

Lab 5: Blood Pressure Measurement & Electromyography

INTRODUCTION:

This lab will demonstrate blood pressure measurements and how they can be linked with plethysmograph readings. It will also demonstrate electromyography measurements. For both measurements, students will expand their experience working with instrumentation, DAQ cards, and LabVIEW for biomedical applications.

REQUIRED PARTS AND MATERIALS:

This lab assignment is performed using:

- 1) PC computer with LabVIEW 8.5
 - 2) ETH-256 bioamplifier
 - 3) BP-600 blood pressure monitor
 - 4) Plethysmograph
 - 5) Stethoscope
 - 6) Hand Dynamometer
 - 7) Isolated amplifier and three EMG leads
 - 8) Alcohol swabs
 - 9) 2 BNC-Alligator clip cables
 - 10) Elvis DAQ interface board
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PRELAB:

1. Print the Prelab and Lab 5 Grading Sheets. Answer all of the questions in the Prelab Grading Sheet and bring the Lab 5 Grading Sheet with you when you come to lab. ***The Prelab Grading Sheet must be turned in to the TA before beginning your lab assignment.***
 2. Read through the LABORATORY PROCEDURE before coming to lab. Note: you are not required to print the lab procedure; you can view it on the PC at your lab bench.
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BACKGROUND:

Part 1: Blood Pressure Measurement

A person's cardiac output, peripheral vascular resistance, blood pressure, and other cardiovascular parameters change hundreds of times in response to the activities and events taking place in the person's daily schedule. A device like the BP-600 makes it easy to study the changes in blood pressure that take place over the course of an event or an activity. The BP-600 has two major components: a blood pressure cuff used to occlude the flow of blood in a subject's brachial artery; and a pressure transducer used to monitor the pressures in the cuff that correspond to the systolic and diastolic blood pressures. The output of the pressure transducer is a voltage that can be recorded by a data acquisition unit and converted into units of pressure (mmHg) by calibration. When the blood flow in the subject's arm has stopped, the pressure is released from the cuff by another student who is listening for the return of pulsatile blood flow in the arm. The first Korotkoff sound to be heard occurs at the systolic pressure and the second Korotkoff sound is at the diastolic pressure. To make it easier for students to find the systolic and diastolic pressures, the output of a pulse transducer attached to the subject's finger can be used to indicate the presence or absence of blood flow in the arm before, during, and after the occlusion of the subject's brachial artery.

When the blood pressure cuff is placed on a subject's upper arm and inflated to a pressure above that person's systolic pressure, blood flow to the lower arm is occluded so that pulse wave will not be seen when a pulse plethysmograph is used or heard when a stethoscope is used. As pressure is released from the cuff, the output of the pressure transducer will go down. Blood will begin to flow as the

pressure in the cuff falls below the subject's systolic pressure. The pressure at which the pulse is first heard or seen on the recording from the pulse plethysmograph can be identified on the recording by a mark that labels the systolic pressure. As the pressure continues to be released from the cuff and the output of the pressure continues to go down, the amplitude of the pulse wave increases up to a maximum. The pressure at which the first maximum pulse wave is seen or heard during the release of pressure from the cuff is the diastolic pressure.

Part 2: Auditory and Visual Reflexes

During our day-to-day lives we detect changes in the environment and react appropriately. An external stimulus is detected by one or more neurons, which send the sensory information to the central nervous system, where it is processed. If a motor response is initiated, it usually involves a series of action potentials that produce a muscle contraction and a movement of one or more parts of the body. A simple reflex is perhaps the easiest of this type of stimulus-response reaction. A loud sound or something flying at your eye makes you blink, while a tap on the tendon under the knee cap produces the knee-jerk (or myotactic) reflex.

