MetaMotion Meter: IoT-Driven Biomechanical Device for Enhanced Hand Rehabilitation and Recovery Monitoring

Namjoshi, Zara (School: Ecole Mondiale World School)

The MetaMotion Meter is a biomechanical assistive device designed to advance hand physiotherapy by offering real-time feedback measurement of pressure exerted by the hand during physiotherapy, muscle force, and tremor frequency during rehabilitation. Physiotherapy currently relies on subjective assessments, which often hinder accurate measurement of recovery, particularly in cases involving arthritis, carpal tunnel syndrome, or post-stroke treatment. The project aims to address these limitations by integrating sensors, including the MPX5050 for pressure measurement and IMU6050 for tremor tracking. These sensors help physiotherapists capture accurate, objective data on hand stability and strength. The device's multiple ergonomic grip designs evolved through prototype testing, improving its usability across different hand sizes and grip strengths, the three final grips were conical, cylindrical, and hexagonal, after several iterations of hand fit and force vectoring capabilities. constructed from Thermoplastic Polyurethane (TPU), the meter's structure and spring stiffness are tailored to each patient's physical abilities, with stiffness adjusted by swapping springs to measure various force levels. Also, FSRs are added at the end of the fingertip to measure and quantify the pressure by each of the fingers separately. The MetaMotion Meter was tested over three months with 180 physiotherapy patients, yielding valuable insights: as spring tension increased, hand stability decreased, and hand jitter frequency rose. These patterns were confirmed through statistical analyses, providing a quantifiable assessment of hand strength and tremor control. This innovation in physiotherapy promises a more tailored, data-driven approach to rehabilitation, allowing for focused treatment.

Awards Won: