Foot-Stimulation Module (FSM) for a Robotic Tilt-Table

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The aim of this master thesis was to develop a new vibration therapy device to modify the existing tilt-table Erigo. This foot-stimulation module has the possibility to stimulate various foot zones at different times. Applied mechanical vibrations are strong enough to activate the human body. The developed device is a promising addition to the robotic tilt-table.

Introduction

Robotics-assisted tilt-table technology has recently been introduced in the field of neurological rehabilitation. This is applied to patients with a variety of impairments including stroke and spinal cord injury. The Erigo system (Hocoma AG) is a leading product in the market. Erigo is a tilt-table with two actuators which move the legs in a cyclical gait-like pattern. It has been shown that an adequate stimulation during the cyclic movement of the lower limbs activates the relevant sensory-motor areas in the brain. This is very important for the restoration of functional capacity after neurological injury or disease. Therefore, it has been hypothesised that an additional foot-sole vibration module for the Erigo can activate further sensory-motor areas.

Materials and Methods

Firstly, a research phase was undertaken to evaluate the technical state of the art concerning vibration devices as well as the physiological background. The knowledge of the technical, as well as the physiological requirements provided the possibility to combine these two fields. This phase concluded with a design proposal. The design process during the second phase was marked by the evaluation of various actuator systems. After a decision on the basic principle was made, three different stages of functional prototypes were built. These prototypes were based on the results of the prior prototype. The final stage was concerned with an analysis of the produced vibration and the modification of the latest prototype.

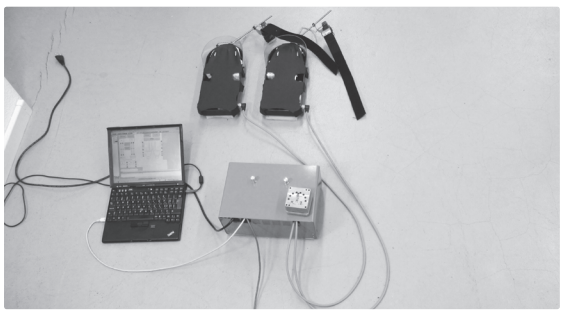
FSM is combined with the Erigo to stimulate different foot zones depending on the actual leg position.

Results

The research phase showed that variable vibration intensities are more beneficial than permanent vibrations. Due to this finding, a novel vibration device was developed which, despite its compact size, can stimulate three different foot zones. The quantification of vibration showed that the oscillations move in all directions and varied strongly with respect to frequency and amplitude.

Discussion

A foot stimulation module was developed, which can stimulate various foot zones in accordance with different positions of the leg. Tests showed that there are physical limits for the FSP which cannot be changed easily. Applied mechanical vibrations are powerful enough to stimulate the human body strongly. The developed device is a promising addition to the Erigo. Physiological and clinical studies are planned for the near future.



The individual parts of the developed FSM with the foot shells, control box and laptop.

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