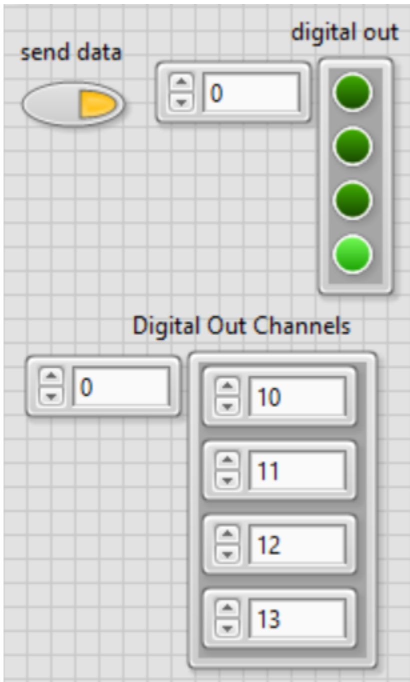
Project #2: Blood Pressure Measurement

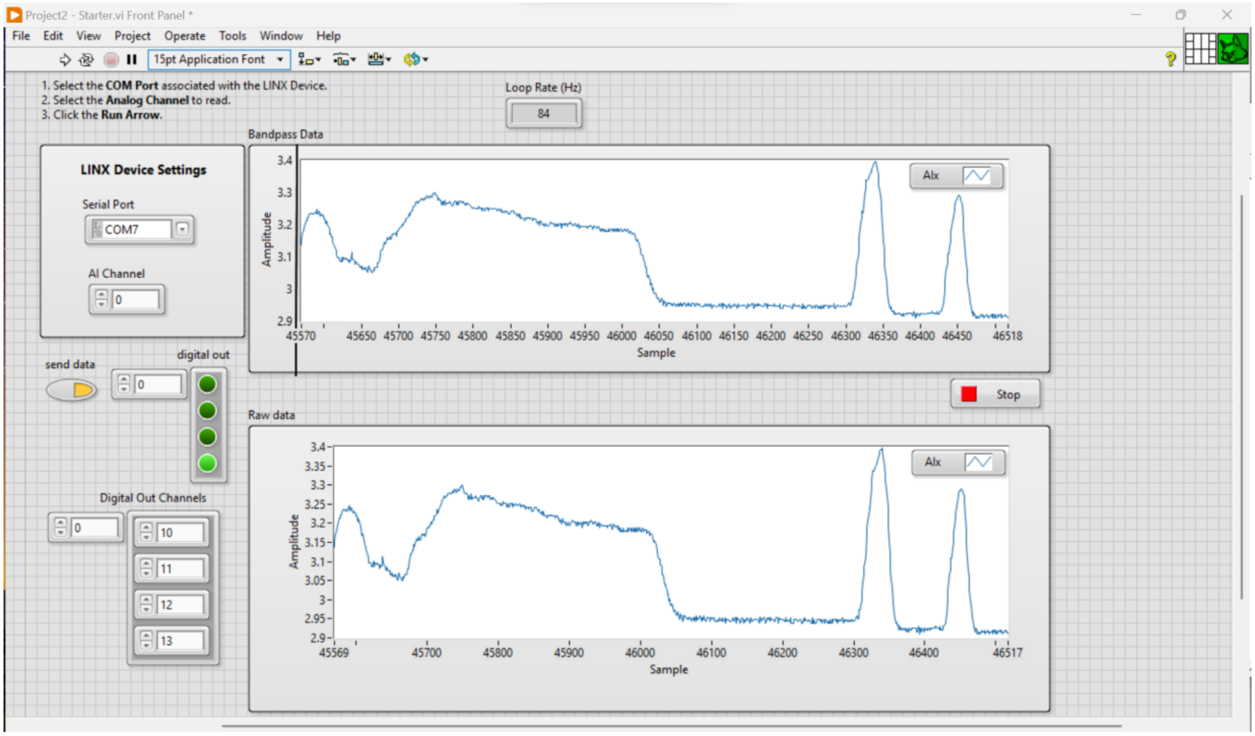
Lamis Hammouda

PART 1: Read out of the pressure signal in LabVIEW.

