Optimal Patient Treatment Speed Determination for Spinal Musculoskeletal Disorder

Degree programme: BSc in Mechatronics and Systems Engineering (Medical technology | Robotics)
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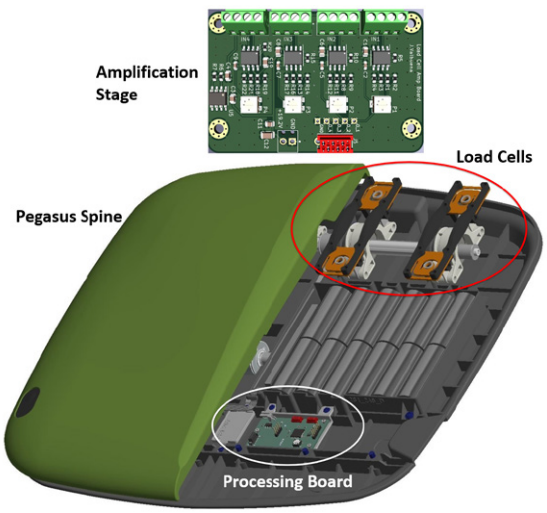
Spinal musculoskeletal disorders cause autonomy loss in the elderly, leading to high healthcare costs and increased risks of depression and chronic illnesses. Movement Sciences developed the Pegasus Spine to mimic spinal rotation during walking by alternately lifting the shoulders. The goal is to automate and integrate the determination of the optimal treatment speed using a concept that measures the body's lateral movement on the device.

Introduction

A BFH project in a residential care revealed that certain treatment speeds with the Pegasus Spine cause the body to move sideways, which can be perceived as unpleasant. The project relied on a pressure sensor array capable of identifying the onset of the resonance behavior as an ideal feature to determine the optimal treatment speed. In a previous Bachelor's thesis, measurements confirmed that this body response and the optimal treatment speed could be found using load cells (weight sensors).

Methods

To ensure precise load cells readings and lateral motion detection in the Pegasus Spine, a compact, battery-powered PCB with instrumentation amplifiers was designed. The STM32 microcontroller was chosen for its low power consumption, computing power, and memory management, ideal for real-time algorithms and future upgrades. An electronic board incorporating this microcontroller is designed to be integrated into the Pegasus, processing the data in real time and communicating the results to the main existing electronics. During testing, a person lies on the Pegasus, aligning the spine with the center line, while the speed is gradually increased and body movement is analyzed by the microcontroller. At the end of the test, the microcontroller proposes an optimal treatment speed. The stability of this speed was evaluated through five tests on the same person and additional tests on four others.

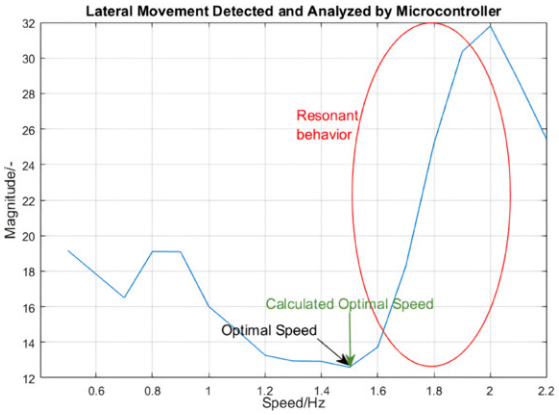


Results

The algorithm implemented within the microcontroller allows for automatic determination of the optimal speed. In four out of five measurements for the same person, the calculated optimal speed matched the actual speed. For the other three individuals, it was 100% accurate, with only a 0.1Hz difference observed for the last person.

Conclusion

The amplification stage ensures accurate load cells readings and precise lateral motion detection. The microcontroller programming confirms concept viability and treatment speed stability, leading to full automation. The electronic board integrates seamlessly with Pegasus mechanics and electronics. Additionally, automation can be enhanced by integrating presence detection using a threshold on the load cell signals.



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