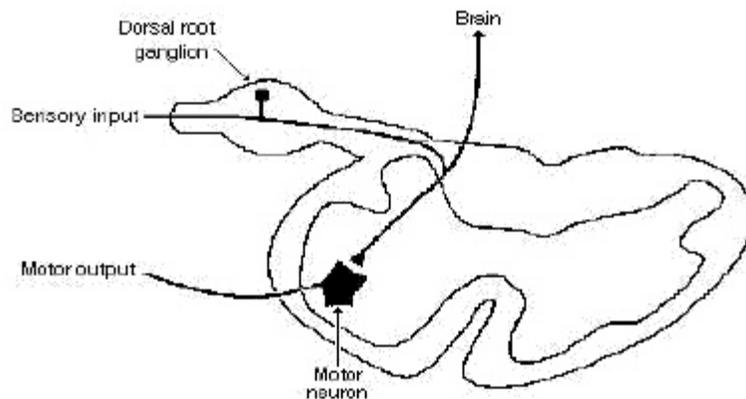


Figure 1: A cross section of the spinal cord showing the single synapse between the sensory and the motor neurons involved in the myotactic reflex.

A simple reflex like the myotactic reflex is produced via single synapses between sensory axons and motor neurons. The required circuitry for this reflex is confined to the spinal cord, as shown in Figure 1. Sensory information also ascends to higher centers, but the brain is not necessary or required to perform the reflex. More complex reflexes usually involve addition (inter-) neurons and more than one population of motor neurons. Thus, more neurons and synapses are involved, which usually results in a longer delay between stimulus and response and often a more complex response. One example of such a complex response is the flexion withdrawal reflex, where a noxious stimulus to one leg causes withdrawal of the stimulated leg and extension of the other.

LABORATORY PROCEDURE:

Exercise 1: Blood Pressure Measurement

Data Acquisition Setup

- 1) Open a Blank page on Labview.
- 2) Click on "Biomedical Applications" → Data Acquisition → Continuous Acquisition → Continuous Acquisition Shell
- 3) Drop the Shell onto your block diagram window.

- 4) On the DAQmx read VI, right click on “sample per channel” input and select Create→Control.
- 5) On the DAQmx timing VI, delete the 1000 input to the “sampling rate”, right click and select Create→Control.
- 6) You can now control the sampling rate and # of samples on the front panel.
 - Set the number of samples to 500
 - Set the sampling rate to 1000 Hz.

Physical Channels

- 7) Go to the front panel of the VI. Click onto Physical channels. Choose Browse. Hold the Ctrl key down and click on ai0 and ai1. Click OK.
- 8) Go to the block diagram and click on the DAQmx Read drop down menu. Select Analog→Multiple Channels→Multiple Samples→1D Waveform.
- 9) Right click and select Programming→Array→Index Array. Place the vi inside the while loop. Connect the data output of the DAQmx read vi into the Index Array input. On the ‘index 0’ input of the vi, right click→create→ constant. Enter a ‘0’. Do the same for the ‘index 1’ input but input a ‘1’ instead.
- 10) Right click→Programming→Numeric→Multiply. Place the multiply vi in the while loop. Connect the first output from the Index Array to the first input of the multiply vi. Enter a constant of -1 for the second input of the multiply vi.
- 11) Right click→Programming→Array→Build Array. Place the build array into the while loop. Connect the output of the multiply into the first input of the build array vi. Connect the second output of the Index Array vi into the second input of the Build Array vi.

Waveform Chart:

- 12) Switch to your front panel and place a ‘waveform chart’.
- 13) On your block diagram, drag the chart into the while loop. Then connect the output of the Build Array vi into the chart.
- 14) On the front panel, right click on the chart and select Visible Items→Digital Display.
- 15) Right click on the chart once again and select Visible Items→Graph Palette
- 16) Right click on the chart and select Properties→Scales. Designate the Y axis to be between 0 Min and 5 Max.

