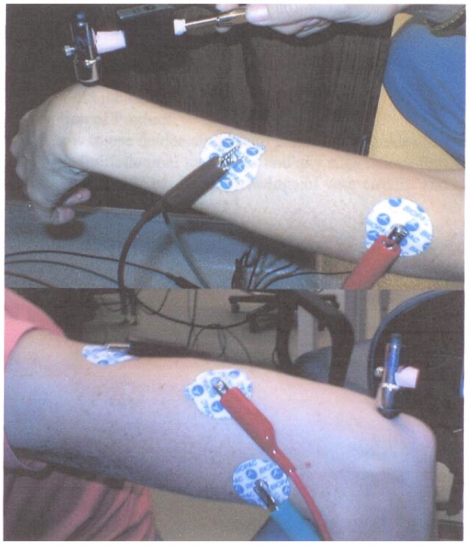
Project 2: EMG Reflex Assignment (EMG)

BIOE 385 Bioinstrumentation Laboratory

Introduction

You are a research engineer working at a major hospital in the Texas Medical Center. Your boss is interested in studying the reflex time associated with muscle response in patients with various neurological conditions. Your job is to create the biomedical instrumentation and documentation that is required to conduct the study.



Assignment

The following features are necessary in your device:

- The EMG signal must be collected with a circuit you design.
- You will have an instrumented reflex hammer for which you must also design appropriate circuitry.
- Each of these signals should be amplified and filtered appropriately and then collected simultaneously.
- You will display the data using LabView, and the user must be able to determine EASILY (if not in an automated manner) the time between the hammer strike and the muscle response.

Report Draft

Each group will turn in a report draft for their EMG-Hammer device (see schedule in syllabus). This draft will be evaluated by your peers and the instructor. The grade obtained in this assignment, as well as the quality of your evaluation of another group's device, will contribute 10 points towards your grade.

The report draft will consist of 2 parts:

1. **User Manual**

   You must write a User Manual that enables a health care professional such as a paramedic or nurse to setup and run the device (*only hardware*) without any previous training.

   Minimum requirements:

   - Detailed table of contents for all sections included in the draft
   - Summary and description of your device (*only hardware*)
   - Clear instructions explaining how to setup and use the device along with pictures and guides that are easy to follow (*only hardware*)

2. **Technical Specifications**

   The second part of the report should include technical specifications that allow other engineering teams to understand how your device is designed, modify it and make further improvements when necessary.

   Minimum requirements:

   - Appendices that include drawings of your circuits and explanations of technical aspects of the device.
   - Challenges associated with the interaction between living and non-living systems.

Longer is NOT better for the purposes of this assignment. A clear, concise, well-written report is preferred. Be sure to review the detailed grading rubric for your report draft in the course website.

Final Report

During the last week, each group will turn in a final EMG-Hammer Report for their device. You will also have the opportunity to demonstrate your device as part of the end of project test.

The final report will consist of 2 parts:

1. **User Manual**

   You must write a User Manual that enables a health care professional such as a paramedic or nurse to setup and run the device (*hardware and LabView program*) without any previous training.

   Minimum requirements:

   - Detailed table of contents
   - Summary and description of your device
   - Clear instructions explaining how to setup and use the device along with pictures and guides that are easy to follow

2. **Technical Specifications**

   The second part of the report should include technical specifications that allow other engineering teams to understand how your device is designed, modify it and make further improvements when necessary.

   Minimum requirements:

   - Clear descriptions of the limitations of the device and any suggestions for improvements.
   - Appendices that include the LabView Code, drawings of your circuits, and explanations of technical aspects of the device.
   - Challenges associated with the interaction between living and non-living systems.

Longer is NOT better for the purposes of this assignment. A clear, concise, well-written report is preferred. Be sure to review the detailed grading rubric for your final report in the course website.

Learning Objectives

Lab 1

Students should be able to:

- Use NI ELVIS Bode Analyzer to obtain a plot that describes a filter's response
- Explain the time constant and how voltage changes in an RC circuit as a function of time.
- Design and build passive filters (low-pass, high-pass, band-pass and band-stop) given a desired cut-off frequency
- Design and build active filters (low-pass, high-pass, band-pass and band-stop) given a desired cut-off frequency
- Explain the differences between active and passive filters
- Explain the differences between lower-order and higher-order filters
- Explain the differences between low-pass, high-pass, band-pass and band-stop filters
- Calculate the cutoff-frequency and time constant of a given filter

Lab 2

Students should be able to:

- Design and build a circuit to measure the output from a reflex hammer
- Calculate the gain and build circuits to amplify voltage using inverting, non-inverting and differential amplifiers
- Solder electrical components

Lab 3

Students should be able to:

- Determine the amplitude and frequency range of an EMG signal
- Explain how the electrical isolation circuit built in class works to protect the patient from the risk of exposure to high voltages or currents in the event of component failure
- Design a circuit to amplify and filter an EMG signal
- Justify the selection of components used to amplify the EMG signal (ie. 2-stage amplification, gain, instrumentation amplifiers, etc)
- Use OP07 and AD620 instrumentation amplifiers to design circuits.

Lab 4

Students should be able to:

- Modify properties of the DAQ to acquire the desired data
- Create digital filters using LabView
- Modify properties of waveform graphs and charts to correctly display the desired data (display correct labels, units, scaling, etc)
- Measure the time associated with a specific event using time stamps, counting iterations OR using other methods that allow a millisecond resolution
- Use a variety of controls and indicators to create an easy to use VI

Lab 5

Students should be able to:

- Set default values for indicators and control the range (maximum and/or minimum value) that the user can manipulate
- Display data from different channels in the same graph or chart
- Merge and split signals
- Store results in a table (front panel) and save them into a file
- Use Inputs from the Express functions in LabView to acquire and simulate signals
- Use Structures, Arrays, Numeric, Boolean, Comparison, File I/O, Timing and Strings from the Programming functions in LabView to create user friendly VIs
- Justify the selection of components used in the circuits designed in lab
- Explain the LabView VI built to calculate reflex time
- Identify and describe the main limitations of your device