Interventional Photoacoustic Registration

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Paper Review

Project Update

• Currently working on
  – 532 nm three point experiment (Milestone 3)
  – Integration of a stereo camera (Milestone 4)
  – Registration between camera and US (Milestone 4)
  – BMEStart competition (Mile stone 5)

• Overall Status: **Project is On Time**
Outline

• Introduction
• Methods
• Results
• Motivation
• Criticisms
• Possible Improvements
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Introduction

• Imaging blood vessels and identifying vulnerable plaques
• Intravascular ultrasound (IVUS) combined with intravascular photoacoustic (IVPA) imaging system
• Other imaging techniques:
  – MRI
  – Electron-beam CT
Introduction: IVUS

- Intravascular Ultrasound (IVUS) System
  - Two types of catheter

Introduction: IVPA

- Optical absorption wavelength
  - Red blood cells
  - Collagen
  - Plaques

- By varying the wavelength of the laser pulses, it is possible to identify different components
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Methods: Experimental Setup

- A motor was required to rotate the sample
- 532 nm or 1064 nm laser
- A ground glass optical diffuser to provide 1 mJ/cm² energy

Methods: Image Acquisition Scheme

• The laser system was fixed
• The sample had to be mechanically rotated
• IVPA system was initiated first, then IVUS was initiated
• Signal averaging, digital filters, and scan-conversion

Methods: Tissue-mimicking Vessel Phantoms

• Phantoms modeling arterial vessel wall and plaques
  – Poly vinyl alcohol (PVA)
  – Two optically absorbing inclusions

• Ex-vivo sample of a rabbit artery
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Results: Phantom with Two Inclusions

Results: Ex-vivo Rabbit Artery

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Motivation

• Similarity
  – Photoacoustic imaging system combined with ultrasound system
  – Experimental setup

• Difference
  – Application of the combined imaging system
  – Integration of a stereo camera
Motivation

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Criticisms

• Why single-element IVUS transducer?

• Clinically feasible?

• What about identifying different components of plaques?
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Possible Improvement

• Intravascular laser optic fiber
  – Optic fiber will be integrated with the IVUS single-element catheter
  – Rotation of the catheter (not the entire sample)

• Rotating intravascular laser optic fiber
  – IVUS catheter with an array of transducers
  – Rotation of the laser fiber
Thank you!