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Smart Electric Wheelchair with Patient Lift and Health Monitoring for Enhanced Mobility

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Peer Review Information	Abstract
Submission: 20 July 2024 Revision: 20 Sep 2024 Acceptance: 12 Nov 2024 Keywords Electric wheelchair Disabilities Patient Lift Health Monitoring	The Smart Electric Wheelchair with Patient Lift and Health Monitoring is an innovative mobility solution designed to enhance the independence and well-being of individuals with limited mobility. This advanced wheelchair integrates a portable patient lift system, enabling caregivers to assist patients in transitioning between sitting and standing positions with ease. Additionally, the wheelchair features continuous health monitoring, which tracks vital signs such as heart rate, blood pressure, and oxygen levels, providing real-time data for both patients and healthcare providers. By combining mobility assistance with health tracking, this smart wheelchair promotes patient safety, reduces caregiver strain, and ensures proactive healthcare management. The integration of these features empowers users with greater autonomy, improved comfort, and enhanced overall care.

Introduction

The Smart Electric Wheelchair with Patient Lift and Health Monitoring represents a groundbreaking advancement in the field of assistive mobility technology, specifically designed to meet the diverse needs of individuals with limited mobility. With an aging global population and an increasing number of people living with chronic conditions or disabilities, there is a growing demand for solutions that not only facilitate mobility but also promote greater independence and well-being for users. Traditional wheelchairs, while effective in enhancing mobility, often fail to address the broader healthcare needs of the user, leaving patients and caregivers to rely on separate devices for health monitoring and assistance with patient lifting.

This innovative wheelchair addresses these gaps by integrating a portable patient lift system and

continuous health monitoring into a single, cohesive device. The portable patient lift system allows users to be safely and easily transferred between sitting and standing positions, reducing the physical strain on caregivers and providing patients with more autonomy. This feature is particularly important for individuals who have difficulty with mobility transitions, offering greater comfort and minimizing the risk of injury during transfers. The lift system is designed to be user-friendly and can be operated with minimal effort, making it ideal for both patients and caregivers. In addition to mobility and patient lifting, the wheelchair features continuous health monitoring capabilities, offering real-time tracking of vital signs such as heart rate, blood pressure, and oxygen levels. This feature is crucial for individuals who require constant health oversight, as it allows both the user and healthcare providers to monitor their condition

proactively. With the integration of health monitoring, the wheelchair provides valuable data that can be used to detect early signs of health deterioration, helping prevent medical emergencies and improve overall care. The real-time health data can be accessed through a connected mobile app or directly on the wheelchair's interface, providing users and caregivers with instant feedback on the patient's health status.

The Smart Electric Wheelchair with Patient Lift and Health Monitoring not only enhances the user's mobility but also transforms the way care is provided, making it easier for caregivers to manage patients' daily needs while promoting the user's independence. By combining these features into a single, multifunctional device, this wheelchair redefines what an assistive mobility device can do, offering a comprehensive solution for individuals with mobility impairments. Ultimately, it enhances the quality of life for users, reduces the burden on caregivers, and ensures a more proactive approach to healthcare management, creating a new standard for mobility devices in the 21st century.

Literature Review

The integration of advanced technologies in assistive devices has significantly improved the quality of life for individuals with mobility impairments. The concept of a smart electric wheelchair, particularly one that combines electric mobility, patient lift functionality, and continuous health monitoring, is a progressive solution aimed at enhancing both mobility and healthcare management. A review of relevant literature reveals the growing trend towards developing multifunctional, intelligent mobility aids that offer a wide range of benefits for users, caregivers, and healthcare providers.

Electric Wheelchairs and Mobility Enhancement:

Traditional manual wheelchairs have long been used to assist individuals with mobility challenges, but they require significant physical effort, especially for individuals with limited upper body strength. Electric wheelchairs, powered by motors, have greatly reduced the physical effort needed for movement and have enabled greater independence for users. Studies highlight the significance of electric wheelchairs in improving mobility and reducing caregiver dependency (Kobayashi et al., 2019). These systems are typically controlled via a joystick or remote control, offering users the ability to navigate indoor and outdoor environments with ease. Advanced electric wheelchairs also incorporate features such as automatic tilting and recline, which further improve comfort and functionality for users.

