

Monitoring Cardiac Health Using a Laser Doppler Approach to Measure Pulse Wave Velocity

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Client Description

Dr. Allen Wilson, Pediatric Cardiology

- ❖ Conducts treadmill stress testing for children
- ❖ Previously focused on reducing noise from Laser Doppler signal during treadmill test
- ❖ Shifted interest to Pulse Wave Velocity before and after exercise testing



Previous Work

❖ Last semester:

- Create a motion-stabilizing device for increased accuracy of Blood Pressure signal at systolic pressure
- A splint device was designed that reduced noise on the Blood Pressure Waveform by 16%
- A blood pressure cuff with a microphone is being used to amplify the noise of the blood flow

■ Our device will no longer be needed for



Figure 1. Splint device created in Fall 2015 to reduce noise on the blood pressure waveform.

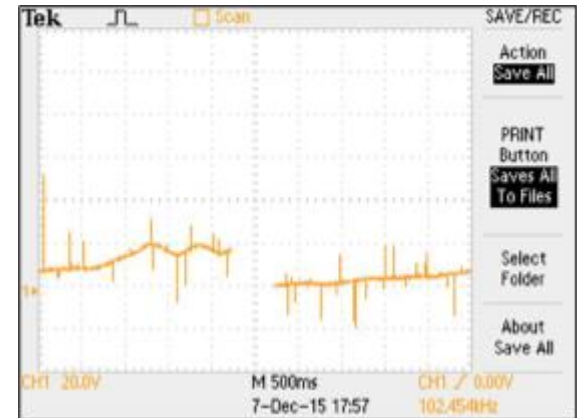


Figure 2. Systolic pressure using the splint device during exercise testing.

Problem Statement

To design and test a technique using laser doppler probes that most accurately measures pulse wave velocity in a patient pre and post treadmill stress test.

Background - Laser Doppler Flowmetry

- ❖ Method used to assess blood perfusion
- ❖ Measures blood perfusion through shifts in light wavelength
- ❖ Client uses Perimed BLF21 Laser Doppler Probe

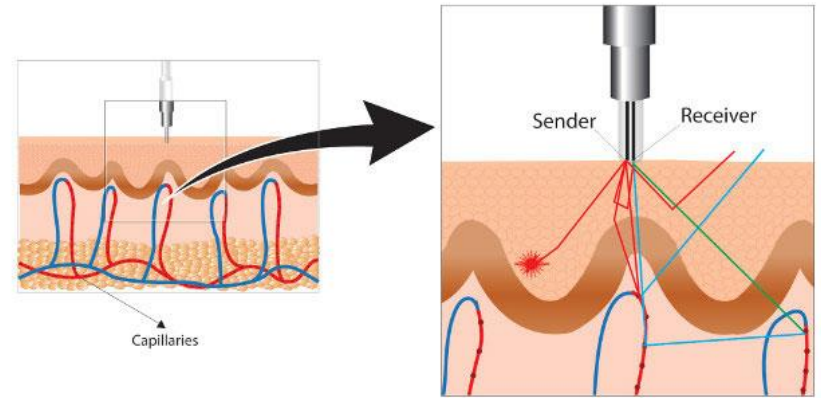
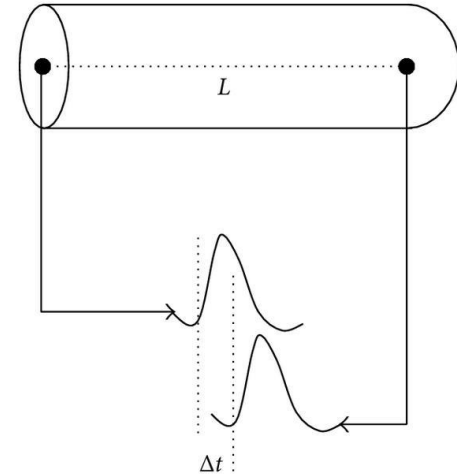


Figure 4. The light hitting the moving blood cells undergo a change in wavelength while the light hitting static tissue does not change. This frequency distribution is used to measure blood perfusion [1].

Background - Pulse Wave Velocity

- ❖ Measure blood flow at two points
- ❖ Divide the distance by the time delay between points
- ❖ Pulse Wave Velocity used to measure arterial stiffness



$$PWV \text{ (m/s)} = L/\Delta t$$

Figure 5. Laser Doppler is used to measure flow at two points. Distance between points is divided by change in time to find pulse wave velocity [2].

Design Constraints

- ❖ Patient comfort while measurements are taken
- ❖ Ease of use for practitioners
- ❖ Clear, accurate pulse wave velocity traces
- ❖ Incorporation of a laser doppler probe

Broader Impact

- ❖ Address cardiac problems

- Monitoring post treatment at follow-up visits

- Early detection of cardiac abnormalities
 - Relevant for various conditions (i.e. hypertension, valve diseases, chronic kidney disease, obesity)
 - Show whether patients have recovered or need further treatment

- ❖ Decrease health care expenditures



Fabrication Goals

- ❖ Client has all electronic equipment
- ❖ Technique - Placement of Laser Doppler to measure pulse wave velocity
 - Forefinger
 - Forearm
 - Upper Arm
 - Chest
- ❖ Measure before and after exercise

Evaluation/Testing Goals

- ❖ Excel or MatLab shell file gives pulse wave velocity between two points
- ❖ At least 5 trials per laser doppler combination
- ❖ Compare differences between combinations via standard deviations
- ❖ Will move forward with combination that has smallest standard deviation of pulse wave velocity between trials

Documentation

- ❖ We will develop a user manual that will outline the test that will be performed.
- ❖ Information included:
 - Standard procedure for the test (ie. length of test)
 - Probe locations.
 - General equipment instructions
 - Data interpretation/analysis techniques.
(oscilloscope, Laser Doppler probe etc.).
 - Running the analysis code (Excel shell file).
- ❖ No particular warnings or cautionary notes with this test as it is non-invasive.



Budget

- ❖ This semester there is no specific budget.
- ❖ All equipment is either carried over from last semester or provided by the client.
- ❖ We do not foresee any expenditures at this time.

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➤ Our advisor, *Professor Thompson*

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References

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