Team 17
Dynamic Muscle Recorder

By:
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Outline

- Purpose
- Previous Works
- Objective
- Specifications
- Components
- Budget
- Methods
Client

- Biomedical Engineering Department

- Dr. Enderle
  - Received his B.S., two M.E.s and his Ph.D. from Rensselaer Polytechnic Institute. He joined the faculty at the University of Connecticut in 1995.
Purpose

- Undergraduate biomedical engineering labs require cheaper muscle recorder
- Students explore muscle characteristics
  - Relationships between electrical/mechanical properties of skeletal muscle
  - Exposed to modeling and optimization.
    - Useful for various fields.
- Utilize LabVIEW/simulink skills towards a meaningful application.
Previous Works

- UCONN PNB (Human anatomy and physiology lab)
- Aurora Scientific
  - 305C-LR Dual Mode Lever System
- PowerLab
  - Data Acquisition Systems
- Fall 2007 Senior design project – Muscle Recorder
Objective

- Design device that is able to measure muscle properties of the frog gastrocnemius muscle
- Device to be used in undergraduate BME Biomeasurements lab
Specifications

- Must be low cost, in range of $200-$300
- Capability to interface with National Instruments hardware and LabVIEW
- Ability to perform two separate experiments: isotonic and isometric muscle contractions
- Deploy with MATLAB program that optimizes a theoretical muscle model according to experimental data and provides capacity to simulate experiment in Simulink
Isometric vs. Isotonic

- **Isometric, “having equal measure”**
  - Length of muscle kept constant during each trial
  - Muscle does not shorten during contraction

- **Isotonic, “having equal tension”**
  - Constant load on muscle during each trial
  - Muscle allowed to shorten during contraction
Isometric vs. Isotonic
Components Overview

- Device to have two separate apparatuses, for isometric/isotonic experiments
  - Electric stimulator to be used to stimulate muscle
    - Stimulator controlled with LabVIEW
  - Force and rotation sensors incorporated to transduce information into electrical signal
  - Signals sent through National Instruments hardware and to LabVIEW for recording
The manufactured device is estimated to be 35% of the prototype cost, which allows for $850 for development.

<table>
<thead>
<tr>
<th>Item</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tekscan FlexiForce force sensor</td>
<td>$65.00 (4-pack)</td>
</tr>
<tr>
<td>Phigets 1109 rotation sensor</td>
<td>$7.00 each</td>
</tr>
<tr>
<td>Set of laboratory masses</td>
<td>~20.00</td>
</tr>
<tr>
<td>Electrode stimulator</td>
<td>~50.00</td>
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<tr>
<td>Power amplifier</td>
<td>TBD</td>
</tr>
<tr>
<td>Aluminum metal</td>
<td>&lt; $50.00</td>
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<tr>
<td>Miscellaneous</td>
<td>TBD</td>
</tr>
<tr>
<td>Projected prototype total</td>
<td>$100 - $200</td>
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</table>
**Muscle Model**

- **Theoretical:** 5 parameter model developed by Dr. Enderle (pictured right)
- **Animal Model:** leopard frog gastrocnemius
- **Procedure**
  - Collect data from animal model
  - Optimize theoretical model parameters
  - Reproduce isotonic experiment with theoretical model

![Diagram of muscle model with symbols: B_1, B_2, F(t), K_{se}, K_{lt}]](image)
Isometric Experiment

- The Length/Tension curve
  - Constant length per trial
  - Record force/time history
  - Several trials at different lengths
  - Max force at each length

- Key component: Force transducer
  - FlexiForce sensor, by Tekscan
  - Force sensitive resistor
Isotonic Experiment

- The Force/Velocity curve
  - Constant force per trial
  - Record length/time history
  - Several trials under different loads
  - Max velocity under each load
- Key component: Rotation transducer
  - 1109-Rotation Sensor by Phidgets
  - Complete circuit with shaft, voltage output
Data Acquisition and Processing

- Labs equipped with National Instruments interface
- LabView software
  - control stimulation
  - Record data
  - process data, length/tension and force/velocity curves
- Matlab optimization routine
  - Determine model parameters
- Simulink
  - Determine model differential equations
  - Simulate isotonic experiment
Conclusion

- Muscle Recorder which will cost several times less than market value.
- Lab setup will conduct for isometric and isotonic experiments to determine mechanical/electrical muscle relationships and allow for them to be modeled.
Acknowledgements

- Dr. Enderle
- Daniel Sierra
- Dave Kaputa
Questions?