The 12ᵗʰ International Conference On e-Health, Telemedicine, And Social Medicine (e-TELEMED 2020)

November 21-25, 2020 / Valencia, Spain

e-TELEMED 5: e-Health Technology and Devices

"Near-Infrared Mobile Imaging Systems For e-Health: Lighting The Veins"

Hüseyin Aşkın ERDEM(*), Işıl ERDEM, Semih UTKU

(*) Computer Engineering Department, Dokuz Eylul University, İzmir, Turkey. huseyinaerdem[at]gmail.com

About the Presenter

- Computer Engineer (M.Sc.) & Electrical-Electronics Engineer.

- PhD candidate at Dokuz Eylül University, Computer Engineering Department.

- Research Interests:
    1. Virtual Reality Environments, Computer Graphics, Image Processing.
    2. Parallel Computing, Quantum Computing.

Content

- **Introduction**
  - ✓ Problem Definition & Aim of the Study

- **Method: Imaging Technique**
  - ✓ Near-Infrared (NIR) Light
  - ✓ NIR Spectroscopy

- **Application**
  - ✓ **Hardware Part of the Study:** Capturing NIR Images
  - ✓ **Software Part of the Study:** Processing NIR Images

- **Conclusion & Future Work**

Introduction

- The need for the multipurpose systems which can work anywhere and anytime.

  ✓ mobile phones and tablets,
  ✓ health applications,
  ✓ mobile measurement.

Introduction

- **Problem Definition:**

  - ✓ **Visibility** of the blood veins varies from person to person.
  - ✓ **Advances** for locating veins are very limited.
  - ✓ No studies have been encountered in which the images obtained are available **as a virtual pre-diagnosis environment**. (via mobile device)
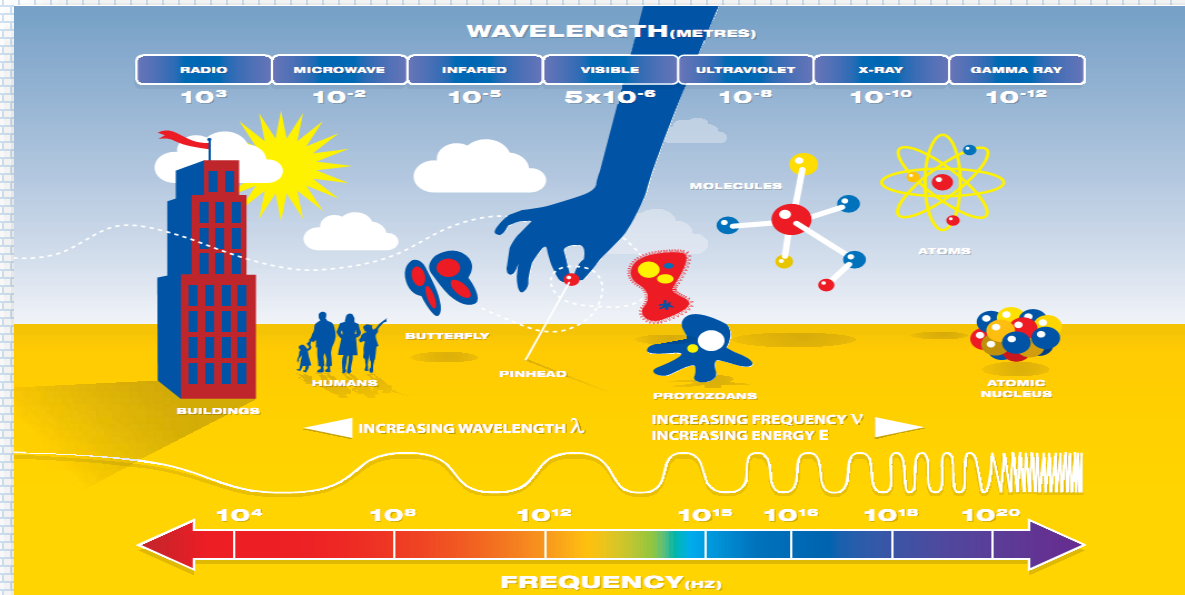
Introduction

- **Aims of the Study:**

    - ✓ **Preliminary detection for degenerations** that may form on different tissues. (Delayed treatment may be prevented.)
    - ✓ Virtual reality environment for **self-diagnosis.** (User will be informed about the concerning diseases that may occur later.)
    - ✓ Non-invasive and low-cost **measurements** utilizing mobile devices.

Method: Imaging Techniques

- **Near-Infrared Light**

  ✓ The diagram constructed of different wavelengths and frequency ranges of the light is called **the electromagnetic spectrum**.

  ✓ Electromagnetic spectrum's IR wavelengths of **700 to 900 nm** are known as **the near-infrared (NIR)** window.

