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# Improved Gait Cycle Detection for Use in Gait Rehabilitation

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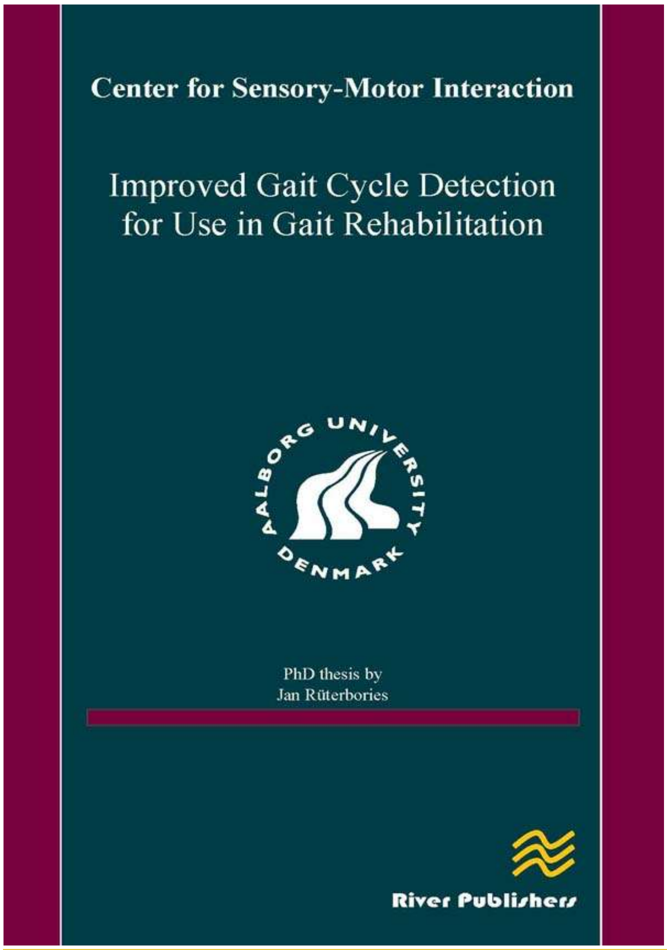
After stroke, hemiparesis is a common problem resulting in very individual needs for walking assistance. Often patients su er from foot drop, i.e. inability to lift the foot from the ground during the swing phase of walking. Gait rehabilitation can be supported by Functional Electrical Stimulations (FES) which requires a reliable trigger signal to start the stimulations. This can be obtained by a simple switch under the heel or by alternative sensor systems. However, the gait phase detection systems available today show limitations regarding their reliability and usability for ambulatory gait detection during overground walking.

In order to investigate present methods of gait analysis and detection for use in ambulatory rehabilitation systems, a meta analysis on research studies was carried out. Further, a new measurement system based on angular accelerations obtained by di erential measurements was developed. The new system was used to investigate the potential of 3D angular accelerations of foot, shank, and thigh to characterize gait events and phases of ten healthy and ten hemiparetic subjects. Subsequently, the real time detection capability of a rule based algorithm was evaluated which detects curve features of the vectorial sum of angular accelerations and maps those to discrete gait states.

This thesis provides an overview of various sensors and sensor combinations capable of analyzing gait in ambulatory settings, ranging form simple force based binary switches to complex setups involving multiple inertial sensors and advanced algorithms. The new measurement system realized a single device setup minimizing the donning/do ng e orts. The system provided gait characteristics as modulated amplitudes of angular accelerations of foot, shank, and thigh. Increasing the gait cadence caused an amplitude increase of the vectorial sum of angular accelerations. A comparison of healthy and hemiparetic gait showed a lower mean of the magnitude of the vector during the loading response in the hemiparetic gait, while during pre-swing and swing no signi cant di erences between healthy and hemiparetic gait were observed. Further, no statistically signi cant di erence between the tangential components was found for both groups.

The developed gait detection algorithm showed an overall detection rate for healthy and hemiparetic gait of 84.8(18.6) (mean(SD)). The sensitivity was 99.1(1.2) (mean(SD)) and the speci city of 99.8(1.0) (mean(SD)). The algorithm detected gait phase changes earlier than the reference system (foot switches) and showed potential to be implemente

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