Supplementary Information: TetriKinesis

Lauren Adams, Emily Yemington, & Siem Yonas
Department of Biomedical Engineering, University of Texas at Austin, TX, USA

Table of Contents

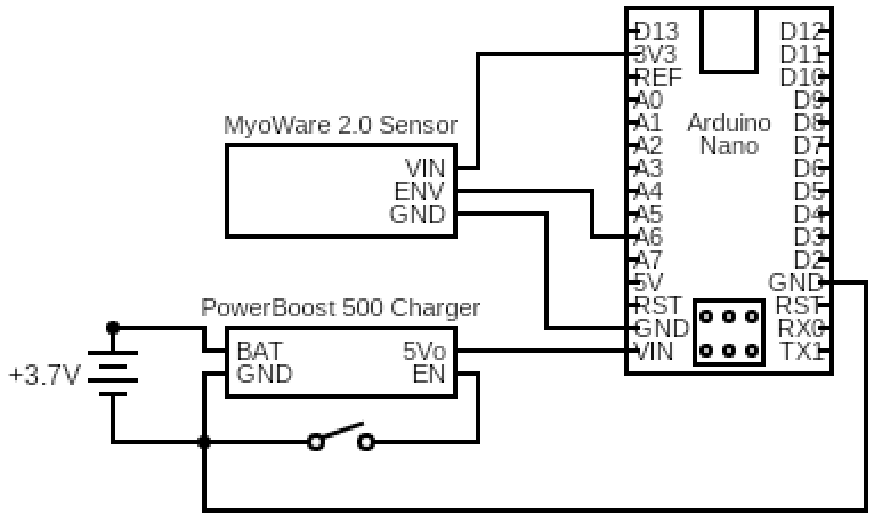

Fig S1. Electrical Schematic

An electrical schematic demonstrating the connections between four main components: a MyoWare® 2.0 myosensor [1], an Arduino® Nano 33 BLE [2], an Adafruit® Powerboost 500 Charger [3], and a 3.7V rechargeable LiPo battery [4].
The PowerBoost Charger uses the 3.7V battery to output a constant 5V to the Nano, which powers the myosensor with 3.3V. A toggle switch between the GND and EN pins of the Powerboost Charger allow the device to be powered off between uses. The ENV pin of the myosensor outputs muscle contraction data to an analog input pin (A6) of the Nano.

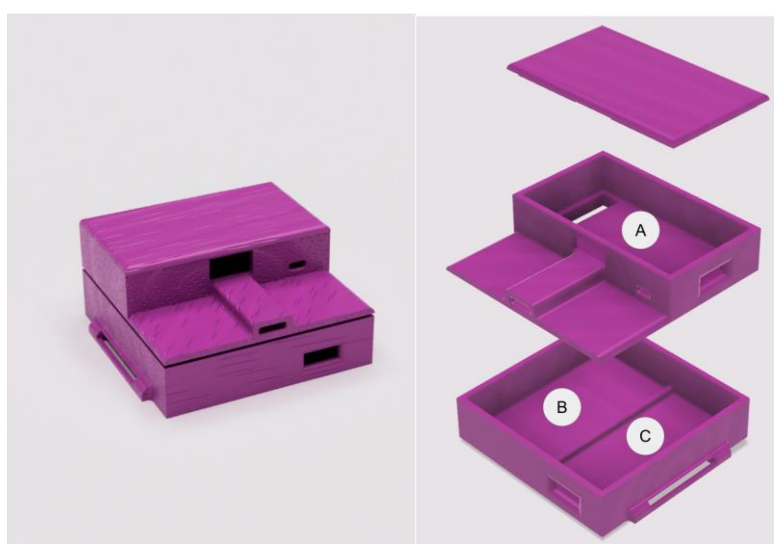

Fig S2. CAD Rendering of Device Casing

Rendering of device casing design, as printed in pink-colored PETG. The casing houses the majority of the electrical components, with the exception of the myosensor: Area A houses the Adafruit® Powerboost 500 Charger, area B houses the 3.7V rechargeable LiPo battery, and area C houses the Arduino® Nano 33 BLE. Ports are cut out into the sides of the casing, allowing for micro-USB access to both the charger and microcontroller, as well as wired access to the myosensor.

