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Empowering Independence: A Comprehensive Review of Paralysis Lifting Equipment and Automation.

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Abstract
Paralysis lifting equipment plays a critical role in improving the quality of life and independence for individuals with paralysis. This study investigates the numerous engineering breakthroughs, knowledge areas, and future opportunities in this sector. Engineering disciplines involved include biomechanics, materials engineering, control systems, robotics, and human factors engineering. These considerations are critical for building lifting equipment that is safe, efficient, and user-friendly while meeting the unique demands of people with paralysis. Automation in disability lifting equipment has various benefits, including increased safety, independence, and a better user experience. Looking ahead, this field's future holds promising opportunities for advancements in mobility solutions, neurotechnology integration, personalised designs, and smart, connected systems, all of which contribute to a more accessible, efficient, and sustainable approach to lifting and transferring people with paralysis. Continued research and collaboration are critical to driving future innovation and ensuring the global development of paraplegic lifting equipment.

Key Words: Paralysis lifting equipment, Engineering developments, Mobility solutions,Sustainability, Accessibility.

Introduction

Damage to the neurological system, particularly the spinal cord, is the most common cause of paralysis. Stroke, trauma with nerve damage, poliomyelitis, cerebral palsy, peripheral neuropathy, Parkinson's disease, ALS, botulism, spina bifida, multiple sclerosis, and Guillain-Barré syndrome are other prominent causes. REM sleep causes temporary paralysis, and disruption of this system can result in waking paralysis. Curare, a drug that interferes with nerve function, can also induce paralysis[1].

In an ever-changing environment, the idea of handicap extends beyond physical restrictions to represent the flexibility, resiliency, and untapped potential of those who encounter unique obstacles. Disability has long been a matter of conversation and action that has compelled society to reconsider preconceived views and progress toward inclusiveness[1]. This review delves deeply into the complex world of disability, including its myriad aspects, the growing situation of disability rights, and inspirational examples of people who have won despite adversity[2]. By highlighting the significance of empathy, understanding, and societal change, we hope to focus light on the rich tapestry of experiences and points of view within the disability community [3]. A thorough discussion of disability and its significant consequences, The number of patients in India is continually increasing [4]. In hospitals, patients are put in risk when they must transition from a wheelchair to a stretcher, a stretcher to a bed, a bed to a wheelchair, or vice versa. Moving patients to hospitals is a typical difficulty for nurses[5]. A mobility aid is a gadget designed to help people with mobility problems move about or to improve their overall mobility. Engineering sciences have resulted in the development of several patient aids. Mechanical assistance for physically challenged persons, particularly immobile patients, are an important subset of these. Wheelchairs, lift assistance, and other assistive technology devices for persons with restricted mobility have all been around for decades[6].

Purpose Of Review

There are lots of aid equipment and alternatives available in the market which will help in the support for the paralysis patients for transportation from one place to another, but they are very expensive and also big in size which are not feasible for everybody and cannot be afforded[7]. New equipment which arrives in the market may require additional training for healthcare providers. The equipment available in the market for the paralysis patients are very big in size and difficult to handle by everyone in order to move and shift. Much human efforts are required in order to lift the patient and transport, there must be upgrades in the lifting and must be automated. The conventional wheelchair available in the market will serve the purpose , but it is difficult to lift the person and it cannot be done by a single person[8].

Engineering Aspects

Voice Commands Technology

Voice recognition on electrical equipment is accomplished through the use of a smartphone voice commands application. A program controls digital sound processing in order to recognize detected speech instructions, which is commonly referred to as speech Recognition[9].

Technology for Disabled People

The use of suitable assistive technology is one strategy to improve the participation of individuals with impairments. Technology for handicapped individuals offers information about device technology and assistive technology services. It is about the lives of users who are handicapped[10].

Transport Mechanism

The transportation mechanism must provide height adjustment and pattern movement, according to the specifications. During the design of the height adjustment mechanism, three alternatives were evaluated.By constructing rack and pinion devices, the patient may be hoisted while also providing comparable vertical displacement[11].

