

Summary

Upper limb functionality is essential for Activities of Daily Living (ADLs), particularly in tasks requiring precise motor control. Remote rehabilitation offers a solution for patient assessment outside clinical settings, but current methods face challenges in accurately segmenting voluntary movements and evaluating movement quality using wearable sensors.

This doctoral thesis investigates movement segmentation, kinematic assessment, and muscle synergy analysis using a single wrist-worn Magneto-Inertial Measurement Unit (MIMU) and surface electromyography (sEMG). The study focuses on the drinking task, a functionally relevant ADL, to assess upper limb movement patterns in a standardized and repeatable manner.

A major contribution of this research is the Dynamic Adaptive Movement Segmentation (DynAMoS) algorithm, developed to improve movement segmentation by accurately detecting movement onset and offset. Compared to state-of-the-art methods, DynAMoS significantly reduces segmentation errors, providing a more reliable and objective analysis of upper limb movements. Additionally, kinematic parameters such as movement duration, orientation, and smoothness were evaluated using a single wrist-worn MIMU, demonstrating their feasibility for home-based rehabilitation without the need for complex motion capture systems.

Furthermore, muscle synergy analysis was performed to gain deeper insights into neuromuscular control during the drinking task. By extracting time-invariant muscle synergies from sEMG data, the study identified consistent activation patterns that characterize motor control strategies. This approach enables a better understanding of functional movement organization, supporting the assessment of neuromuscular impairments and rehabilitation progress.

The findings of this thesis contribute to the development of standardized assessment protocols for telerehabilitation, ensuring repeatability and clinical relevance. By integrating MIMU-based kinematic analysis and muscle synergy evaluation, this research establishes a foundation for personalized rehabilitation

strategies, advancing remote patient monitoring, therapy optimization, and movement disorder assessment.