Instrumented Assessment of Abnormal Muscle Reaction

Rachel Coryell – Biological Engineering
Faculty Mentor – Dr. Trent Guess, Associate professor
Contributor – Dr. Jamie Hall, Assistant Teaching Professor

MAC
MIZZOU MOTION ANALYSIS CENTER

Introduction

- Muscle spasticity affects millions of people worldwide.
- Unfortunately, it is very difficult for health care professionals to manually assess the severity of the patient's muscle spasticity with accuracy, and thus makes it difficult to determine the appropriate treatment.
- To combat these difficulties, an automated method using two sensors was developed for the measurement of the spastic joint angle.
- Throughout the course of the experiment, it became apparent that the spasticity has a very clear signature in the position data.
- This signature allowed for the identification of the joint angle and velocity at the moment of spasticity.
- After further refinement, this device has the potential to make diagnosis and treatment of muscle spasticity easier and more accurate.

Modified Tardieu Scale

- The Modified Tardieu Assessment involves manipulating the joint rapidly (the spasticity is often velocity dependent) until the therapist feels a sudden resistance, the R1 catch.
- The joint angle can be found by estimating the approximate configuration at which the spasticity occurred and using the goniometer to measure the joint angle at that configuration.
- This method is not very accurate in determining the joint angle, a value that physical therapists use to select and evaluate muscle spasticity treatments, and improvements are needed to improvement muscle spasticity assessment.
- This method is also not able to measure the spastic velocity, a value that potentially could make the assessment more consistent.

Photo credit: https://www.youtube.com/watch?v=A0Cqoqa4Rno

Materials - Sensors

- Polhemus PATRIOT ™ sensors
  - Able to track six degrees of freedom
  - Ideal for measuring position and orientation in real time
  - Chosen for their availability and performance