Robotics and automation

Expertise in robotics and automation is used to create advanced robotic devices that can aid in lifting and moving paralyzed patients, with capabilities that enable precise and adaptable motions[12].

Sustainability and Environmental Engineering

This knowledge is utilised to guarantee that the lifting equipment's design and production processes are ecologically benign, emphasising the use of sustainable materials and energy-efficient technology. This also contributes to environmental conservation for future generations[13].

Innovations By Engineers

There are a number of current advancements in the subject of paralysis patients lifting equipment, with a particular emphasis on technical solutions to improve the quality of life and mobility for people with paralysis. Highlights of some general trends and developments being investigated[14].

1. **Advanced Exoskeletons:** Researchers were working on more sophisticated and lightweight exoskeletons to help those with paralysis. These exoskeletons were designed to improve movement and provide greater assistance for daily duties, ultimately increasing overall quality of life[15].
2. **Neuroprosthetics:** Engineers and researchers were also investigating neuroprosthetics, which entail implanting electrical devices into the nervous system to restore motor capabilities. These developments were supposed to give patients with paralysis with more natural and efficient control over prosthetic limbs[16].
3. **Assistive Robotics:** Robotics was becoming more prevalent in the field of paraplegic lifting equipment. Engineers were working on developing more intelligent and adaptive robotic devices that may help with lifting, transporting, and assisting those with paralysis with different everyday routines[17].
4. **Smart Assistive Devices:** Sensor technology advancements and data processing capabilities were leading to the creation of smart assistive devices. These technologies were created to anticipate user demands and give personalised assistance, fostering more freedom for those with paralysis[18].
5. **Hydraulic and Pneumatic Systems:** Engineering advancements have focused on developing more efficient and responsive hydraulic and pneumatic systems for lifting and sustaining paralyzed patients. These systems were designed to be more adaptive to varied situations and capable of giving users with a greater range of motion[19].

6. **Biomechanical Engineering Innovations**: Advancements in biomechanical engineering have led to the development of more ergonomic and user-friendly lifting devices. These innovations focus on designing equipment that closely mimics the natural movement of the human body, ensuring better comfort and safety for individuals with paralysis during lifting and transferring processes[20].
7. **Sensor and Control Systems:** Integration of advanced sensor and control systems has enabled the development of smarter and more responsive paralysis lifting equipment. These systems can adapt to the specific needs and movements of individuals with paralysis, offering more precise and personalised support during lifting and transferring activities[21].

Advantages Of Automation

1. **Enhanced Safety:** Safety measures integrated into automated lifting equipment, such as emergency stop mechanisms and collision detection systems, reduce the danger of accidents and injuries during lifting and transferring activities.
2. **Increased Independence:** Individuals with paralysis can use the lifting equipment independently without the need for continual support from carers or healthcare experts, enabling increased autonomy and self-reliance.
3. **Precision and Control:** Automated solutions allow for precise and regulated motions, providing smooth and accurate lifting and transferring of paralyzed patients and reducing discomfort and potential strain during the procedure..
4. **Reduced Physical Strain on Caregivers:** Automation relieves carers of physical effort, allowing them to offer greater care and assistance to those with paralysis without overexerting themselves, lowering the risk of caregiver weariness and injury[22].
5. **Customizable Settings:** Automated paralysis lifting equipment frequently has customisable settings that may be adapted to the exact requirements and preferences of individual users, offering individualised support and improving overall comfort and enjoyment.
6. **Data Collection and Analysis:** Lifting and transferring data may be collected and analysed by automated systems, providing insights into user preferences and behavior patterns that can be utilised to enhance the design and functioning of future lifting equipment.
7. **Improved User Experience:** Lifting equipment automation improves the entire user experience by allowing for smoother and more seamless operation, making those with paralysis feel more comfortable and safe during the lifting and transferring procedure.

Paralysis lifting equipment may considerably enhance the quality of life for people with paralysis, allowing them to live more independent and happy lives while also making caretakers' and healthcare professionals' jobs easier[23].