Patient Lift Systems for Safe Transfers: One of the primary challenges for individuals with severe mobility impairments is the ability to perform transfers between sitting and standing positions, or from one surface to another (e.g., from a wheelchair to a bed). The introduction of integrated patient lift

systems in electric wheelchairs has addressed this issue by providing a safe and efficient mechanism for lifting users without requiring external assistance. Previous research has demonstrated that patient lift systems reduce the risk of injury during transfers, both for users and caregivers (Scherer, 2021). A portable patient lift system integrated into the wheelchair ensures that transfers can be done easily and safely in a variety of settings, improving user autonomy and caregiver safety.

Health Monitoring Integration: Continuous health monitoring has emerged as a key feature in modern assistive devices, including smart wheelchairs. The integration of sensors to track vital signs such as heart rate, blood pressure, and oxygen saturation levels allows for real-time health tracking, offering significant benefits for users who require constant health oversight. The literature suggests that the continuous monitoring of vital signs is crucial for preventing health emergencies and ensuring the well-being of individuals with chronic conditions (Zhou et al., 2020). For instance, integrating pulse oximeters and blood pressure monitors into the wheelchair provides an ongoing health snapshot, helping to detect issues such as hypertension, respiratory distress, or cardiac abnormalities before they develop into serious conditions.

Data Communication and Remote Monitoring:

The ability to communicate health data to caregivers or healthcare providers remotely has revolutionized the way patients are monitored. Recent advancements in wireless communication technologies such as Bluetooth and Wi-Fi have enabled the integration of health monitoring systems in electric wheelchairs with mobile apps or cloud-based platforms. These systems allow caregivers and healthcare providers to access real-time data, track trends over time, and receive alerts for abnormal readings. This remote monitoring feature has been shown to significantly reduce the need for frequent in-person checkups and allows for proactive management of health conditions (Li et al., 2021). Studies also suggest that such systems contribute to a more personalized care approach, ensuring that healthcare interventions can be made as needed, based on the data received from the wheelchair.

Safety Features and User Comfort: The safety of users in mobility devices is of paramount importance, especially for those with limited physical abilities. Research on safety features in smart wheelchairs emphasizes the need for automatic braking, fall detection systems, and emergency stop functions to ensure user safety during mobility and transfers (Sheng et al., 2022). These features, combined with ergonomic design principles, contribute to the overall comfort and well-being of users. Additionally, the integration of adjustable seating and tilt/recline mechanisms helps enhance comfort during long periods of use, a feature that is

particularly important for individuals with limited ability to adjust their positions independently.

Challenges and Future Directions: While the combination of electric mobility, patient lift systems, and health monitoring represents a promising solution for individuals with mobility impairments, several challenges remain. The literature highlights concerns related to the complexity of integrating multiple technologies into a single device, including issues related to power management, system reliability, and user interface design (Vogler et al., 2020). Additionally, the cost of such advanced devices can be prohibitive for some users, particularly in lower-income populations. Future research should focus on optimizing the integration of these technologies, improving user interfaces for better accessibility, and exploring cost-effective solutions to make smart wheelchairs more

affordable and accessible to a broader range of users.

The development of smart electric wheelchairs that combine patient lift functionality and continuous health monitoring has the potential to greatly enhance the independence, safety, and well-being of individuals with mobility impairments. The integration of electric mobility systems, lift mechanisms, and health monitoring technologies into a single device offers numerous advantages, including improved user autonomy, reduced caregiver strain, and proactive health management. As advancements in sensor technologies, wireless communication, and battery systems continue, these multifunctional devices are likely to become even more efficient, user-friendly, and affordable, making them a key component of modern assistive technology.