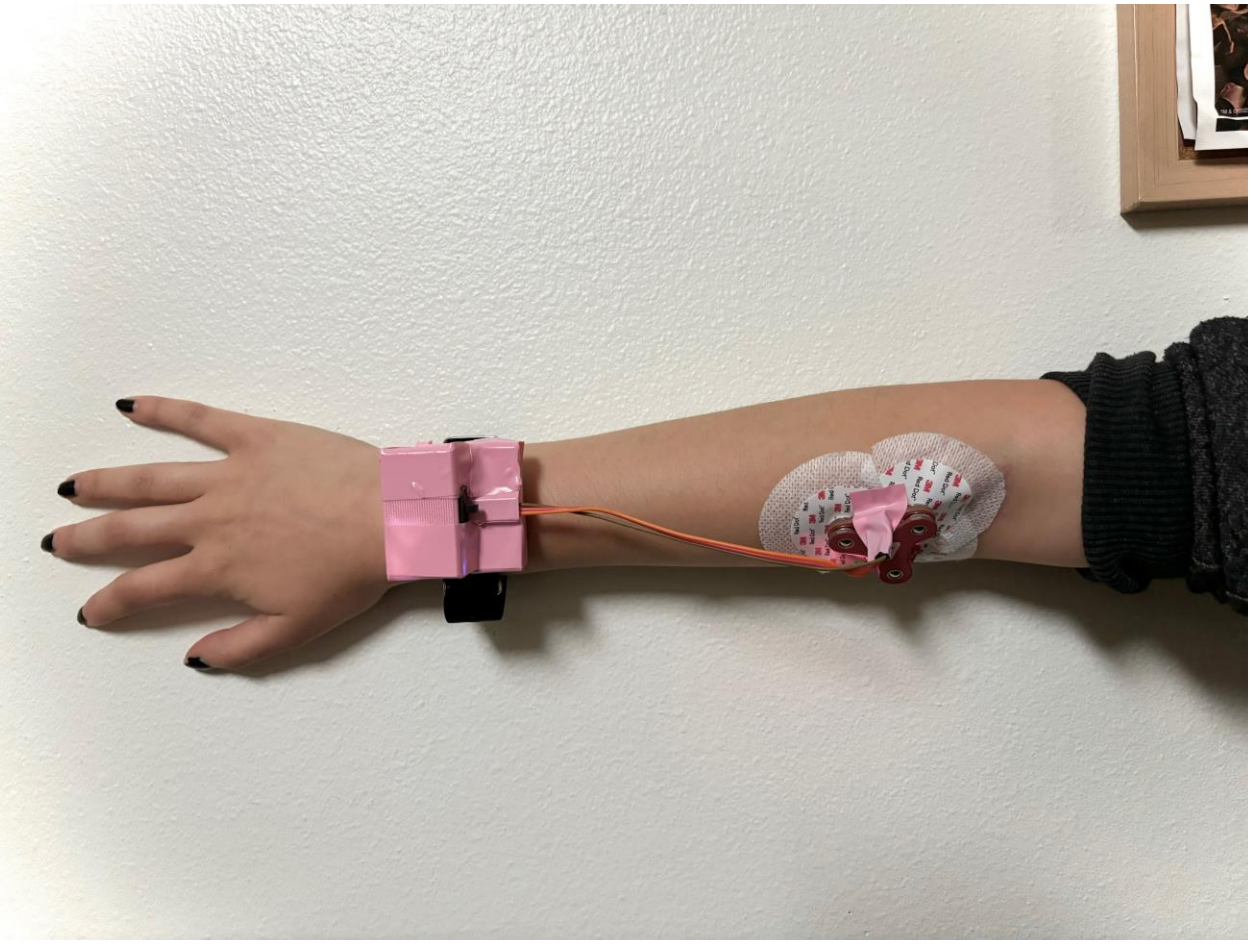

Fig S3. Image of Device On Wrist, Myosensor Connected To Brachioradialis Muscle

Photograph of the TetriKinesis controller worn on the wrist, with the myosensor attached to the brachioradialis muscle using sticky EMG pads. Though the controller is attached to the wrist and brachioradialis for demonstration purposes, it can be worn on any body part capable of swiping and rotating, and the myosensor can be attached to any muscle that can be read by EMG [5].