Scope For Future Development

1. **Enhanced Safety Features:**
To protect the safety of both patients and caregivers throughout the lifting process, advanced safety features such as real-time monitoring, intelligent weight distribution, and automated emergency braking systems can be integrated[24].
2. **IoT Integration for Remote Monitoring:**
Incorporating Internet of Things (IoT) technology can enable remote monitoring of the equipment, providing real-time data on usage, maintenance requirements, and patient condition. This can lead to proactive maintenance and improved patient care[25].
3. **Advanced Materials for Durability and Comfort:**
The use of Internet of Things (IoT) technology allows for remote monitoring of the equipment, delivering real-time data on consumption, maintenance requirements, and patient condition. This can result in proactive maintenance and better patient care[26].

Conclusion

To summarise, the field of paralysis lifting equipment has seen significant advances and continues to advance as a result of diverse technical discoveries and a growing emphasis on improving the quality of life for persons with paralysis. By merging numerous technological domains such as biomechanics, materials science, robotics, and control systems, developers have been able to construct complicated and user-friendly lifting devices that prioritise safety, comfort, and autonomy. Continued research, collaboration, and

technological advancements are necessary to improve the development of paralyzed lifting equipment on a global scale, with the objective of making it more accessible, efficient, and sustainable. By emphasising user-centric design and merging cutting-edge technology, the sector is poised to make significant contributions to enhancing the overall well-being and independence of persons living with paralysis. The paralysis lifting tool will make transportation easier for caretakers while also allowing the patient to move without discomfort. Automation in these devices has brought a variety of benefits, including improved safety, independence, and user experience, which has benefited both persons with paralysis and their caregivers. The device will be used by all hospitals and health care associations to ensure that patients are transported safely.

References

1. de Almeida Ribeiro PR, Brasil FL, Witkowski M, Shiman F, Cipriani C, Vitiello N, Carrozza MC, Soekadar SR. Controlling assistive machines in paralysis using brain waves and other biosignals. Advances in Human-Computer Interaction. 2013 Jan 1;2013:3-.
2. Kasukawa Y, Shimada Y, Kudo D, Saito K, Kimura R, Chida S, Hatakeyama K, Miyakoshi N. advanced equipment development and clinical application in neurorehabilitation for spinal cord injury: Historical perspectives and future directions. Applied Sciences. 2022 Apr 29;12(9):4532.
3. Verbrugge LM, Rennert C, Madans JH. The great efficacy of personal and equipment assistance in reducing disability. American journal of public health. 1997 Mar;87(3):384-92.
4. Neely MB. Using technology and other assistive strategies to aid students with disabilities in performing chemistry lab tasks. Journal of chemical education. 2007 Oct;84(10):1697.
5. Story MF, Schwier E, Kailes JI. Perspectives of patients with disabilities on the accessibility of medical equipment: examination tables, imaging equipment, medical chairs, and weight scales. Disability and health Journal. 2009 Oct 1;2(4):169-79.
6. Isyanto H, Arifin AS, Suryanegara M. Design and implementation of IoT-based smart home voice commands for disabled people using Google Assistant. In2020 International Conference on Smart Technology and Applications (ICoSTA) 2020 Feb 20 (pp. 1-6). IEEE.
7. LaPlante MP, Kaye HS. Demographics and trends in wheeled mobility equipment use and accessibility in the community. Assistive Technology®. 2010 Mar 17;22(1):3-17.
8. Rashid Ahmed K, Razack SA, Salam S, Vishnu Prasad KV, Vishnu CR. Design and fabrication of pneumatically powered wheel chair-stretcher device. International Journal of Innovative Research in Science, Engineering and Technology. 2015 Oct;4(10).
9. Bogue R. Robotic exoskeletons: a review of recent progress. Industrial Robot: An International Journal. 2015 Jan 19;42(1):5-10.
10. De Looze MP, Bosch T, Krause F, Stadler KS, O'sullivan LW. Exoskeletons for industrial application and their potential effects on physical work load. Ergonomics. 2016 May 3;59(5):671-81.
11. Wang H, Kasagami F. A patient transfer apparatus between bed and stretcher. IEEE Transactions on Systems, Man, and Cybernetics, Part B (Cybernetics). 2008 Jan 16;38(1):60-7.
12. Marsolais EB, Kobetic RU. Development of a practical electrical stimulation system for restoring gait in the paralyzed patient. Clin Orthop. 1988 Aug 1;233:64-74.
13. Birbaumer N, Cohen LG. Brain–computer interfaces: communication and restoration of movement in paralysis. The Journal of physiology. 2007 Mar 15;579(3):621-36.
14. Marshall JC, Halligan PW, Fink GR, Wade DT, Frackowiak RS. The functional anatomy of hysterical paralysis. Cognition. 1997 Jul 1;64(1):B1-8.
15. Coulson SE, Croxson GR, Adams RD, O'dwyer NJ. Reliability of the "Sydney,""Sunnybrook," and "House Brackmann" facial grading systems to assess voluntary movement and synkinesis after facial nerve paralysis. Otolaryngology–Head and Neck Surgery. 2005 Apr;132(4):543-9.
16. Bobde S, Borkar N, Apte S, Ghuguskar S. Automated wheelchair convertible stretcher. IRJET. 2017;4:889-92.
17. Tiwari MK, Prabhu DP, Chavan A, Sharma A, Tiwari M, Kalkotwar M. Design of an Indigenously Developed Patient Transfer Assistive Device.