Save data:

- 17) Search for the Write To Measurement File Express VI, place it on the block diagram, and configure it as in previous labs (see Lab 3 part 2 if needed). Change the filename to **Lab5_1.lvm**. Connect the output of Build Array to the input of the “Write To Measurement File”. Add an enable button to control the writing process.
- 18) Save your VI

Bio-Amplifier:

- 19) Turn the ETH-256 bioamplifier on. Switch is in back.
- 20) Connect a BNC to alligator clip cable from the output channel 1 of the amplifier to the ACH0+ and AIGND of the Elvis Board.
- 21) Connect the Blood Pressure Cuff to channel 1 of the Amplifier. Use the 8-pin extension cable to increase the cable length if necessary.
- 22) On the amplifier, set the following parameters for Channel 1: HF = DC , LF = 150, Gain = 1x
- 23) Attach the Plethysmograph sensor into channel 2 of the amplifier.
- 24) Set the parameters for channel as follows: HF = DC, LF= 50 , Gain = 5x.
- 25) Lab Partners will take turns being the patient and the data analyzer.
- 26) Patient needs to sit up straight in the chair with both arms resting on the table in a comfortable position. Try to minimize any movement during the recording process.

Blood Pressure Cuff Setup

- 27) Put the blood pressure cuff on the upper arm of the subject. Align the arrow on the cuff over the subject's brachial artery (on the inside of the arm). Wrap the Velcro strap around the end to hold the unit firmly in place.

IMPORTANT: READ THROUGH STEPS 28 – 36 BEFORE PERFORMING THE ACTUAL STEPS.

- 28) Make sure the cuff is fully deflated by turning the knob on the inflator bulb counter clockwise.
- 29) Press the Run button and monitor the baseline voltage of the signal (look at the digital display). If it is above or below zero, use the offset knob on the ETH-256 to make the signal level out at 0 Volts.
- 30) Next, turn the knob on inflator bulb clockwise to seal the cuff and allow it to retain pressure.

Relation Between Pressure and Voltage:

- 31) Inflate the pressure in the cuff to 20 mmHg as read on the aneroid gauge of the cuff.
- 32) Press the Run arrow. Document the voltage value on the digital display.
- 33) After 5 seconds, increase the pressure to 40 mmHg and document the voltage at that pressure.
- 34) After 5 seconds, increase the pressure to 80 mmHg and document the voltage at that pressure.
- 35) Release the pressure from the cuff until pressure is 0 mmHg.
- 36) Press the stop button.
- 37) Using the values you collected, determine the mathematical relation between mmHg and volts for the patient being tested. Show your calculations to your TA before moving on.

Plethysmograph

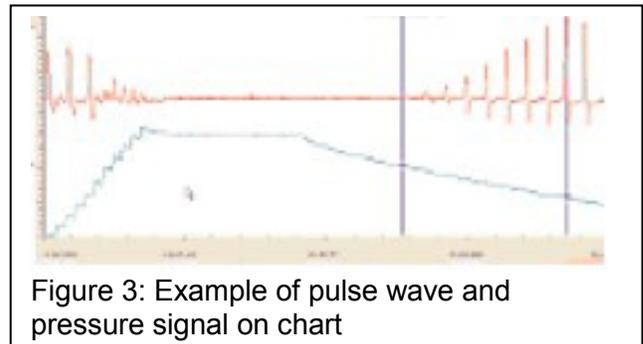
- 38) The patient should strap the plethysmograph sensor to the middle digit of middle finger.
- 39) The patient should rest with both arms on the table and minimize any movements.

Data Acquisition:**IMPORTANT: READ THROUGH STEPS 40 – 45 BEFORE PERFORMING THE ACTUAL STEPS.**

- 40) The other lab partner should click on the Run button. Both the Pressure and Plethysmograph should appear on the chart.
- 41) Monitor the Plethysmograph until it has stabilized.
- 42) If the waveforms overlap then add an artificial 'offset' by adding a constant value to one of the waveforms. This can be done by inserting an 'Add' vi and creating a constant on one input and the waveform on the other.
- 43) Once the plethysmograph is stabilized, click the Enable button to start writing data into a file. Begin pumping pressure into the cuff until the pressure pulse disappears.
- 44) Once the pulse wave disappears, release the cuff pressure at the rate of 10 mmHg per second. Continue to release the cuff pressure until the gauge reads 0 mmHg. Click the Stop button.
- 45) To view the data, open Matlab and type the following commands to plot the recorded data.

```
load Lab5_1.lvm
plot(Lab5_1(:,1), Lab5_1(:,2))
hold on
plot(Lab5_1(:,3), Lab5_1(:,4), 'r')
```

Figure 3 shows what the waveform should look like. The top signal is the pulse wave and the bottom signal is the pressure from the cuff.



