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Developing an Automated Platform for Breast Cancer Biopsy Imaging

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Introduction

Approximately 1 in 8 women will be diagnosed with invasive breast cancer in their lifetime and 1 in 39 women will die from breast cancer\(^1\).

The Screening and Diagnosis Paradigm

Breast Mammography/Ultrasound

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Image Guided Needle Biopsy

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Pathological Analysis

2-3 weeks
- Increased patient anxiety
- Negative impact on care

Lack of reliable access to pathologists in LMICs\(^2\)
Our Solution: Rapid assessment by leveraging fluorescently tagged HS-27 inhibitor to bind to the surface of heat shock protein 90 (Hsp90) which is overexpressed on aggressive breast cancer cells\textsuperscript{3}. Currently, HS-27 is applied by manually staining biopsy specimen\textsuperscript{4}.

Manual Staining Protocol Disadvantages

- Inconsistent Processing Times
- Lack of Standardization
- Biopsy prone to breakage
Prior Work

Thomas Vincent began this project by developing the biopsy collection platform and holder for staining and washing.

His results showed promise that using the platform design for staining and cleaning was as effective as the manual protocol at staining tissue with fluorescence.

The next step was to automate this process using his platform design.
Design Needs/Specifications

Need #1: Integrity of biopsy specimen maintained
- Stays in platform for the whole process
- Pump flow rate is less than 15 mL/min

Need #2: Can be transported by clinician
- Platform fits on 30 x 30 cm aluminum breadboard

Need #3: Fluorescent images are comparable to conventional microscopes
- Establish Wide-field and High-Resolution mode resolution within 10 microns of confocal resolution

Need #4: System can be implemented in LMIC
- Use Pocket Colposcope for imaging
- Use PLA materials for design
Design Proposal

**Biopsy Holder Design**

- **Position 1:** Collection
- **Position 2:** Staining/Washing

- Biopsy washed into here

**Imaging Holder Design**

- **Wide Field Mode**
- **High Resolution Mode**

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Design Proposal
Pump Automation Workflow

Diagram showing the workflow with components including a GUI Display Monitor, Microcontroller, H-Bridge Driver Motor Circuits, DC Power Supply, and three pump assemblies connected to Blopsy Sample, PBS, and Waste Stain.
Results

Flow Rate Experiment
- Biopsies of chicken breast tissue and fat
- Most critical condition at the outlet tube with fat biopsy
- No horizontal turbulence detected below 15 mL/min

Resolution of Pocket Colposcope using Imaging Holder
- Intensity Line Profile using ImageJ
- Resolvable if two smaller peaks are \( \frac{1}{2} \) the value of the maximum intensity

<table>
<thead>
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<th>Distance from target resolution slide (mm)</th>
<th>Overall Resolution (um)</th>
<th>Field of View (mm)</th>
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<tr>
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<td>5.52</td>
<td>6.20</td>
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<tr>
<td>22 (Wide Field)</td>
<td>17.54</td>
<td>26.3</td>
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Parameters of standardized wide-field and high resolution modes using imaging platform
Future Work

• Check platform for stain residue
• Compare manual to automated staining protocol using 4T1 tumors from mice studies
• Add battery power as a power source
• Insulate wiring between microcontroller, circuit, and pumps
• Modify platform to be able to stain and wash multiple biopsies at once
References