Optical Medical Imaging at NIST

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Approach of NIST Optical Medical Imaging Program

Imaging Standards/Protocols
Testing and Evaluation of Modalities

Microscopy (confocal, widefiled, dark-field etc.)

Wide-field Hyperspectral Imaging

Broad-band or hyperspectral approaches

Analysis, Modeling, and Algorithms

Tissue Phantoms for Optical Imaging

Physical phantoms with standard characteristics (static-solid, dynamic-microfluidics-based)

HIP-based digital phantoms

Measurement Standards of Molecular Biomarkers

Physiological factors: Hb/HbO₂, Cyt C

Therapeutics/diagnostics: HSP 90, Fluorophores, etc.

Macro (phantom, in vivo, clinical)
Imaging – NIST partners
(OSU, UTA, CUA, FDA, etc.)

Dynamic Imaging of target biomarkers

Optical diagnostics using scene end members

Outreach

Translational research laboratories, standards orgs (DICOM, RSNA), FDA, NIH, industry

Current Activities-In House

Quantifying a Biomarker Remotely

Uncertainty Analysis on Quantitative Imaging Identifying and quantifying uncertainty sources

- Instrument-drift, noise, non uniformities
- Scene—geometric and radiometric factors
- Calibration and validation model being used robustness of both the calibration model and the analysis algorithm

Tissue Oxygenation (various partners)

How do we validate the % sat O₂ scale in the hyperspectral imaging results?

How do we compare it to other clinical oximetric methods? What is the level of uncertainty in a % sat O₂ reading from this type of measurement?

- Create "ground-truth" testbed, i.e., dynamic tissue phantom
- At the same time, remote sensing analysis approach of scene based decomposition to find the most important contributors to reflectance signal
- Full uncertainty analysis of the measurement—investigate sources of uncertainties

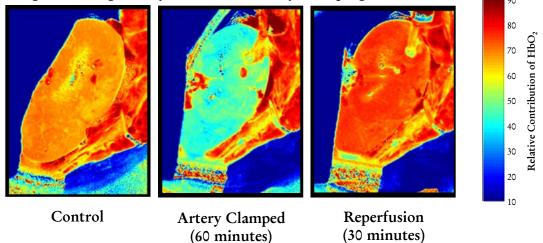
Tissue Oxygenation

Kidney Surgery DLP Hyperspectral Imaging System

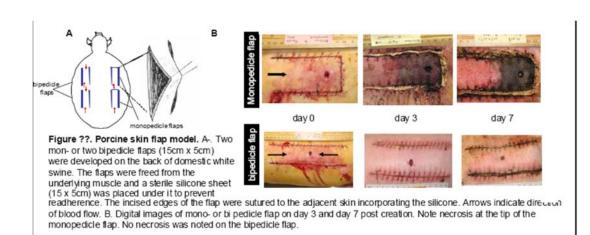
Stationary detection, source waveband scanning

Zuzak, et al

Images from Pig Kidney with Arterial Only Clamping

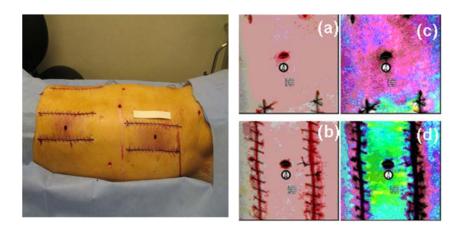


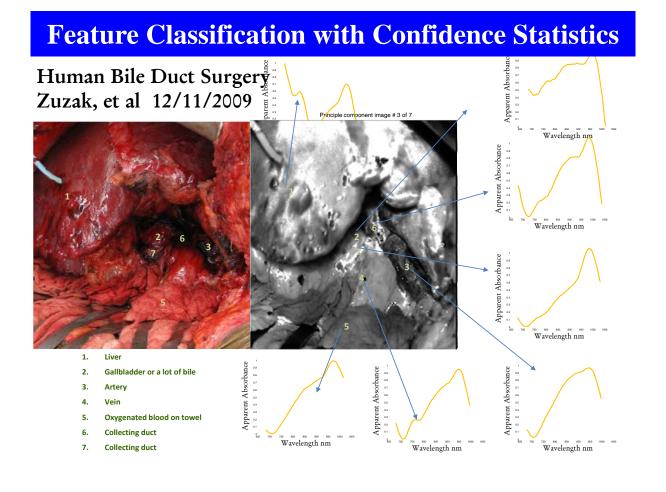
Animal Model in Collaboration with OSU



Animal model cont'd

Using spatially scanning hyperspectral imager





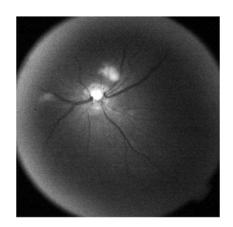
Quantifying Bilirubin in Tissue

Similar problem to oxygenation except there's nothing to ratio against

Patient clinical lab data available (de-identified)

Calibration model using pure bilirubin (optical bench) and using accepted clinical lab standard calibration protocols

Image component analysis for signal contributors (e.g. Hb)

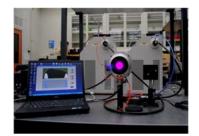


Other OMI activities (wide field imaging)

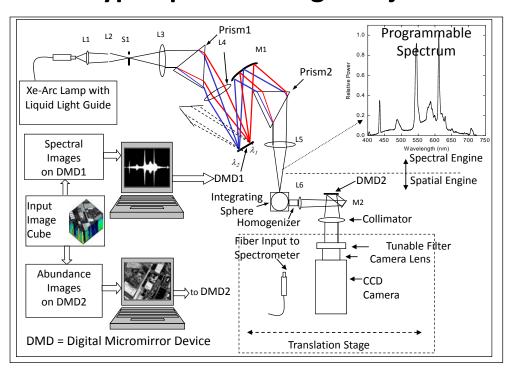
Image pre-processing (pre-analysis) techniques procedures for correcting images prior to analysis

Development of tissue phantoms (artifact) and digital (Hyperspectral Image Projector HIP) for optical systems calibration and development

Enhanced contrast illuminant
Calibration tools development
standard materials, protocols



Hyperspectral Image Projector



Digital Tissue Phantom Result