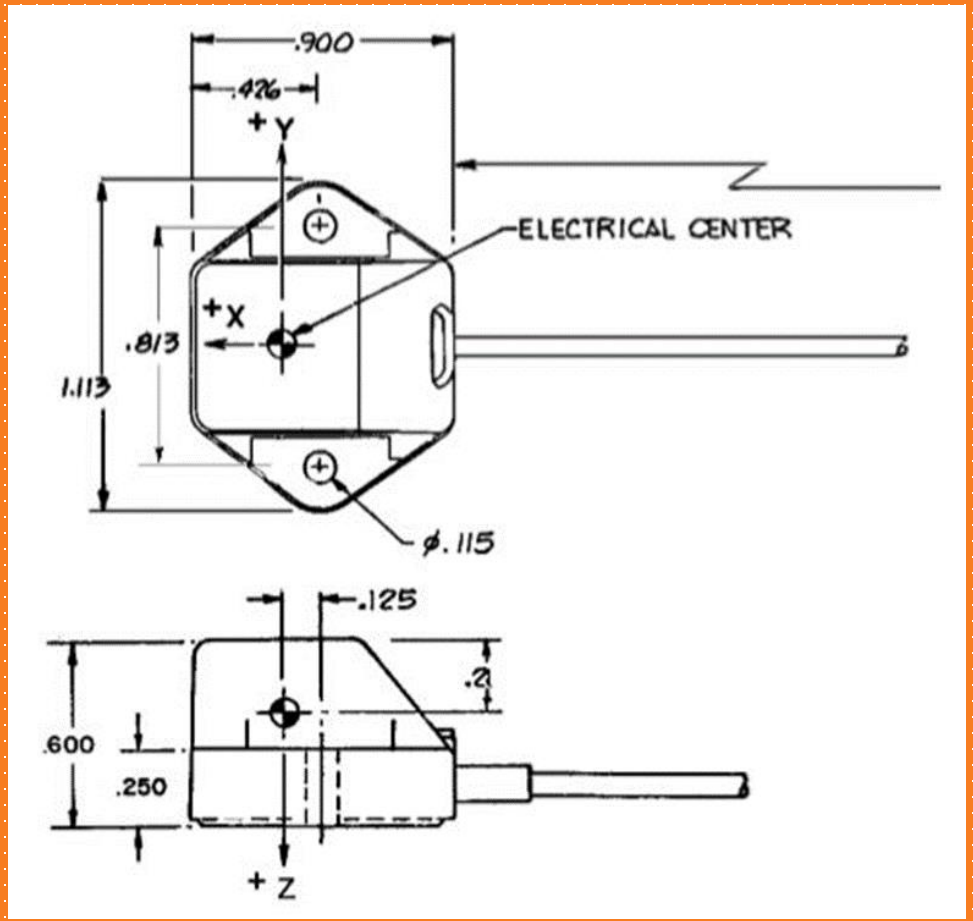
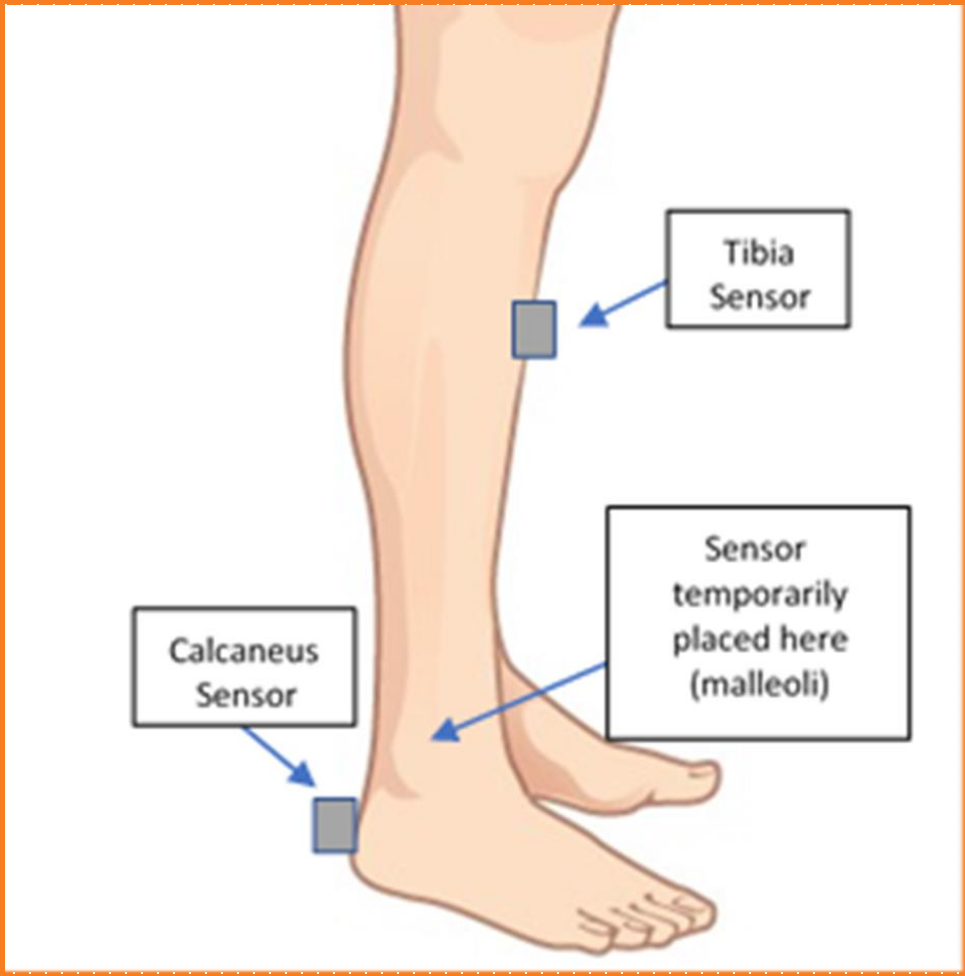


Photo credit: https://polhemus.com/_assets/img/PATRIOT_brochure.pdf

Assessment & Sensor Placement

- Attach tibia sensor
- Record lateral malleoli position
- Record medial malleoli position
- Attach calcaneus sensor
- Record neutral position
- Record Modified Tardieu Assessment

