Noninvasive Hemoglobin Level Measurement Using Spectroscopy

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Blood sample from finger tip

Blood sample from heel prick

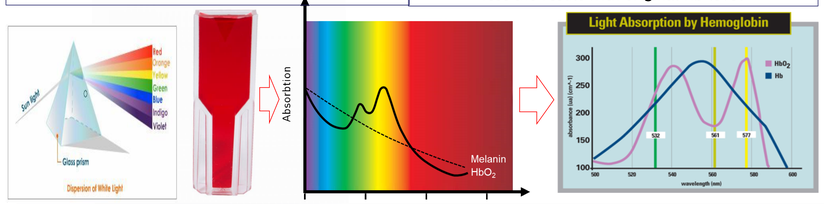
Motivation

- Hemoglobin (Hb) level is an important bio-marker for evaluating health condition.
- Thalassemia and sickle cell diseases are most common genetic diseases.
- Sickle cell patients and premature infants who have anemia need to check their hemoglobin level very frequently.
- Current invasive Hb measurement technology does venipuncture.
- Blood tests need the blood sample in medical laboratories.
- It requires laboratory equipment and facilities, specific specimen of blood, cost and time.
- Spectrum analysis give higher accuracy level value.
- Small size spectrometer are available in the market.

The

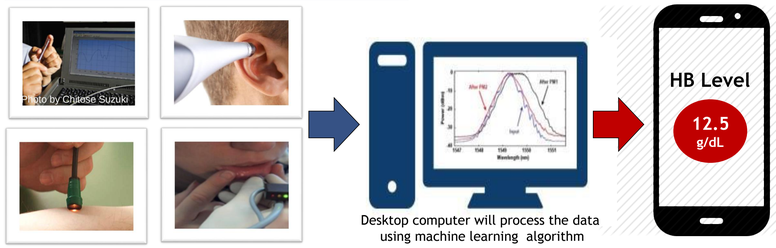
First Phase: Develop the Fundamental Theory

- Blood Spectrum Collection
  - Spectrum data are taken from liquid blood of each person.
  - Different dilution of liquid blood are tested.
  - Spectrometer will be used for spectrum collection
- Data Analysis and Algorithm Design
  - Matlab tools are used
  - Outlier data are removed
  - Mathematical model are made
  - Algorithmic steps are determined
  - Test the result with original Hb level



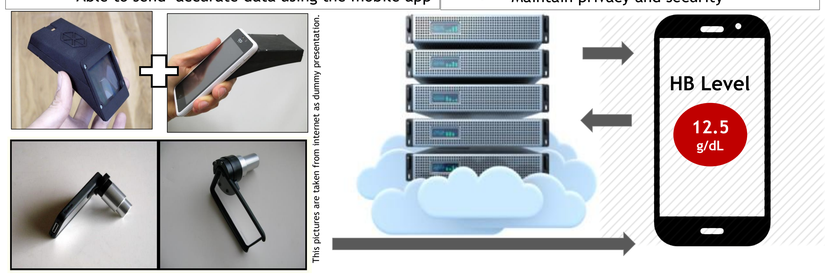
Second Phase: Build the System and Algorithm

- Data Analysis
  - Spectrum data can be transferred to computer through USB.
  - Noise free spectra are considered
  - Absorption picks are evaluated
  - Personalized data are analyzed in this phase
- Algorithm Design
  - Machine learning algorithms are applied
  - For each person, spectra from different locations are considered
  - Other physiological data like age, gender, blood pressure, heart beat are also recorded



Final Goal

- Develop the mobile spectrometer that will be
  - Cheaper and user friendly
  - Easily attached with mobile cover
  - Able to collect the spectrum faster
  - Able to send accurate data using the mobile app
- Cloud based solution for
  - Data collection
  - Response to mobile devices
  - Algorithm design
  - Maintain privacy and security



Disclaimer: The pictures are dummy and used to understand what type of device are planning to make for the end users. We are aiming to make the devices cheaper and user friendly. Thanks to the authorities for sharing these pictures in Google.

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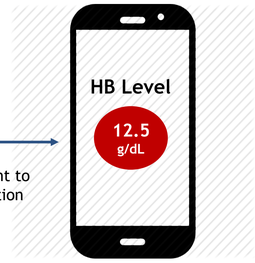
System Architecture

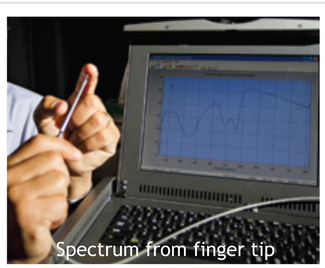
Step 1:
- Collect the data from finger tip, ear helix, hand, and lip
- Send these spectra from the spectrometer to mobile using Bluetooth.
- If the spectrometer has Wi-Fi support then we can send the data directly to the cloud.

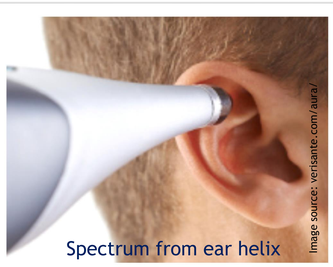
Step 2:
- If smart phone receives the spectra then it will preprocess the data and send to the cloud for decision making

Step 3:
- The cloud computer run the algorithm and send the decision within very short period of time to the smart phone app.
- Mobile application will show the result to the user, store the data for the future.

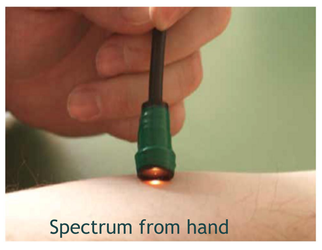
1 Spectrum are sent to mobile application

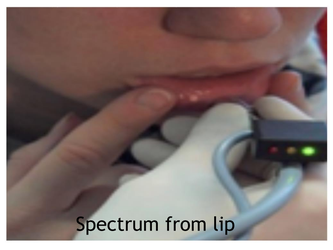



Spectrum from finger tip



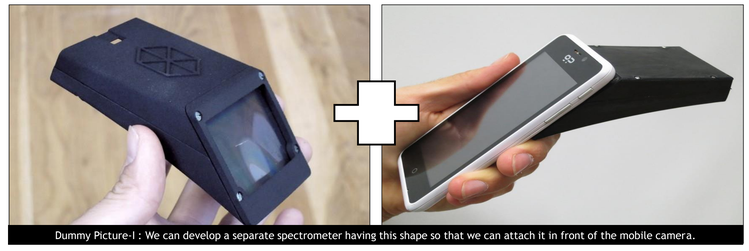
Spectrum from ear helix


Spectrum from hand


Spectrum from lip

Proposed Data Collection System

- Finger tip, ear helix, hand and lower lip are considered as expected location to collect spectrum.
- Optical fiber probe will be used
- UV-vis range light is considered
- Wavelength 300nm – 700nm
- Light absorption technology


Dummy Picture-I : We can develop a separate spectrometer having this shape so that we can attach it in front of the mobile camera.


Dummy Picture-II : We can build the mobile spectrometer and put it inside the mobile cover that will allow us to easily attached with smart phone.

Our Vision: Mobile Supported Cheap Hardware and Accurate Result

- Develop smartphone supported mobile spectrometer.
- That can be easily attached with smartphone camera
- Make the device cheaper and affordable
- Mobile app to collect, preprocess the data.
- Data collection should be easier
- Spectrum needs to be accurate
- Preprocessing should be faster
- Data transfer and result shown should be with in couple of second
- Better result (~95% accuracy)