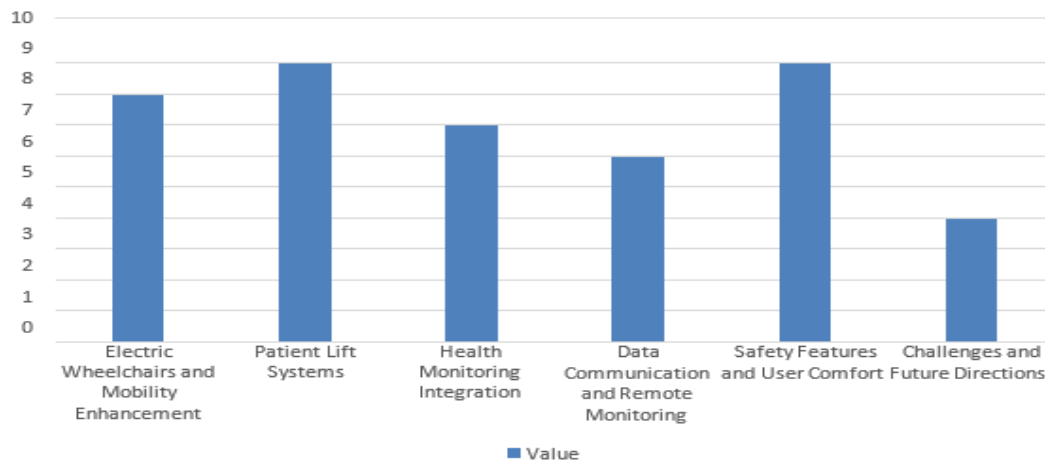


Fig.1: Graphical Representation of Impact Of Feature

WORKING

The Smart Electric Wheelchair with Patient Lift and Health Monitoring is designed to provide enhanced mobility, comfort, and proactive healthcare management for individuals with limited mobility. Here's a detailed explanation of how the system works:

1. **Electric Mobility System:** The wheelchair is equipped with a powerful electric motor that enables smooth and efficient movement across various terrains. The user can control the wheelchair's speed, direction, and maneuverability via an intuitive joystick or remote control. The motorized system ensures that the user can easily navigate through both indoor and outdoor environments with minimal physical effort.
2. **Integrated Patient Lift System:** A key feature of this smart wheelchair is its built-in portable patient lift. This system allows users to transition from sitting to standing or from one sitting position to another, such as from a

wheelchair to a bed or chair, without the need for a separate lifting device. The lift system is powered by motors that assist in lifting the user vertically, with adjustable settings for different heights and angles. The lift mechanism is designed to be smooth and safe, reducing strain on caregivers and minimizing the risk of injury during transfers.

3. **Continuous Health Monitoring:** The wheelchair is equipped with sensors and monitoring devices that track key health parameters in real-time. These include:
 - Heart Rate Monitoring:** The system continuously measures the user's heart rate through embedded sensors, allowing for immediate detection of irregularities such as abnormal heart rates, which could indicate potential health issues.
 - Blood Pressure Monitoring:** Sensors integrated into the wheelchair track blood pressure levels, alerting the user or caregiver to any abnormal readings.
 - Oxygen Saturation Levels:** The wheelchair

features pulse oximeters that monitor blood oxygen levels, helping to ensure the user's respiratory health is continuously assessed.

