Development of a Stochastic Vibration Platform

Supervisors: Prof. Dr. Volker M. Koch and Prof. Dr. Jörn Justiz
Institutions: Institute for Human Centered Engineering – BME Lab, Bern University of Applied Sciences
Examiners: Prof. Dr. Volker M. Koch and Prof. Dr. Lorenz Radlinger

Back pain is a very common and cost intensive concern that is present in today's society. Stochastic whole body vibration training seems to be an efficient method to adress this increasing problem. Based on the lack of suitable commercial devices for further research a novel platform for trunk muscle activation using mechanical stimuli was developed and successfully tested.

Patric Eichelberger

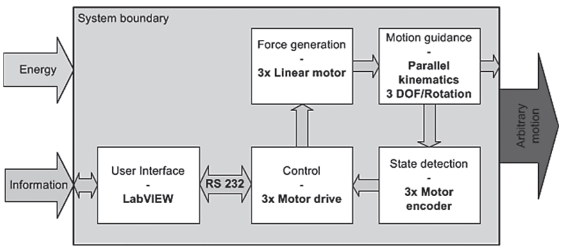
Introduction
The Swiss State Secretariat for Economic Affairs (SECO) amounts the economic costs caused by back pain to 4.3 billion per year. Recent studies propose stochastic whole body vibration exercise as an efficient method to treat back pain. Further research is necessary to better understand the mechanisms. Many commercial devices enabling whole body vibration training are already available today, but only few provide stochastic motion patterns. Furthermore, none of these allow to set up exactly defined stimulation patterns. Yet, the precise control over the stimulation pattern is crucial for a profound and systematic research in the field. Therefore, a novel device addressing those needs is required.

Materials and Methods
Requirements for a new research device that is able to activate the trunk muscles of the human body with mechanical whole body stimuli were defined. The most important point was to find the necessary degrees of freedom. The main challenge was to define the term **optimal stimulation**. The kinematics is designed in relation to the functional anatomy of the trunk muscles and it was found that stimulation must be applied over three rotational degrees of freedom. An input-output analysis brought out the system concept shown in the figure below. To estimate the loading conditions a body model based on anthropometric data was developed. The system was specified during the detailed study, which included calculations, definition of mechanical and electrical setup as well as the development of software and user interface.

Results
A functional prototype was developed based on which the functionality could be proven. The device provides a range of motion of +/– 13° around each of the three rotation axes. The parallel kinematics together with the linear motors leads to low internal inertia and therefore permits high accelerations. Amplitudes larger than 1° can be generated with frequencies of up to 15 Hz. The prototype allows to set up arbitrary rotation axes and to perform harmonic oscillations around them. Stochastic motion can be introduced through random variation of frequency, amplitude or rotation axis.

Discussion
The current development provides a new and unique research tool to any researcher interested in the interaction between human and mechanical whole body stimuli. The new system offers a stimuli generation dependent on the research needs. Researchers do not have to rely on commercial devices anymore that offer only a limited range of oscillation settings. Through its flexible stimulation patterns, our system enables a broader research that aims to better understand the effects of mechanical whole body stimuli onto the human. We expect that the effectiveness of stochastic whole body vibration for reducing back pain can be proven in the future and that in this way the current development helps people suffering from back pain.

Acknowledgements
The project was supported by the Institute for Sport Sciences, University of Bern and from the industry partners idiag AG and Girsberger AG. Their contribution is gratefully acknowledged.



System concept with a parallel kinematic mechanism providing three rotational degrees of freedom.