SP.718 Special Topics at Edgerton Center: D-Lab Health: Medical Technologies for the Developing World
Spring 2009

Vital signs monitoring devices measure and display vital physiological parameters.

The purpose of this lab is to introduce you to a 3 types of vital signs monitoring devices:

- **Pulse Oximeters**
  Pulse oximeters measure arterial blood oxygen saturation by sensing absorption properties of deoxygenated and oxygenated hemoglobin using various wavelengths of light. A basic meter is comprised of a sensing probe attached to a patient's earlobe, toe, finger, or other body locations, and data acquisition system for the calculation and display of oxygen saturation level, heart rate, and blood flow.

- **Electrocardiogram (ECG, also known as an EKG)**
  An electrocardiogram (ECG) is a test that records the electrical activity of the heart. An ECG is used to measure:

  - Any damage to the heart
  - How fast your heart is beating and whether it is beating normally
  - The effects of drugs or devices used to control the heart (such as a pacemaker)
  - The size and position of your heart chambers

- **Electronic Stethoscope**
  The stethoscope is an instrument used for auscultation, or listening to sounds produced by the body. It is used primarily to listen to the lungs, heart, and intestinal tract. It is also used to listen to blood flow in peripheral vessels and the heart sounds of developing fetuses in pregnant women. The stethoscope used in our lab is a LDM-VES has an electronic audio-out feature that will allow you to record the sounds produced when listening to the heart. To activate the electronic stethoscope, plug in the dual-phono plug into the audio jack.

There are three models of Pulse Oximeters available for the lab:

1. **OctiveTech 300C** is a white finger pulse device that can provide a numerical readout of Oxigen concentration (SpO2) and Pulse Rate). It will make a beep noise for every pulse cycle. The readout panel is fairly straightforward:

Image removed due to copyright restrictions. Diagram of OctiveTech 300C display.

2. **CMS-50E** is a black and white finger pulse device that has features an OLED display. It also features more processing power than the 300C. It can display everything the cheaper 300C, but also includes a Pleth Waveform that can look like this:

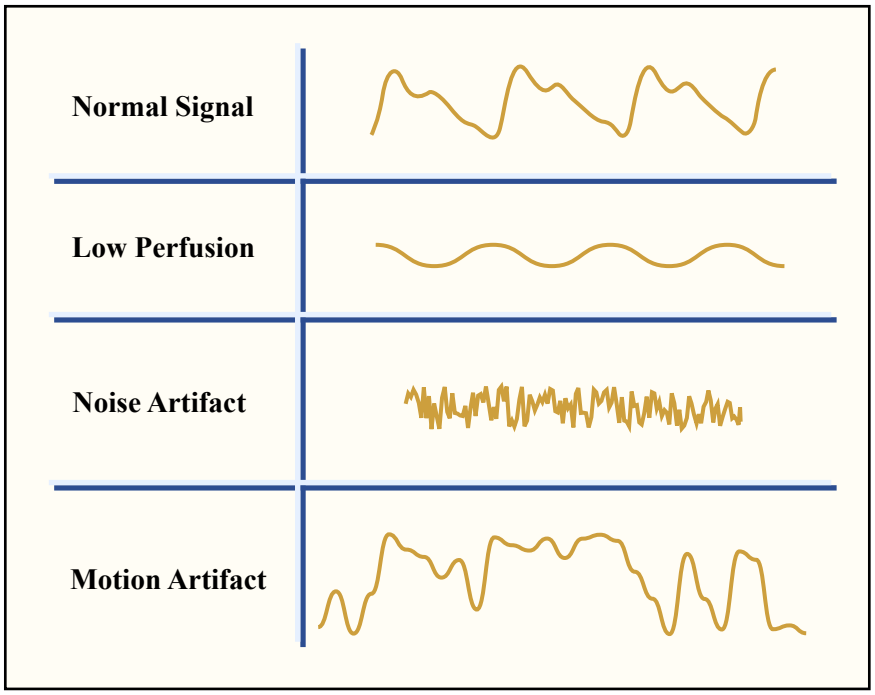

Figure by MIT OpenCourseWare.

3. LDM-VES also features a pulse oximetry mode when you connect the detachable finger probe.

Getting Started

Table 1 describes the summary of tasks to complete this lab.

	Pulse Ox (**300C**)	Pulse Ox (**CMS-50E**)	EKG	Stethoscope
*(1) Collect Line In/Out**				X
(2) Collect Audio Direct	X	X		X
(3) Collect Audio Transmitted	X	X		X
(3) Collect Video	X	X	X	
(4) Collect Matlab Direct				X
(5) Collect Matlab Transmitted				X
Combine	X	X	Bonus	X

**The electronic stethoscope is the only instrument that has a Line-Out (earphone) plug. The other signals will have to be determined with the computer's microphone and Audacity.*

What does this table mean?

(2) **Collect Audio Direct**: Record the sounds coming from the device with either the computer's own microphone or the available electronic tape recorder (Sony) to then download the files into your computer.

(3) **Collect Audio Transmitted**: With the help of a lab partner, transmit the sounds of the device using one of the baby monitors as a stand-in for a field radio. Record the sounds coming from the baby monitor as it transmits the beeps or heart sounds that your lab partner is transmitting on the other of the lab. Tip: Do not be in the same room as the transmitter to avoid creating a feedback sound.

(3) **Collect Video**: Using one of the Flip Video cameras, record 3 minutes of each device and submit them as part of your lab report with the discussion questions.

(4) **Collect Matlab Direct versus (5) Collect Matlab Transmitted**: All this means is that you will create two sets of Matlab sets to compare your Direct Vital Signs measurements with those transmitted over the Baby Monitor. The goal is to clean up the Transmitted Vital Signs sets to get as close as possible to the original.

(5) Combine: Accurately superimpose the filtered versions of the Pulse Ox (300C), Pulse Ox (CMS-50E), and Stethoscope. Bonus: Superimpose the EKG as well.

Questions:

- Why is the waveform display useful? How can you justify the higher price of such a feature?

- In what type of situations would the video capture be as useful, more useful, or less useful than audio transmission of the different outputs of each device?

- Which modality is better suited for real-time instructions from a far-away doctor giving instructions to traveling nurse?

- Matlab can be very useful for filtering out noise and creating a usable signal for interpretation. It costs $2,000 per license. Propose a solution that allows for the type of signal processing you just did that can be affordable. Tip: Remember the parameters for design.
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- Why do think we bothered to record the audio and digitize it instead of just capturing the digital signal from the devices? Can you think of how a similar circumstance could happen in the field?

- How would you improve the devices to make them shine in the field? Would you rate them high on the Parameters for Design scale? How would you improve their score? (e.g., In a TB ward, would they transmit infection? How would you make them more user-friendly for an infant?)

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