- 46) Look at the section of data recorded while the pressure in the cuff was being released. Zoom in the figure to determine at which amplitude of the cuff pressure the pulse wave reappears.
- 47) Using the mathematical relation you calculated in step 37, determine what pressure the pulse wave disappeared. This will be the systolic pressure.
- 48) Next, observe when the pulse wave amplitude becomes maximum (amplitude becomes nearly constant again). Monitor the cuff pressure amplitude at this time. Use the calibration ration from step 37 to determine the pressure. This will be the diastolic pressure.
- 49) You have successfully calculated your friend's blood pressure. According to the National Heart, Blood, and Lung Institute, a reading of
- 120/80 or lower is normal blood pressure
 - 140/90 or higher is high blood pressure
 - 120 and 139 for the top number, or between 80 and 89 for the bottom number is prehypertension

- 50) Allow the TA to scroll through your data to make sure the experiment went as expected and check the results.

Stethoscope

- 51) Assemble the stethoscope (if not already assembled)
- 52) Wipe the earphones using alcohol swabs.
- 53) Place the diaphragm on the inside of the elbow under the cuff. Put on the ear phones.
- 54) Pump pressure into the cuff until the sound of the beat disappears
- 55) Start releasing the pressure in steps of 10mmHg
- 56) Note the pressure on the gauge at which the beat re-appears.
- 57) Continue releasing the pressure and note the pressure at which the beat is loudest.

Exercise 2: Auditory and Visual Reflexes

- 58) Attach the event marker into channel 1 of the amplifier.
- 59) Set the parameters for channel 1 as follows: HF = DC, LF = 50, Gain = 1x.
- 60) Attach the plethysmograph into channel 2 of the amplifier.
- 61) Set the parameters for channel 2 as follows: HF = DC, LF = 50, Gain = 1x.

Reaction Time and Sound

- 62) The reaction time to a tapping sound is going to be measured. Have the subject sit with their back to the computer screen.
- 63) Have the subject listen while another student taps the white surface of the plethysmograph. Make sure the subject can hear, but not see, the taps.
- 64) The subject should click the event marker as soon as they hear a tap.
- 65) Click the "Write to Measurement File" and change the filename to **Lab5_2.lvm**. Run the LabView program and start to write the data into file
- 66) Present the subject with a total of five taps. They should be in a pattern that is difficult to predict (vary the time in between taps).
- 67) Stop the LabView program. Plot the data in Matlab as described before and calculate the intervals between the tap on the plethysmograph and the pressing of the event marker.
- 68) Drop the fastest and slowest intervals, and then average the rest. Write this number down on your data sheet.

Reaction Time and Predictable Sounds

- 69) Repeat steps 61-67, but tap the plethysmograph with a predictable interval.
- 70) How does the average reaction time in this exercise compare to the previous one?

Reaction Time and Visual Cues

- 71) Have the volunteer sit in a chair and face the computer screen.
- 72) Have the subject watch the screen and press the event marker as soon as they see a deflection in the stimulus trace.
- 73) Out of sight of the subject, another student should gently tap the plethysmograph so that the subject cannot hear the tap.
- 74) Run the LabView program.
- 75) Present the subject with five trials in an unpredictable pattern.
- 76) Stop the LabView program.
- 77) Calculate the average reaction time by the same method as step 67. Write this number on your data sheet. How does this time compare to the first reaction time (audio stimulus, unpredictable pattern)?
- 78) Repeat all three tests in exercise two with the other student as the subject.

This completes the lab procedure. Please clean up your lab station before leaving the lab.