MOWA 3D - Activity monitoring in every-day life

Degree programme: BSc in Micro- and Medical Technology
Specialisation: Medical technology
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Inertial measurement units (IMUs) measure how the attached object moves and rotates using built-in accelerometers and gyroscopes. This project explores whether a single IMU placed on the leg can detect how active a person is throughout the day. Designed to work with a wearable orthosis for people with lower-limb impairments, the system aims to track movement intensity and to support smarter, more personalized rehabilitation and care.

Introduction

Understanding how much and how intensely a person moves is crucial in fields such as physical therapy, rehabilitation, and long-term health tracking. For people using wearable orthoses, such as those with partial paralysis, drop foot, or muscle weakness, knowing how active they are can help personalize care and detect trends in recovery.

Goals

This thesis investigates whether a single IMU (Inertial Measurement Unit) placed on the leg can accurately estimate daily activity levels and detect whether the orthosis is being worn. The goal is to create a sensor-based system that automatically classifies how active the user is throughout the day and distinguishes between wear and non-wear periods, all without requiring multiple sensors or user input.

Methods

The IMU sensor, mounted just below the knee, records acceleration data during real-world activity trials performed by volunteers. These participants differ in body type and movement style to ensure broad applicability. Using machine learning techniques, the recorded motion data is segmented into short windows. For each window, time-domain signal features are extracted and used to train a classifier that estimates both activity intensity and wear-time. The target activity levels include:

- Not wearing the device (non-wear)
- Sitting or standing still (rest)
- Lightly moving (e.g. walking slowly)
- Moderately active (e.g. walking or climbing stairs)
- Very active (e.g. running)

Results

The trained algorithm successfully assigns activity intensity levels and detects whether the orthosis is worn, using only raw accelerometer data. It demonstrates high classification accuracy and repeatability in controlled tests. Initial validation with a participant not included in the training phase showed promising generalization, though broader testing across more subjects remains to be conducted.

Outlook

Integrating this algorithm into the MOWA orthosis could allow healthcare professionals to automatically track device usage and physical activity over time, without relying on manual input. Future development should focus on improving generalizability across different users and movement styles, refining the handling of ambiguous motion patterns, and expanding the range of real-world scenarios in which the system can operate reliably.

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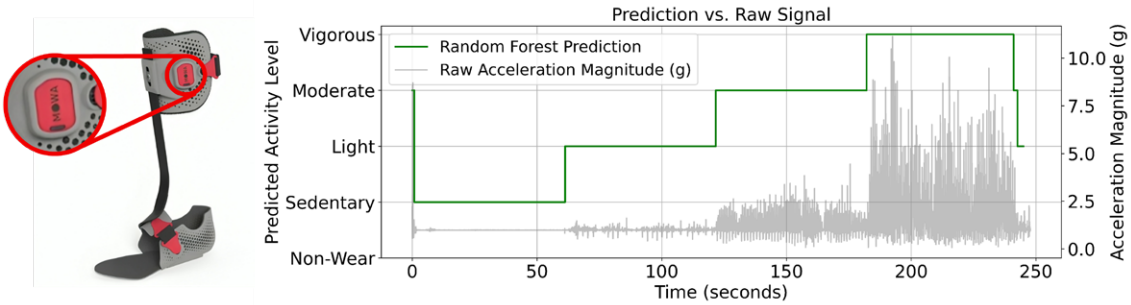

MOWA 3D Orthosis with IMU sensor (left) and raw signal with corresponding activity predicted by the algorithm (right)