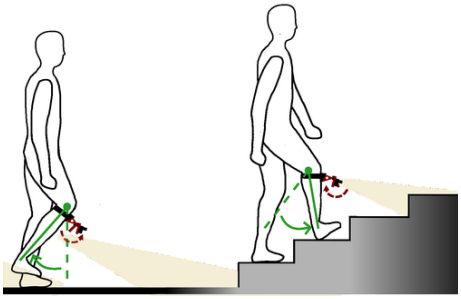
Friedrich-Alexander-Universität
Institute of Autonomous Systems
and Mechatronics | ASM

09.02.2024

Master Thesis

Design and Development of a Wearable Robotic Vision System with Stabilized Imaging for Terrain Classification in Lower Limb Prostheses

Entwurf und Entwicklung eines tragbaren robotischen Sehsystems mit stabilisierter Bildgebung zur Geländeklassifizierung in Unterschenkelprothesen Interaktion



Continuous terrain classification based on the gimbal during walking. [1]

Powered lower limb prostheses have gathered attention for their potential to restore mobility and improve the quality of life for humans. However, controlling these robotic devices in various applications is challenging as it generally requires the coordination of effective motion control and the detection of human intent. This challenge is particularly pronounced in dynamic environments requiring rapid adaptation to varying terrain surfaces and inclinations, as well as different tasks, such as turning or ascending/descending stairs. On-board camera-based solutions can be employed to acquire environmental information, which can then be used to plan control tasks accordingly. However, as with many camera-based robotic applications, real-time stabilization is critical. The motion of the prosthesis and vibrations caused by walking can result in blurry, poorly focused images, rendering them unreliable. This thesis aims to explore, design, and develop a camera stabilization system for terrain classification in lower limb prostheses.

Project assignment

- Research of state-of-the-art in the field of stabilization of computer vision systems.
- Systematic mechatronic design and implementation of a suitable real-time stabilization mechanism, e.g., gimbal.
- Functional evaluation with data extraction using the RealSense depth camera D455.
- Documentation and presentation of results.

Requirements

- Good investigation and organization skills.
- Experience with mechanical design.
- Basic knowledge of control theory and mechatronics.

References

[1]. Li, L., Wang, X., Meng, Q., & Yu, H. (2023). A Wearable Computer Vision System With Gimbal Enables Position-, Speed-, and Phase-Independent Terrain Classification for Lower Limb Prostheses. IEEE transactions on neural systems and rehabilitation engineering, 31, 4539-4548.

[2]. Pahl, G., Beitz, W., Feldhusen, J., & Grote, K. H. (1996). *Engineering design: a systematic approach* (Vol. 3). London: Springer.

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