

ABSTRAK

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PEMBUATAN PERANGKAT EXOSKELETON EKSTRIMITAS LENGAN
ATAS MODE BILATERAL DAN MODE UNILATERAL (MODE BILATERAL)
xviii + 116 Halaman + 7 Tabel + 9 Lampiran

Stroke merupakan salah satu penyebab utama disabilitas fisik, terutama yang memengaruhi fungsi motorik anggota tubuh bagian atas. Di daerah terpencil, proses rehabilitasi sering kali terhambat akibat keterbatasan tenaga medis serta kurangnya fasilitas pendukung. Oleh karena itu, diperlukan pengembangan alat bantu rehabilitasi yang dapat digunakan secara mandiri, efisien, dan mudah dioperasikan oleh pasien. Penelitian ini bertujuan untuk merancang dan mengimplementasikan sistem eksoskeleton lengan atas dengan dua mode operasional, yakni bilateral dan unilateral, sebagai solusi alternatif dalam rehabilitasi pasien pasca stroke. Sistem ini menggabungkan penggunaan motor DC bertorsi tinggi sebagai aktuator utama dan sinyal elektromiografi (EMG) sebagai sumber input kendali, memungkinkan gerakan dilakukan secara responsif berdasarkan aktivitas otot pengguna. Pengujian dilakukan terhadap delapan responden pria dengan karakteristik tangan normal dan ketebalan jaringan lemak yang rendah untuk memastikan akurasi akuisisi sinyal EMG.

Untuk memantau sudut gerakan fleksi dan ekstensi lengan, digunakan sensor MPU6050. Hasil pengujian menunjukkan bahwa sistem mampu mendeteksi kontraksi otot dengan baik melalui EMG, serta mengukur sudut gerakan dengan akurasi tinggi. Nilai kesalahan terkecil tercatat sebesar 1,17 dan tertinggi 4,99. Frekuensi tertinggi sinyal EMG yang terekam adalah 263 Hz, sementara frekuensi sampling sistem mencapai 943 Hz. Meski performa sensor menunjukkan konsistensi pada beban tinggi, terdapat beberapa kendala teknis seperti ketidakstabilan pembacaan sudut saat postur tubuh responden tidak ideal, serta noise pada rangkaian EMG akibat ground loop saat pengisian daya. Penggunaan isolator USB atau komunikasi nirkabel disarankan sebagai solusi. Secara keseluruhan, sistem eksoskeleton ini terbukti akurat, adaptif, dan potensial sebagai perangkat rehabilitasi mandiri yang efektif dan terjangkau.

Kata kunci : Exoskeleton, Rehabilitasi, MPU6050, ESP32, EMG, Motor DC
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ABSTRACT

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CREATION OF UPPER ARM EXTREMITY EXOSKELETON DEVICES IN BILATERAL AND UNILATERAL MODE (BILATERAL MODE)

xviii + 116 Pages + 7 Tables + 9 Appendices

Stroke is one of the leading causes of physical disability, particularly affecting motor function in the upper limbs. In remote areas, rehabilitation efforts are often hindered by limited medical personnel and inadequate facilities. This situation highlights the need for assistive rehabilitation devices that are independent, efficient, and user-friendly. This study aims to design and implement an upper-limb exoskeleton system with two operational modes bilateral and unilateral as an alternative rehabilitation solution for post-stroke patients. The proposed system integrates a high-torque DC motor as the main actuator and electromyography (EMG) signals as the control input, enabling the device to respond in real time to user muscle activity. System testing involved eight male participants with normal hand characteristics and low subcutaneous fat levels to ensure reliable EMG signal acquisition.

To monitor the flexion-extension angle of the arm, the MPU6050 sensor was employed. Experimental results indicate that the system effectively detects muscle contractions through EMG and measures joint angles with high accuracy. The minimum error recorded was 1.17, while the maximum reached 4.99. The highest EMG signal frequency observed was 263 Hz, with the system's sampling rate reaching 943 Hz. While sensor performance was consistent under higher loads, several technical challenges were identified. The MPU6050 exhibited unstable angle readings when the participant's posture deviated from the ideal anatomical position. Additionally, the EMG circuit was prone to noise especially when the Arduino was connected to a charging laptop likely due to ground loop interference. Factors such as improper electrode placement and skin condition also affected signal quality. To mitigate these issues, the use of USB isolators or wireless communication is recommended. Overall, the exoskeleton system demonstrated accurate and responsive performance, offering a promising, cost-effective solution for independent rehabilitation of post-stroke patients

Keywords : Exoskeleton, Rehabilitation, MPU6050, ESP32, EMG, DC Motor.

References : 30 Journals (2015-2024)