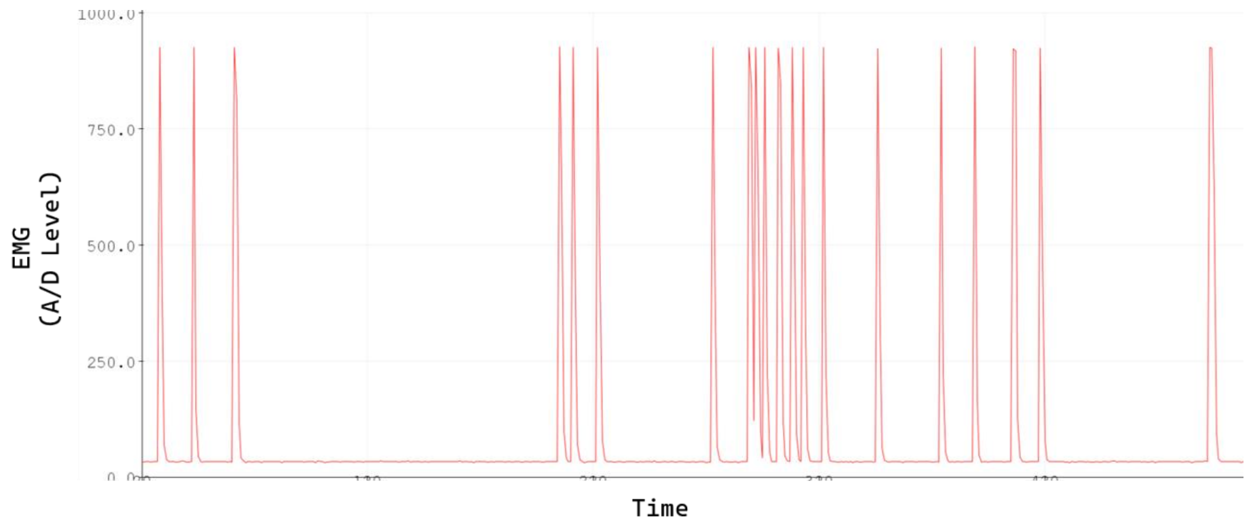

Fig S4. Myosensor Output and Thresholding

Example Arduino myosensor trace with multiple flexions. When the myosensor voltage exceeds the threshold (see Table S1) while rising, a flexion is read.