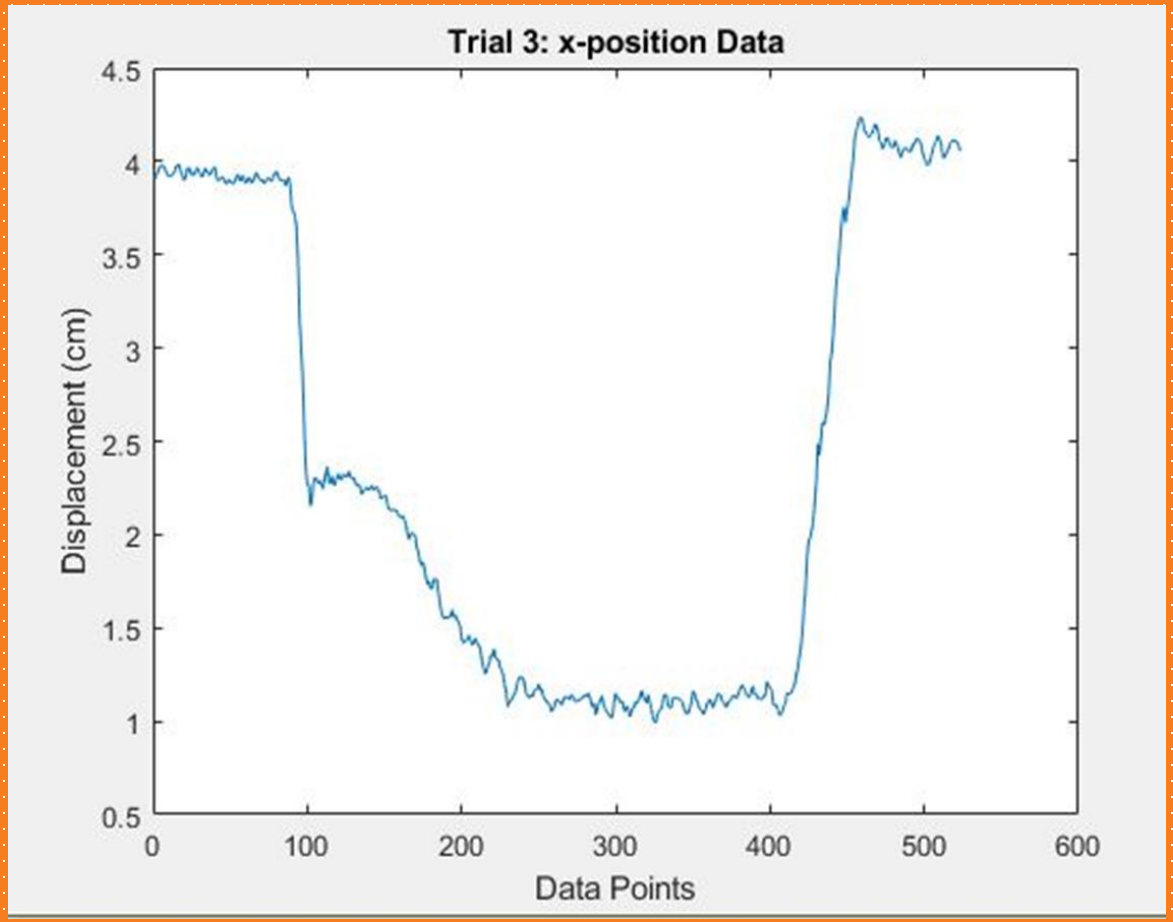


Unedited image Case courtesy of Assoc Prof Craig Hacking, Radiopaedia.org, rID: 59080

