Muscle Recorder

Roua Taha
Angela Correa
Mark Mazmanian
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Background

Client:

Dr. John D. Enderle
Program Director and Professor
University of Connecticut
A.B. Bronwell Building, Room 217
260 Glenbrook Road, Unit 2247 Storrs, CT 06269-2247
Phone: (860) 486-5838 Fax: (860) 486-2500
Email: jenderle@ engr.uconn.edu
Web: www.engr.uconn.edu/~jenderle
Statement of Need

The University of Connecticut’s BME Dept. has requested a muscle recorder for use in the program’s Biomedical Engineering Measurements course. The device will allow the students to understand the mechanics of muscle contraction by recording the force-velocity and length-tension relationships for a variety of muscles. Moreover, the students will learn how the LabVIEW® program operates in conjunction with the experiment in order to gain as much knowledge and practice in the course.
Related Works

- ELECTRONIC MUSCLE/NEUROMUSCULAR STIMULATORS: The Electronic Muscle/Neuromuscular Stimulators are used in diagnosis, evaluation and treatment of muscle dysfunction caused by peripheral and C.N.S. (Central Nervous System) disorder.

- The High Voltage Electronic Galvanic Stimulator, model EGS100-2S, generates pulses from 1 to 120 per second at voltage from 0 to 500 volts to stimulate nerves, joints, and muscles in water.
U.S Patent 20070032750 by Oster, et al. A **Muscle Strength Assessment System** that determines patient's muscle strength of a lever arm comprising a leg, ankle, and foot. A value indicative of the strength is determined based on at least one eccentric and concentric pressure values associated with the lever arm, as well as at least one weight based. The values may be entered remotely or locally to a computer that outputs the value indicative of the strength.

U.S Patent 20060105357 by Benesch, et al. **Tissue Sensor**. A change in a biological parameter is measured by the sensor, such that a change occurring when the tissue is contacted is detected by the sensor. It includes a single sensor/tissue assemblies and arrays of such assemblies, including plates comprising tissues in combination with one or more sensors.
Optimal Design

- Overall Set Up
  - Overview
- Major subunits
  - Stimulator
  - Transducer
  - Hall Effect Sensor
Overall Set up
The muscle has to be stimulated by an electric pulse of about 12mA so that the muscle responds by contracting.

A muscle stimulator is simply a current pulse which is directly attached to the skeletal muscle.

LAB View® is capable of being programmed to deliver this current pulse on its own.

We need to deliver stimulation patterns, acquire and monitor the data through PCI-boards.

Once the software starts the stimulation sent to the muscle, it records the voltage from the Hall Effect sensor against the time.

A DAQ board to collect and store muscle force, angular position, and velocity data on the PC for later analysis is needed.
Transducer

- Takes the analog reading of how much force is produced and translates it into digital code (readable by a computer).

- LabVIEW® software is capable to acquire signals that will be provided via the User Interface.

- This acquisition can then be stored and read; in addition it can then be exported and used in Microsoft Excel.

- Measurement of isolated muscle under isometric conditions can be made by attaching one end of the muscle to a transducer and the other end to a fixed frame of reference.
The most common way to measure strain is with a transducer.

We will use a strain gage which is a force transducer.

The strain experienced by the test specimen is transferred directly to the strain gauge.

To measure the strain requires accurate measurement of very small changes in resistance.

To measure such small changes in resistance, strain gauges are almost always used in a bridge configuration with a voltage excitation source.
Hall Effect Sensor

Hall Effect is defined as the development of a voltage between the two edges of a current carrying conductor whose faces are perpendicular to a magnetic field, and a Hall Effect Sensor is a device that converts the energy stored in a magnetic field to an electrical signal by means of the Hall effect.
Graphs

- Force-Velocity Curve
- Length-Tension Curve

Figure 1: the force-velocity curve

Normal operating range
- total force
- passive force
- active force

Length (proportion of resting length)

Force (%age max contraction)
Equations

- \( F_{\text{net}} = ma \)
- \( F_{\text{net}} = \Sigma F \)
- \( F_{\text{net}} = F_{\text{gHall}} + F_{\text{gLever}} + F_{\text{gMasses}} - F_{\text{tMuscle}} \)
- \( W = U + K \)
- \( V = lwh \)
- \( V = IB \)
- \( \sigma = (L_f - L_o) / L_o \)
# Budget

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Conclusion

We would like to express our gratitude to our kind advisor and client Dr. John Enderle, who has been supportive of our group during the semester.

We would also like to thank Mr. William Pruehsner for his valuable input regarding our project design.
Questions