Design and Development of Sit to Stand Trainer for Personalised Rehabilitation

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Abstract

Sit-to-stand (STS) movement is a fundamental biomechanical activity essential for independent daily functioning. However, individuals with lower limb weakness, particularly stroke survivors, often experience difficulty in performing this transition due to reduced muscle strength, impaired balance, and limited coordination. Conventional rehabilitation systems are often expensive, bulky, and unsuitable for continuous home-based use, creating a need for compact and cost-effective assistive solutions. This study presents the design and development of a fiber-based sit-to-stand trainer for personalized rehabilitation. The proposed system integrates a linear actuator-driven lifting mechanism with a microcontroller-based control unit to provide assisted and controlled motion. A glass fiber reinforced polymer (GFRP) structure is utilized to achieve a high strength-to-weight ratio, improving portability while maintaining structural stability. The device incorporates a push-button interface that allows users to control the lifting process according to their physical capability and comfort. The system is designed in alignment with the four biomechanical phases of STS movement: flexion momentum, momentum transfer, extension, and stabilization. Anthropometric measurements and chair dimension analysis were considered to ensure ergonomic compatibility across different users. The developed prototype demonstrates improved stability, reduced user effort, and safe repetitive training capability. Compared to conventional metallic rehabilitation devices, the proposed design significantly reduces weight and cost while maintaining functional efficiency. This work highlights the potential of integrating lightweight composite materials with simple electromechanical systems to develop accessible and user-friendly rehabilitation devices for home-based therapy, thereby enhancing patient independence and recovery outcomes.