TEAM 4

Near Infrared Imaging System (NIRIS)

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Outline

• Background
• Purpose and Objective
• Design
• Project Parts
• Budget
• Team member contributions

Figure 1.0: Using Infrared Imaging to Detect Thermal Gradient in Human Body
Background

- Near-Infrared Imaging
  - Non-invasive imaging method that uses light between 650 and 950nm
  - Used to probe the concentration of hemoglobin in the brain, muscle, and other tissues
  - Can penetrate several centimeters of biological tissue

- NIRIS Advantages
  - Portable
  - Does not require a dedicated technical staff
  - Does not require the patient to be injected with any isotopes
Purpose and Objective

- This project aims to create a near-infrared imaging system using laser diodes for imaging biological tissue
- Our solution will deliver a LabVIEW-compatible system that will help our client in her field of clinical instrumentation
- Dr. Quing Zhu works on devices that are used to detect cancerous tumors in the body

Figure 1.1: Dr. Quing Zhu
Previous Works

• NIR Diffusive Light Imaging System (A senior design project at the University of Connecticut Electrical and Computer Engineering Department)

• Near Infra-Red Spectroscopy: a low cost device

• Design of a portable Near Infrared System for topographic imaging of the brain in babies.

• Design of a hand-held laser breast scanner (LBS) which accurately distinguishes between malignant and benign tumors
Design Overview

- Laser Diode
- Photodetector
- Amplification of Current
- Hardware Filtering

- Digitizer
- ADC
- Noise Conditioning in PXI-5114
- Transmission through BNC

- DAQ Assistant VI
- Filter VI (Butterworth Bandpass)
- Filtered Signal Graph

- Raw Signal Graph
- User Interface
- Multiple Signal Detection Code
Hardware - General

• Hardware consists of essentially three different circuits
  • Laser Diode Circuit
  • Photodetector Circuit
  • Amplifier Circuit
• Two sinusoidal inputs are taken from two function generators stimulating the Laser diodes
• AC and DC grounds are kept separate to prevent noise interference
• Circuit is powered by a wall AC to DC converter
Hardware – Laser Diodes

- Laser Diode circuit uses a current driver to produce a stable current
- The current driver, FL-500, takes two different wave forms and uses this to stimulate the two laser diodes
- This chip feature bypasses the need for a stable DC component to drive the laser diodes and then add an additional component to supply the AC signal

Figure 2.0: Circuit Configuration for Laser Diodes Using the FL-500 to drive Both simultaneously
Hardware – Photodetector

- An Avalanche Photodetector is used as the source of detecting the laser diodes fed into the AC amplifier.
- The amplifier uses resistors to control the GAIN of the amplifier increasing magnitude of the signal.
- The output of the amplifier is our input for the computer.

Figure 2.1: Photodetector Circuit
Figure 2.2: AC Amplifier circuit
Software

- Accepts data from device through National Instrument Data Acquisition Unit (DAQ)
- DAQ puts data through ADC process
- User defines sampling frequencies of Laser Diodes
- Software calibrates laser amplitude thresholds for optimal detection
- Analyze and detect signals
Software

Figure 3.0: Screenshot of user interface
Enclosure

- Enclosure made of PVC plastic material
- BNC Adapters used for power source, frequency and output to computer
- Smaller internal box to house tissue sample

Figure 4.0: Front of Enclosure  
Figure 4.1: Back of Enclosure  
Figure 4.3: Inside of Enclosure
Team Member Contributions

• **Albert Pham**
  - Hardware Design
  - Construction of laser diode and detector circuits
  - Construction of hardware filter
  - Construction of amplifier circuit
  - Construction of PCB circuit

• **Barbara Adu-Baffour**
  - Research on near infrared imaging devices, circuitry, and components
  - Coding of software and analysis in LabView
  - Housing/Packaging of completed device.
  - Ordering of parts
Team Member Contributions

- Amir Nasser Bigdeli
  - Software Design
  - Construction of Labview Program
    (including software filters and GUI)
  - Integration of software and hardware components
## Budget

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<th>Merchandise</th>
<th>Price (USD)</th>
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<td>Laser Diodes (x6)</td>
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<tr>
<td>FL-500 current driver</td>
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<td>Avalanche Photodiodes (x2)</td>
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<tr>
<td>Plastic Enclosure</td>
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<tr>
<td>Smaller Plastic Enclosure</td>
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<td>Circuit Components</td>
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Acknowledgements

- Dr. John Enderle
- Dr. Quing Zhu
- Pete Glaude, Machine Shop
- Serge Doyon, Machine Shop
- Dana Hinckley, Wavelength Electronics, Inc.
- Marek Wartenberg
- Emily Jacobs
References

- Near Infra-Red Spectroscopy: a low cost device Peter Rolfe, Giovanni Mondo, Fabio Bottini, Davide Repetto, Carmelina Ruggiero
- NIR Diffusive Light Imaging System
  http://www.ee.uconn.edu/SeniorDesign/projects/ecesd89/index.html
- Design of a portable near infrared system for topographic imaging of the brain in babies
- Near-Infrared Imaging
  http://www.medphys.ucl.ac.uk/research/borg/research/NIR_topics/imaging_exp.htm
Questions