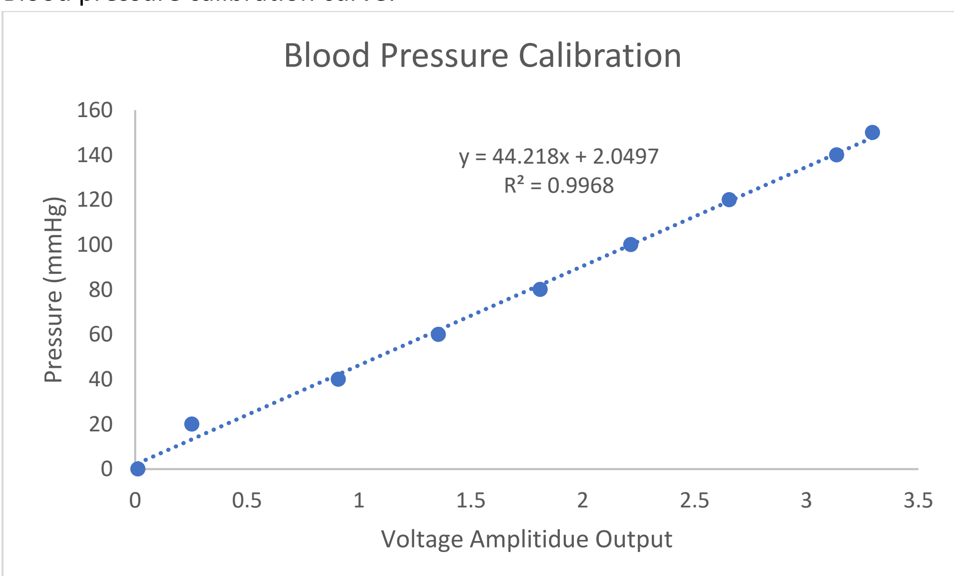
1. N/A
2. N/A
3. Front panel configuration enabling an amplification of 128: (where pin 13 is connected to D3 on the LTC6915)



4. Testing the setup and ensuring that we can reach 140 mmHg:



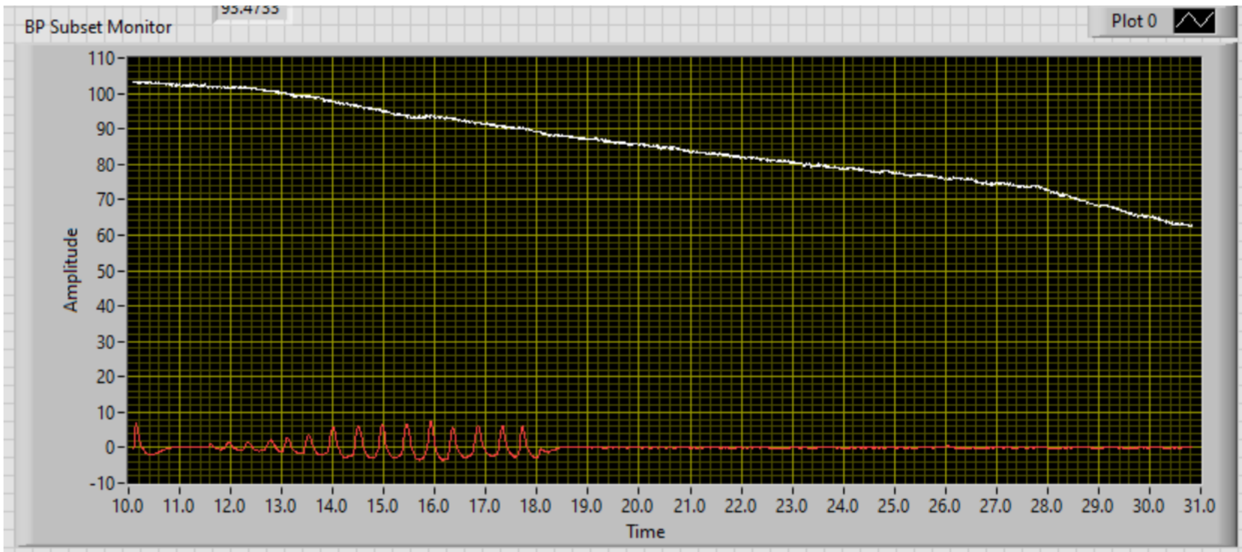
5. N/A
6. Blood pressure calibration curve:



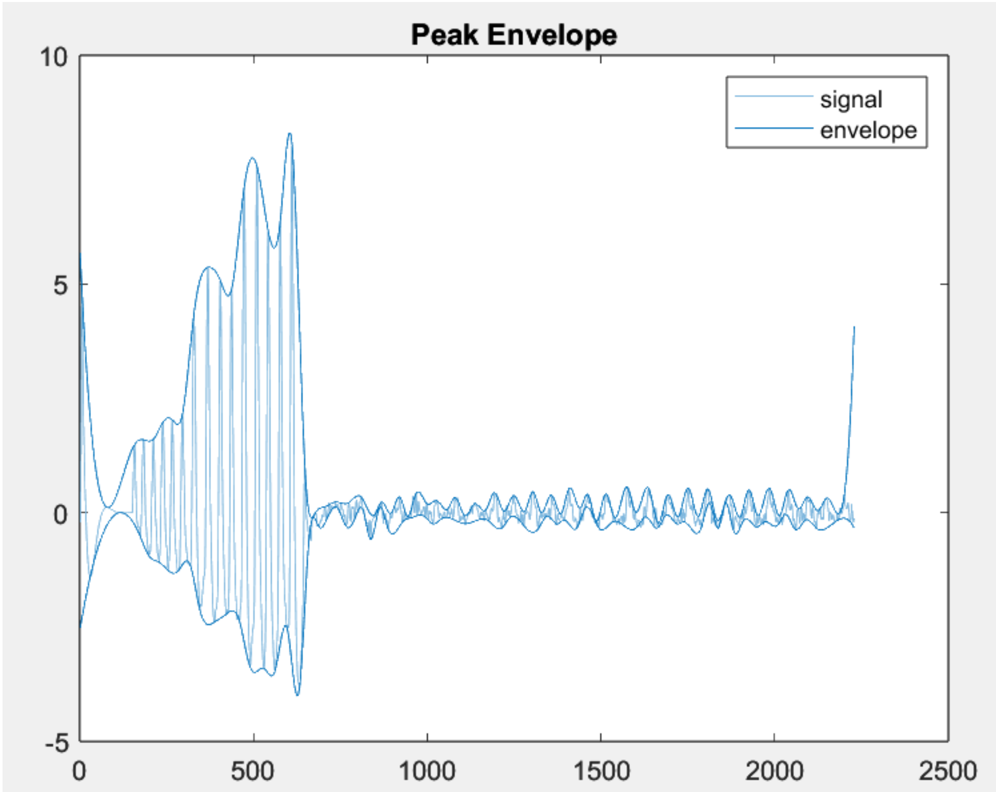
The calibration equation is y = 44.218x + 2.0497 where x is the voltage output and y is the pressure (mmHg).