Introduction to Spectroscopy. (Last Accessed: 07.11.2020) http://www.rsc.org/learn-chemistry/resource/res00000281/introduction-to-spectroscopy?cmpid=CMP00000321
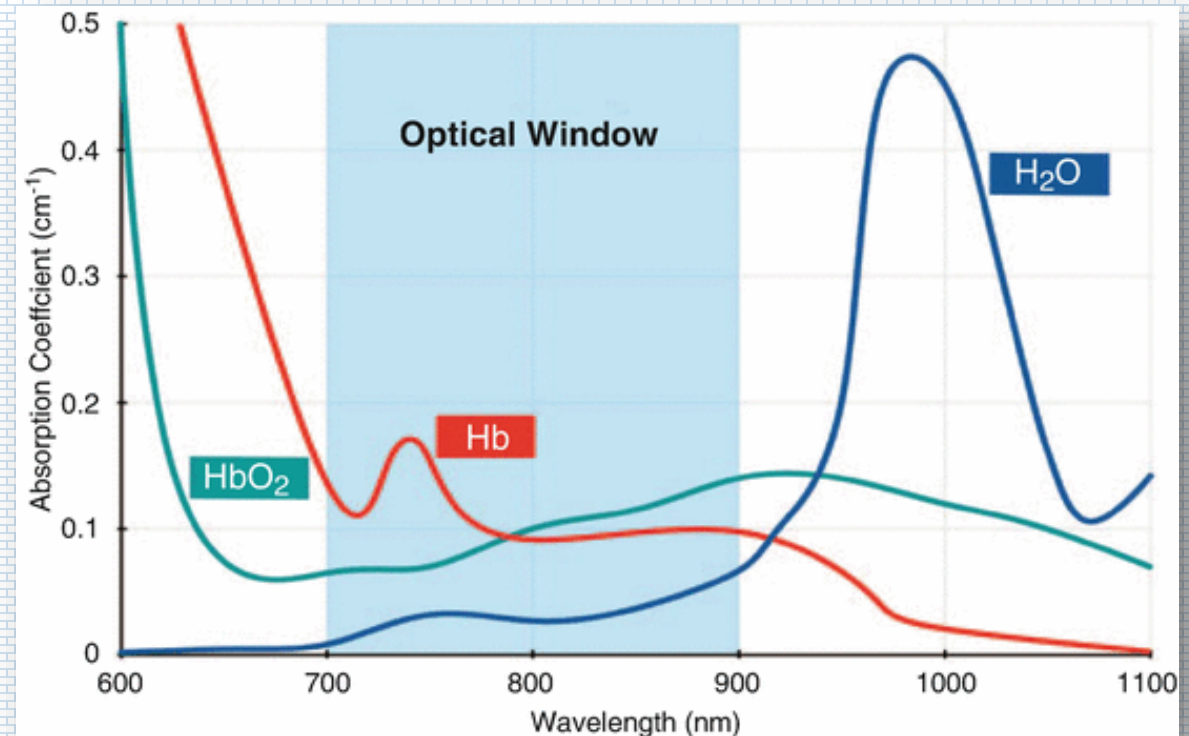
Method: Imaging Techniques

- **Spectroscopy**

  ✓ **Information** about the molecules forming the substance can be obtained via spectroscopy (the interaction of «light/electromagnetic radiation» and «the substance»).

Method: Imaging Techniques

- **NIR Spectroscopy**

  ✓ Different tissues absorb the IR light differently.

  ✓ Radiation in this range is absorbed;

  - ✓ slightly by the oxygenated Hb (O2Hb) in the arteries,
  - ✓ strongly by deoxigenated Hb (Hb) in veins.

Crisan, S. (2017). A novel perspective on hand vein patterns for biometric recognition: Problems, challenges, and implementations. In Biometric Security and Privacy, pp. 21-49. Springer International Publishing.

Method: Imaging Techniques

- **NIR Spectroscopy**

  ✓ Requires cameras with infrared-pass filters (which allow NIR rays to reach the camera lens).

  ✓ <u>NIR Imaging Steps:</u>

      1. Subject's skin is illuminated with NIR light.

      2. Photons are scattered by skin and fat layer (these tissues have low absorption coefficient) but absorbed by blood.

      3. The NIR image is created by the photons reflected back to the camera lens.

      4. Blood seen as dark region and the others lighter in the NIR image.

      5. Recorded NIR image is processed and analysed by computer (NIR image quality analysis).

Application: Hardware Part of the Study

- **Capturing NIR Images**

    ✓ A USB-powered NIR camera.

    ✓ Wavelength of 850 nm NIR LEDs which placed in a circular form around the camera lens.

    M. Francis, A. Jose, and K. K. Avinashe, "A novel technique for forearm blood vein detection and enhancement", Biomedical Research,28(7),pp.2913-2919,2017

Hardware Part

- Illumination of the image with 850 nm NIR LEDs.
- Reflected rays form the image with the NIR camera.

Software Part

- Convertion of a NIR image that is RGB to a grayscale image.
- Elimination of small noises with a median filter.
- Two consecutive CLAHEs for intensity adjustment.
- Detecting the edges of blood veins by applying Gabor filter.
- Binarization is applied according to the threshold value.
- Morphological procedures that sharpen the blood veins are performed.
- Determination of ROI.

Application: Software Part of the Study

- **Prosessing NIR Images**

  ✓ The recorded images were examined,

  ✓ The images transferred to the server computer were processed with the MATLAB program,

  ✓ The vein images consisting of black and white colors were recorded.

  M. Francis, A. Jose, and K. K. Avinashe, "A novel technique for forearm blood vein detection and enhancement", Biomedical Research,28(7),pp.2913-2919,2017

Hardware Part

- Illumination of the image with 850 nm NIR LEDs.
- Reflected rays form the image with the NIR camera.

Software Part

- Convertion of a NIR image that is RGB to a grayscale image.
- Elimination of small noises with a median filter.
- Two consecutive CLAHEs for intensity adjustment.
- Detecting the edges of blood veins by applying Gabor filter.
- Binarization is applied according to the threshold value.
- Morphological procedures that sharpen the blood veins are performed.
- Determination of ROI.

Application: Software Part of the Study

- **Before/After Image Processing**

The Raw NIR image of forearm.

The Processed NIR image of forearm.

Conclusion & Future Work

- The blood flow changes will be reported as preliminary diagnostic data.

- Future studies;
    - ✓ The developed system will be used to monitor patients who may have suspected vascular occlusion.
    - ✓ Possible delays in treatment are avoided.

Thanks for Listening...