Conquering the Sensor-Tissue Contact
-- for A Breast Cancer Detector

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Distinguishing Two Projects

• His Project
  – Navigation
  – Improving the Circuit

• My Project
  – Stabilized detection
  – Mechanical Aspect

• Common Goal
  – Detect the cancerous tumors non-invasively
Big Picture

• Primary goal of the group
  – Use NIR light as a source to non-invasively monitor angiogenesis with diffuse spectroscopic techniques.

• Challenges addressed under this project
  – Optode-tissue coupling
  – Pressure equalization throughout the surface of interest
Alignment

- **Foam**
  - Tilt the detectors to fit the contours of the breast

- **Rigid Plate**
  - Equalization

<Diagram showing alignment setup with components labeled: Force sensor, Backing plate, Foam, 5.0mm, 10mm, Detector>
Materials Used

• Foam
  – Poron Quick Recovery Polyurethane Foam
    • Instant recovery
    • Compliance: 1-5psi

• Force sensor (same as before)

• Backing Plate
  – Delrin

• Photodiode
  – 9.7mm * 9.7mm VS 2.3mm*2.3mm active area
  – Higher SN ratio than the previous
My Probe

- Backing Plate
- Force Sensor
- Foam
- Photodiode
Sensor Circuitry

- Differential Circuit

```
R6  R7  V5
R8  R9
|     |
|     |
R1  43K
R3  43K
R5  1Meg
1Meg

5V
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Force Sensor

\[ R_f = 1\text{M Ohm} \]
\[ R_i = 40\text{K Ohm} \]
\[ \text{Gain } \sim 20\text{X} \]
Diode Circuitry

Current → Voltage → Amplify

Diagram details:
- Diode (D1)
- Capacitor (C1, 8pF)
- Resistor (R1, 1meg)
- Operational Amplifier (U1, OP37)
- Paths and connections labeled (3, 2, 0, OUT, Vout)
Experimental Setup

- Control Box
- Labtop for display
- Phantom
- Probe
- Sand Bags
- Output voltage
- Circuit Board
- Probe
- Output voltage
Experimental Results

Comparison of two force sensors

- Mass (g)
- Output (mV)

FS1 (mV) vs FS2 (mV)

Linear (FS1 (mV)) vs Linear (FS2 (mV))
More Results

Abdominal Test

Voltage (mV) vs. Mass (g)

- FS1
- FS2
- 730nm
- 805nm
- 850nm
- Linear (FS1)
- Linear (FS2)
Closer Look at the Signal Output

![Signal Output Graph]

- Voltage Output (mV)
- Points
- Signal From the photodiode
- 100g markers at various points

Graph showing voltage output over points for different wavelengths:
- 805nm
- 850nm
- 730nm
Improvements Made

• Change the point-contact from skin to plate
• Permit localized articulation
  – Elasticity of Foam
• Allow equalization with the aid of a rigid backing plate
In The Future...

• Future Work
  – Complete fabrication
  – Circuitries

• Recommendations
  – Minimize Friction
  – Use an improved differential amplifier
  – Packaging (more presentable to patients)