

# Further Development and Performance Evaluation of Functional Movement Stimulator

Francesco Bonanomi



Supervisor(s): Prof. Dr. Juan Fang, Prof. Dr. Sebastian Tobler  
Institution(s): Bern University of Applied Sciences,  
Institute for Human Centered Engineering  
Examiners: Prof. Dr. Juan Fang, Prof. Dr. Sebastian Tobler

## Introduction

Patients with neurological conditions such as spinal cord injury, multiple sclerosis and stroke face a range of physical and cognitive challenges. These conditions have a significant impact on the quality of life of patients and require specific and personalised interventions for their treatment and recovery [1]. The Functional Movement Stimulator (FMS) is a prototype device developed at the Bern University of Applied Sciences in collaboration with GoByYourself SA (GBY) with the intention of using it as a rehabilitation device in the future. Its outstanding feature is the integration of different exercises and movements in a single device, allowing a combination of sit to stand exercises, arm-leg cycling and rowing. The aim of the project is to develop an innovative automatic seat to assist patients during their rehabilitation process.

## Materials and Methods

The initial analysis of the sit-to-stand, cycling and rowing exercises was crucial in determining the specific seat requirements, such as the optimum height from the floor and distance from the front of the machine for each exercise. The seat was then divided into three main functions: a lifting system for vertical movement, a sliding system for forward and backward movement and a backrest system for backrest adjustment. In addition, a knee system was developed to secure the knees during the sit-to-stand exercise. The entire seat system was developed using Siemens NX. Three motors were used to implement these functions and TwinCAT was used to control them. The overall CAD concept of the FMS was optimised, and a new version of the entire machine was proposed.



Figure 1: The final FMS' automatic seat.

## Results

The seat can be adjusted in height by 30cm, forwards and backwards by 50cm, and the backrest can be tilted by 50°. The synchronisation between seat and backrest during the exercise was promising.

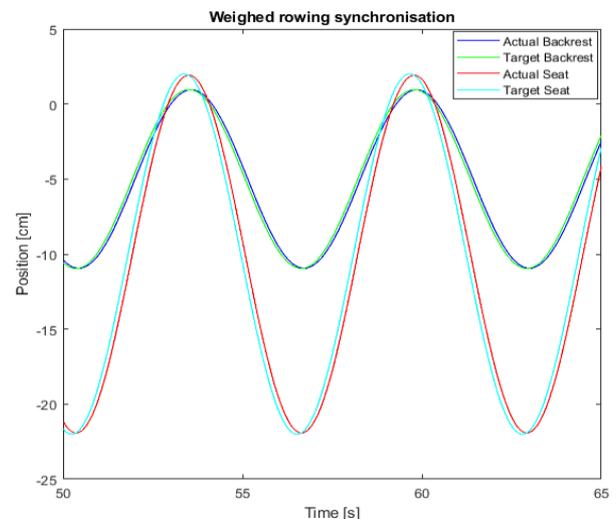


Fig. 2: Weighted rowing synchronisation.

## Discussion

The results obtained are in line with what was previously hypothesised and developed during the materials and methods phase. The solution is simple, cost-effective, and aesthetically pleasing. All the movements studied are automatic and no significant differences were observed between the target inputs given to the seat and the actual outputs that the seat performs.

## References

[1] Y. Al'joboori, S. Massey, S. Knight, N. Donaldson, and L. Duffell. The effects of adding transcutaneous spinal cord stimulation (tscs) to sit-to-stand training in people with spinal cord injury: A pilot study. *Journal of Clinical Medicine*, 9:1–22, 9 2020.

## Acknowledgements

I would like to thank my supervisors, Prof. Dr. Juan Fang, and Prof. Dr. Sebastian Tobler, for their invaluable advice and support throughout this project. I would also like to thank Dr. Edeny Baaklini and Dr. Efe Anil Aksöz for generously sharing their experience with me.