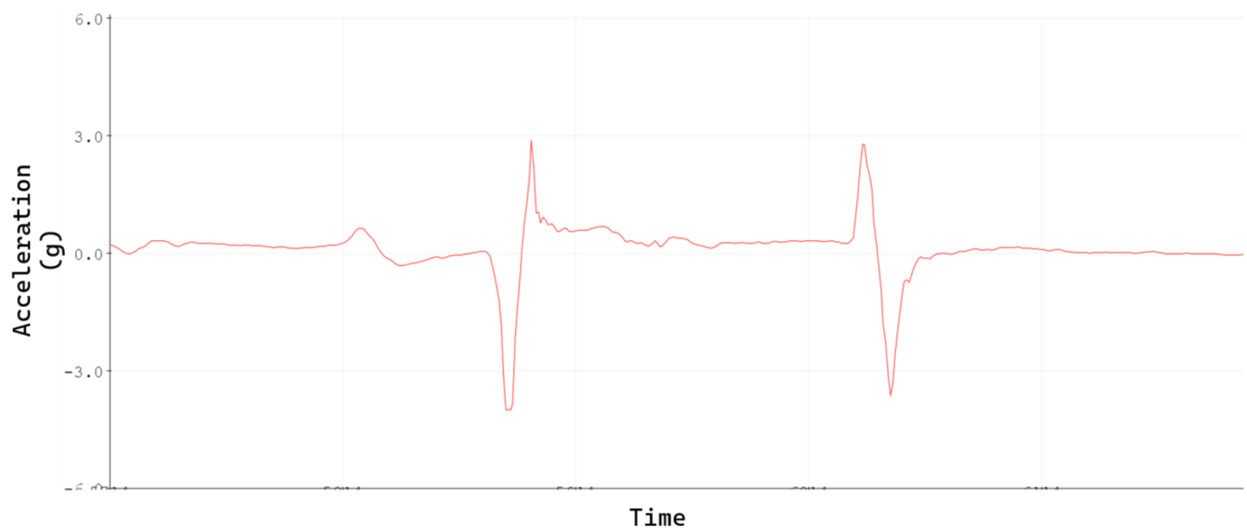

Fig S5. Accelerometer Output and Thresholding

Example Arduino accelerometer trace of a left swipe followed by a right swipe. When the accelerometer reading exceeds the positive threshold (see Table S1), a right swipe is read [6],[7]. Likewise, when the negative threshold is exceeded (see Table S1), a left swipe is read. After a swipe is read, all IMU outputs are debounced for 500 ms.

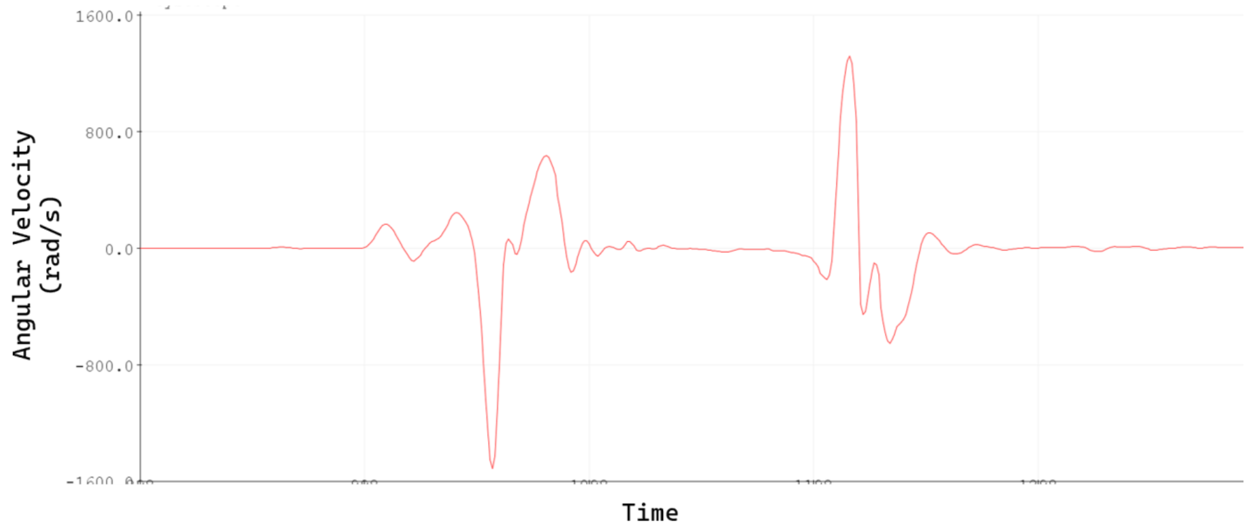

Fig S6. Gyroscope Output and Thresholding

Example Arduino gyroscope trace of a counterclockwise rotation followed by a clockwise rotation. When the accelerometer reading exceeds the positive threshold (see Table S1), a clockwise rotation is read [8]. Likewise, when the negative threshold is exceeded (see Table S1), a counterclockwise rotation is read. Just like the accelerometer, after a rotation is read, all IMU outputs are denounced for 500 Ms.