PART 2: Determine the mean arterial pressure.

1. N/A
2. Filtered signal (in red) and unfiltered pressure data (white):



3. The write VI file is in the main project 2 VI. I used MATLAB to analyze the data so a read VI file was not necessary.
4. N/A
5. Used the method described to find MAP on LabVIEW file.
    a. The MAP is when the amplitude of the signal is the largest. The maximum peak is possibly not the real MAP location because there could be another peak that isn't as large but has a larger corresponding valley which makes the amplitude larger.
    b. A better way to find MAP is to envelope the signal and find the maximum amplitude in that envelope.
6. The systolic pressure is found before the max peak and its amplitude corresponds to 0.55 * MAP amplitude. The diastolic pressure is found after the max peak and its amplitude corresponds to 0.85 * MAP amplitude. One method of doing this would be to envelope the filtered pressure signal and calculate the max amplitude. This location would correspond to the MAP. Find the location where the amplitude is equal to 0.55 * max amplitude in the data before the MAP. This corresponds to the systolic pressure. Find the location where the amplitude is equal to 0.85 * max amplitude in the data after the MAP. This corresponds to the diastolic pressure.
7. I used MATLAB to analyze the signal and calculate MAP, systolic, and diastolic pressures using the oscillometric method. First, I read the data from the excel file containing all the LabVIEW data to the program and assignment a variable to each column (time, pressure, etc). Then, I used the envelope function to find the envelope of the signal. I subtracted the bottom envelope from the top envelope to find amplitudes of the envelope. The MAP was the maximum of the amplitudes. To find the systolic pressure, I found the distance of each amplitude from the amplitude of 0.55 * max and the minimum distance was closest to that systolic amplitude. The systolic pressure had to be in the data before the MAP so I found the minimum distance in only the beginning part of the array until the maximum. I used the index of the systolic pressure amplitude to find the systolic pressure from the unfiltered pressure array. I did a similar method for diastolic pressure, but since the point had to be after the MAP, I replaced all the amplitude values before with 0 so they are not searched. The MATLAB code is attached and called "Lamis Hammouda Project 2 Envelop Signal." Image of the signal with envelope:



DISCUSSION:

1. A possible source of error from the oscillometric method is that the pulse/blood volume flow that it uses to calculate blood pressures could be irregular or the patient could be moving. Both of these factors can lead to inaccuracies in the data that will affect the pressure measurements. Additionally, many papers have different results on what values correspond to the systolic or diastolic amplitudes. Therefore, using one calculation might underestimate or overestimate the pressure.
2. LabVIEW code methodology:
   Data collection & subset: I first converted the voltage reading from the pressure sensor to a pressure value (in mmHg) using results from the calibration. As the values came in from the sensor, I deleted the first value from the array and appended the array with the pressure value. I calculated the time by subtracting the time of each measurement from the starting time and converting it to seconds. The timestamps were added to an array using the same method as pressure. I plotted the time and pressure on the pressure monitor. To create subsets, I created a case structure that when true, would take the data and add it to an array. When false, the subset ends or nothing happens and a subset is created.
   Filter: I filtered the pressure data outside the subset because performing the filtration inside created initial unwanted data spikes. I used a Butterworth bandpass filter from 1Hz to 10Hz. The filtered data was fed into the subset case structure.
   Peak detection: Inside the subset structure, the filtered data was fed into the peak detector VI to find the locations and amplitudes of the peaks and valleys.

MAP: As an initial attempt at finding the MAP, I first found the maximum value from the peak amplitudes array. Using the index of that value, I interpolated the location of that amplitude. I used that location to interpolate the pressure from the original pressure array. This value was the mean arterial pressure (mmHg).

Write to file: I added a sequence to the case structure so that when the program ends, all the collected subset data is sent to an excel file. The columns are as follows (in order written): timestamps, pressure, filtered pressure, peak amplitudes, and valley amplitudes. The first three columns of this file were used to find a more accurate MAP & blood pressure in MATLAB.

3. VI file name: Lamis Hammouda Project 2 Code