's needs, improving overall convenience and quality of life.

On a societal level, the wheelchair addresses accessibility challenges by providing a cost-effective and reliable solution, fostering greater inclusivity and equal opportunities for individuals with disabilities. Its development aligns with the principles of universal design, aiming to bridge the gap between assistive technology and everyday usability.

Overall, the voice-controlled wheelchair stands as a testament to the potential of assistive technology to transform lives, offering not only mobility but also dignity, independence, and enhanced social engagement for individuals facing mobility challenges.

4.2 CONCLUSION

The voice-controlled wheelchair represents a transformative innovation in assistive technology, combining advanced engineering, artificial intelligence, and human-centered design to address the mobility challenges faced by individuals with physical disabilities. By enabling hands-free operation through voice commands, it redefines independence for users who face limitations in traditional manual or joystick-operated wheelchairs. This groundbreaking solution empowers individuals to navigate their surroundings with ease, significantly enhancing their quality of life.

The incorporation of safety features such as obstacle detection and emergency stop mechanisms underscores the device's focus on user security, ensuring safe and reliable operation in diverse environments. These features are not only essential for mitigating risks but also for building user confidence in the technology. Moreover, the integration of smart functionalities such as smart home connectivity and customizable settings expands the wheelchair’s scope beyond basic mobility, transforming it into a versatile tool for daily living.

The development of this wheelchair also marks an important step toward inclusivity and accessibility. By addressing the specific needs of individuals with severe physical impairments, the device bridges the gap between assistive technology and real-world usability. It reflects the broader goals of universal design, aiming to ensure that technology is accessible to all, regardless of their physical capabilities.

Beyond its immediate functionality, the voice-controlled wheelchair has the potential to inspire further advancements in assistive technology. Its success could pave the way for more sophisticated and inclusive solutions, driving innovation in healthcare and rehabilitation industries. As society moves toward embracing smart technologies, devices like the voice-controlled wheelchair play a crucial role in fostering independence, dignity, and social inclusion for people with disabilities.

In conclusion, the voice-controlled wheelchair is not just a mobility aid; it is a symbol of empowerment and progress. By leveraging technology to overcome physical limitations, it provides users with newfound freedom, enhancing their ability to engage with the world around them. Its impact extends beyond individual users, contributing to a more inclusive and equitable society where everyone has the opportunity to live with autonomy and dignity.

4.3 FUTURE SCOPE

Voice-controlled wheelchairs have the potential to significantly enhance the quality of life for individuals with mobility impairments. Here's an overview of their future scope:

1. Integration with AI and IoT:
   - Advanced AI can enable context-aware navigation, such as adjusting the wheelchair's path based on user preferences or environmental conditions.
   - IoT connectivity can allow seamless integration with smart home devices, enabling users to control lights, doors, and appliances through voice commands.
2. Multilingual and Adaptive Voice Recognition:
   - Future models can support multiple languages and adapt to individual speech patterns, accents, or impairments, making them more inclusive.
   - Noise-cancellation technologies can improve usability in noisy environments.
3. Health Monitoring and Alerts:
   - Sensors integrated into the wheelchair can monitor vitals like heart rate, blood pressure, and oxygen levels, alerting caregivers in case of abnormalities.
   - Voice commands could provide real-time updates about health metrics.
4. Enhanced Navigation and Safety:
   - AI-powered obstacle detection and autonomous navigation can enhance safety.
   - Users could give voice commands for pre-mapped locations, and the wheelchair could navigate autonomously.
   - Integration with GPS can aid in outdoor navigation, offering directions or route suggestions.
5. Customizable Features:
   - Future designs may include voice-controlled seat adjustments, climate controls (like heated seating), and storage access.

CHAPTER 5

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