Neuromuscular Biomechanics Test System
using MCC 172 and Raspberry Pi®

Introduction

The Neuromuscular Biomechanics Laboratory at the University of Wisconsin-Madison conducts research on the biomechanics and neuromuscular coordination of human movement, with applications in orthopedics and rehabilitation. Computer simulations are used to characterize musculotendon dynamics, estimate internal loadings, and test principles guiding movement control. The overall goal of the research is to establish a scientific basis for the clinical treatment and prevention of impairments that limit locomotor performance.

The Challenge

Shear wave tensiometry is a non-invasive technology that facilitates measurements of muscle-tendon loading during motion. It has traditionally been done with benchtop systems which confine usage to laboratory environments. A Raspberry Pi-based solution allows the data acquisition to be performed in a portable package, liberating experiments to explore real-world biomechanical behavior.

The Solution

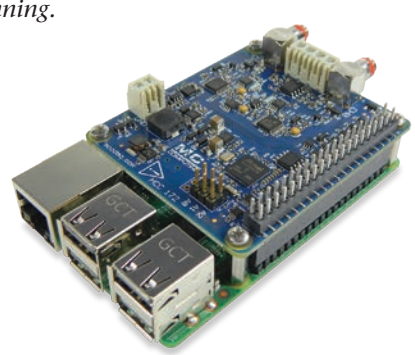
A shear wave tensiometer is a first-of-its-kind sensor which can non-invasively track tendon forces inside the body during dynamic activities (e.g. walking and running). The applications for tensiometers can be expanded tremendously if the sensor can be made portable and wearable in non-laboratory environments. High-speed, reliable data acquisition is critical for the success of a wearable tensiometer.

For one tensiometer, two single-axis accelerometers are sampled at 51,000 Hz, which is done on a single MCC 172 IEPE Measurement HAT. For multi-tensiometer experiments, two HATs are used to acquire data on two tendons simultaneously.

The system consists of a Raspberry Pi 4B, two MCC 172 HATs, and two single-axis accelerometers. Triggering is supported remotely by a Pololu Wixel, a general-purpose programmable module featuring a 2.4 GHz radio and a USB interface.

The system was programmed using Python™ scripts for continuous, multi-HAT acquisition. Post-processing of data is done in MATLAB®.

The small size of the Raspberry Pi and MCC 172 allowed researchers to create a lightweight and wearable DAQ solution to measure dynamic activity during walking and running.



The MCC 172 is an IEPE measurement DAQ HAT for Raspberry Pi with 2 simultaneous inputs, 24-bit resolution, 51.2 kS/s/ch sample rate and 1 digital input.

Result

The completed system is a small, portable solution that allows researchers to measure biomechanical behavior of tendons in real-world settings.

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