Sensor	Motion	Threshold	Key Binding	Tetris Control
Myosensor	Brachioradialis flexion	> ~2.26 V (A/D Level 700)	“M”	Hard drop
Accelerometer	Right swipe	> 2.5 g	“R”	Move Right
	Left swipe	< -2.5 g	“L”	Move Left
Gyroscope	Clockwise (Right) rotation	> 1000 deg/s	“A”	Rotate Right
	Counter-clockwise (Left) rotation	< -1000 deg/s	“C”	Rotate Left

Table S1. Sensor Thresholds and Key Binding

Five motions as measured by three sensors and their corresponding signal thresholds. Each motion is assigned a letter used to communicate with bluetooth-connected devices as described in Supplementary File 2. For proof-of-concept, each letter can be associated with a movement in the game Tetris®, which includes hard drops, lateral movement, and rotational movement.

For all IMU (gyroscope and accelerometer) readings, there is a 500 ms debounce period to prevent errant inputs. The myosensor only triggers one input per input pulse.

Supplementary File 1. CAD Drawings of Device Casing | TK_Drawings.pdf

Three CAD drawings of the casing: “Tetrikinesis Casing” shows projected views and key dimensions of the casing as a whole; “Tetrikinesis Layer 1” shows the bottom layer of the casing, where the microcontroller and battery are housed (see Fig S2); “Tetrikinesis Layer 2” shows the top layer of the casing, where the charger is housed and where the wires connected to the myosensor exit the case.

Supplementary File 2. Code Uploaded To Microcontroller | Tetrikinesis.ino

Code uploaded to the microcontroller to evaluate sensor data and to control a bluetooth-connected device. The microcontroller acts as a bluetooth keyboard and sends letters ‘M’, ‘R’, ‘L’, ‘A’, and ‘C’ based on the key binding and sensor thresholds as shown in Table S1.

References

[1] “MyoWare 2.0 Muscle Sensor - DEV-21265 - SparkFun Electronics,” *www.sparkfun.com*. https://www.sparkfun.com/products/21265

[2] “Arduino Nano 33 BLE,” *Arduino Online Shop*. https://store-usa.arduino.cc/products/arduino-nano-33-ble?selectedStore=us

[3] A. Industries, “PowerBoost 500 Charger - Rechargeable 5V Lipo USB Boost @ 500mA+,” *www.adafruit.com*. https://www.adafruit.com/product/1944 (accessed Apr. 30, 2024).

[4] “Amazon.com: 3.7V 703050 1000mAh Lithium Polymer ion Battery Rechargeable Polymer Battery Pack with JST 2.0mm Connector : Health & Household,” *www.amazon.com*. https://www.amazon.com/703050-1000mAh-Lithium-Rechargeable-Connector/dp/B0C2KQ5T9X (accessed Apr. 30, 2024).

[5] K. Tatarian, M. S. Couceiro, E. P. Ribeiro, and D. R. Faria, “Stepping-stones to Transhumanism: An EMG-controlled Low-cost Prosthetic Hand for Academia,” Sep. 2018, doi: https://doi.org/10.1109/is.2018.8710489.

[6] “Accelerometer Basics - SparkFun Learn,” *learn.sparkfun.com*. http://learn.sparkfun.com/tutorials/accelerometer-basics?_ga=2.75704733.940991030.1714201257-436762418.1714201257 (accessed Apr. 30, 2024).

[7] D. Qiao, G. K. H. Pang, Mui Man Kit, and D. C. C. Lam, “A new PCB-based low-cost accelerometer for human motion sensing,” Sep. 2008, doi: https://doi.org/10.1109/ical.2008.4636119.

[8] “Gyroscope - SparkFun Learn,” *learn.sparkfun.com*. http://learn.sparkfun.com/tutorials/gyroscope/all#:~:text=When%20the%20gyro%20is%20rotated (accessed Apr. 30, 2024).