Methods –MATLAB Code

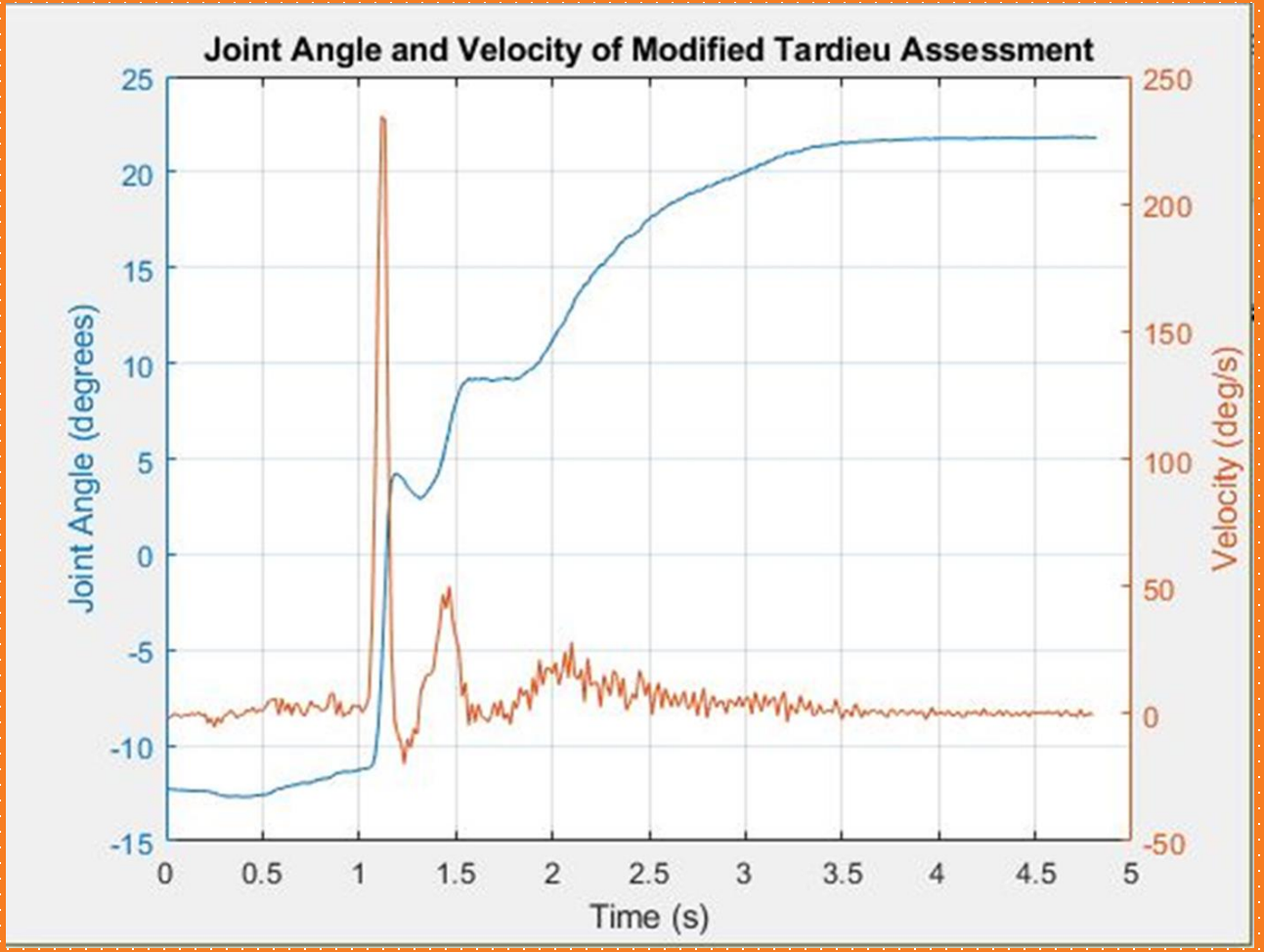
- Four inputs: lateral malleoli text file, medial malleoli text file, neutral position text file, and Modified Tardieu Assessment text file
- Two outputs: joint angle and joint velocity
- The code uses the relative position and orientation (quaternions) of the sensors to determine the joint angle and spastic joint velocity

Spastic Catch Signature - Position



Results

- Average spastic joint angle (for single individual): 4.663 degrees
- Average spastic velocity (for single individual): 226.8 deg/sec



Discussion

- Potential future work:
  - Determining the reliability of the method on different individuals
  - Analyzing the accuracy of the outputted data
  - Use in clinics and biomechanics research
  - Development of a rigid attachment system for the sensors
  - Adaptation for different spastic muscles other than the gastrocnemius

Conclusion

- Muscle spasticity affects millions of people worldwide and this device has the potential to aid in the assessment and treatment of these people.
- This design process has been able to successfully develop a device that can measure and output the joint angle and velocity at the moment of muscle spasticity.
- The device has demonstrated consistency with the estimated joint angle values given by a physical therapist.
- Further work should be continued on this project to assess the accuracy and reliability of the design as well as possible applications.