18. Sunny JK, Karunakaran KP, Paul T, Roy V, Varkey B. Design and Fabrication of Stretcher cum Wheel Chair. International Journal for Innovative Research in Science and Technology. 2016 Apr;2(11):647-53.
19. Shah Y, Patel N, Patel N, Patel S, Surani P. Design and fabrication of wheelchair CUM stretcher. Int J Eng Adv Technol. 2021;10:210-4.
20. Patole MG, Lad MP, Pawar MA, Patil MV, Shaikh MS, Salunkhe MA. DESIGN AND FABRICATION OF AUTOMATIC WHEELCHAIR CUM STRETCHER/BED.
21. Rashid Ahmed K, Razack SA, Salam S, Vishnu Prasad KV, Vishnu CR. Design and fabrication of pneumatically powered wheel chair-stretcher device. International Journal of Innovative Research in Science, Engineering and Technology. 2015 Oct;4(10).
22. Hirudkar A, Bhusari C, Khedkar A, Parekar A, Daf SP. Automatic stretcher cum wheelchair. Int. Res. J. Eng. Technol. 2017 Mar;4(3):1659-63.
23. Borkar NM, Apte SA, Deshmukh TN, Apte SM. Mechanically operated wheelchair convertible stretcher. Int. J. Mech. Eng. Technol.(IJMET). 2016 Mar;7(2):261-5.
24. Vaghela PA, Ramanuj VD, Patel DB, Patel DR, Kaneriya PC, Patel JR. Stretcher cum Wheelchair for Patients. International Journal of Futuristic Trends in Engineering and Technology. 2014;1(03).
25. Bag SS, Lohe PD, Hajare HK, Madne AN, Hande AS. Design and fabrication of multiutility wheelchair. Int J Innov Res Sci Technol. 2017;3(10):182-8.
26. Vignesh V, Prakash R, Stephen SM, Kumar SA. Design and development of two in one foldable stretcher cum wheel chair. Int Res J Eng Technol. 2017;4(6):2739-45.
27. Swapna P, Sharmila B, Dharshan Y. Electric wheelchair for physically challenged. International Research Journal of Engineering and Technology. 2016 May;3(05):1090-4.
28. Randive P, Chaudhari A, Das B, Katre D, Pardhi P. DESIGN AND FABRICATION OF TRI-WHEEL MULTI–OPERATIONAL STRETCHER–CUM–WHEELCHAIR.