Faculty of Electrical Engineering & Computer Science
Master Degree Course Electronics Engineering, MSc EE

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**Development and Implementation of Ground Inclination Approximation Algorithm with Hardware Integration and Testing for an Adaptive Reciprocal Walking Device.**


## *ABSTRACT - Masterthesis*

Patients with paralyzed lower extremities due to spina bifida, paraplegia or polio for instance, can walk with a reciprocal orthotic walker on even grounds as long as there are no inclinations to overcome. As soon as an inclined ground is to be overcome, the adaption of foot units is crucial, which has been realized with the present model.

A low cost approach is followed to realize an initial step in order to find solutions providing the foot unit of the reciprocal orthotic walker with adaptation functionality. Thus, it can be used for walking even on inclined grounds. Low cost components were used in order to follow the low cost approach.

The aim of this thesis is the development of a mathematical model for the foot unit of a reciprocal orthotic walker which computes the slopes of the ground below the foot. This helps to generate reference points to the actuators of the foot unit to adapt according to the slopes before it steps on to the ground while walking. The developed mathematical model is implemented with a combined software and hardware solution to practically validate the functionality of the adaptive foot unit with respect to the ground at different slopes. Finally testing and evaluating the setup is done to find out the possible error sources, limitations to try and minimize the errors in order to make the setup robust.

For this a first modelling and simulation approach with the help of Scilab has been undertaken. Based on this first concept an enhanced approach has been elaborated within this work and implemented in C programming language on a Cortex M4 based microcontroller. Low cost distance measuring IR, Ultrasonic sensors and 9 degrees of freedom inertial measurement unit sensor were used as inputs for the embedded adaption system. These compute the reference values for the positioning of actuation units (motion controller devices EPOS2 by maxon motor in combination with respective DC current motors for each Direction of Freedom). CAN, RS232, UART and I2C communication protocols were used for communication between microcontroller, sensors and actuators. Finally the modified foot unit is practically tested on grounds with different inclinations and the results, conclusions are presented.