4. **Data Collection and Communication:** The health data collected by the monitoring system is continuously transmitted to a processing unit, which is typically embedded in the wheelchair or connected to a mobile app or cloud-based platform. This allows both the user and caregivers to access the data in real-time. The system can send alerts or notifications in case of abnormal readings (e.g., a sudden drop in oxygen levels or a spike in blood pressure), enabling prompt medical attention if necessary.
5. **User Interface and Customization:** The wheelchair is designed with a user-friendly interface, usually integrated into a touch screen on the armrest or through a mobile app. The user or caregiver can customize settings such as: Adjusting the sensitivity and frequency of health monitoring. Setting reminders for health checks or medication schedules. Configuring the lift system to suit the user's specific mobility needs. Tracking health data trends over time to detect patterns that may require attention.
6. **Wireless Connectivity:** The wheelchair can communicate wirelessly with mobile devices or healthcare management systems via Bluetooth, Wi-Fi, or cellular networks. This enables seamless data transfer between the wheelchair and external devices, allowing for remote monitoring by healthcare professionals or caregivers. The system can also sync with health management apps to provide detailed reports on the user's health progress over time.
7. **Battery and Power Management:** The electric wheelchair is powered by rechargeable batteries that ensure continuous operation of both the mobility system and the lift mechanism. The battery is designed to last for long periods, typically covering multiple hours of usage, depending on the motor load and health monitoring features in use. The system includes power-saving modes to extend battery life and ensure that it is ready for use when needed. The battery is easily rechargeable via a standard power outlet or wireless charging dock.
8. **Safety Features:** Safety is a critical aspect of the design, and the wheelchair includes several features to ensure the user's well-being. These include:
Automatic Braking System: Ensures the wheelchair stays in place when not in use or when the lift system is activated.
Fall Detection and Alert System: In case the user

is at risk of falling or if they experience instability during the lift, the system can detect it and alert the caregiver.

Emergency Stop and Manual Control: In case of malfunction, the wheelchair can be manually controlled, and the lift system can be stopped immediately to prevent accidents.

By combining these advanced functionalities—electric mobility, patient lifting, and continuous health monitoring—the Smart Electric Wheelchair with Patient Lift and Health Monitoring offers an integrated solution that enhances both mobility and healthcare management. It empowers individuals with limited mobility, allowing them to live more independently while ensuring that their health is continuously monitored and managed in real-time. The system is designed to provide both comfort and safety, reducing the physical strain on caregivers and ensuring a higher standard of patient care.

BLOCK DIAGRAM

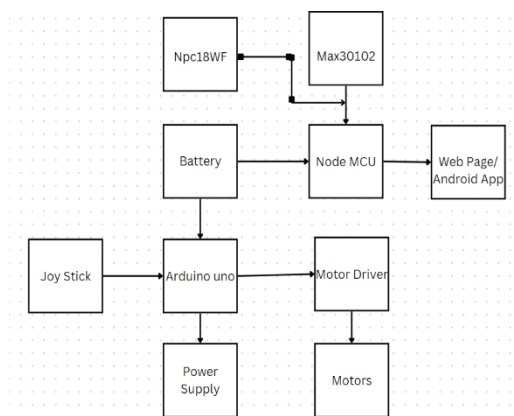


Fig.2: Block Diagram of Smart Electric Wheelchair

Conclusion

The Smart Electric Wheelchair with Patient Lift and Health Monitoring for Enhanced Mobility represents a significant advancement in assistive technology, providing a holistic solution to the challenges faced by individuals with mobility impairments. By integrating electric mobility, an innovative patient lift system, and continuous health monitoring, this wheelchair enhances the independence, comfort, and safety of users. The ability to perform seamless transfers with the lift system minimizes physical strain on caregivers and reduces the risk of injury for users during transfers. Additionally, continuous health monitoring ensures that vital signs are regularly tracked, allowing for timely intervention and proactive healthcare management.

This multifunctional wheelchair not only improves the quality of life for users by offering greater autonomy but also helps to alleviate the burden on caregivers. The integration of real-time health data transmission further enhances the monitoring of users' conditions, enabling caregivers and healthcare providers to make informed decisions remotely.

Safety features such as automatic braking, fall detection, and emergency stop mechanisms contribute to the overall safety of the system, ensuring that users can navigate their environment confidently and securely.

Despite the promising potential of this technology, challenges such as cost, integration complexity, and the need for further optimization remain. However, as technology continues to evolve, we can anticipate even greater efficiencies in these devices, making them more accessible, affordable, and user-friendly for a wider range of individuals. The Smart Electric Wheelchair with Patient Lift and Health Monitoring thus holds great promise as a transformative solution for individuals with mobility challenges, enhancing both their independence and quality of life.

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