Spectrally tunable sources and filters: tools for clinical bioimaging
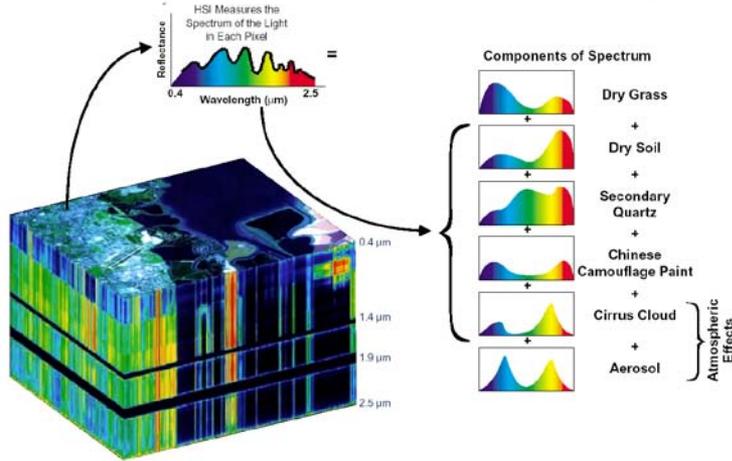
Toni Litorja, David Allen, Eric Shirley, Steve Brown, Joe Rice

Optical Technology Division
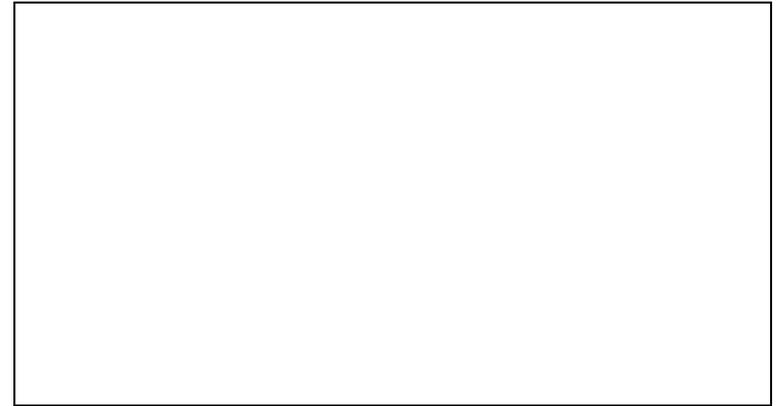
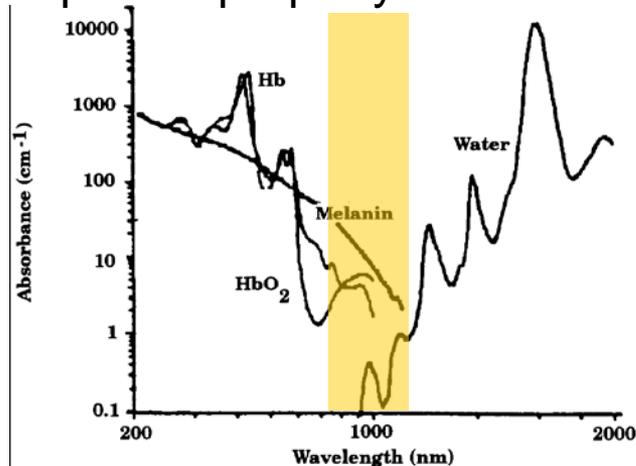National Institute of Standards and Technology
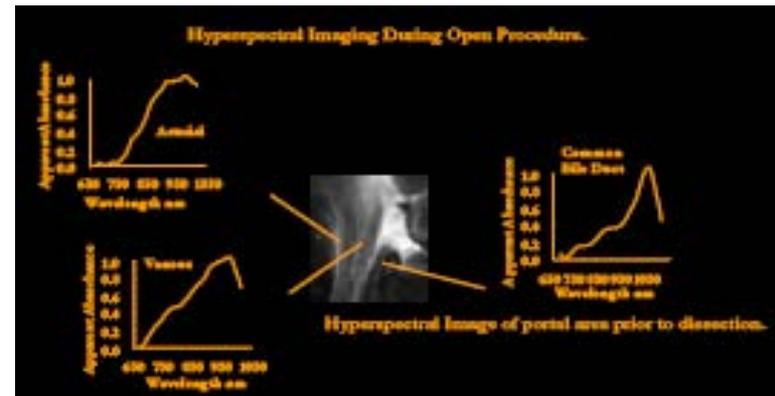
Hyperspectral Imaging

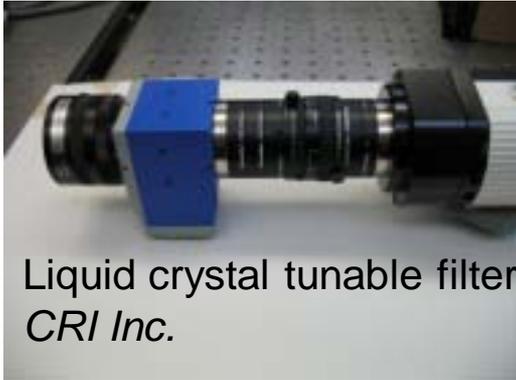Environmental remote sensing

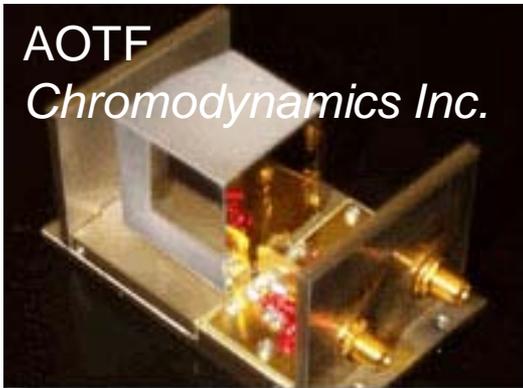
Chemical imaging spectroscopy

Spectral property of tissue

Hyperspectral imaging for clinical use

Using Tunable Filters

Liquid crystal tunable filter
CRI Inc.

AOTF
Chromodynamics Inc.

New filter technologies still under development

- Clinical hyperspectral imaging
- Uses ambient lighting
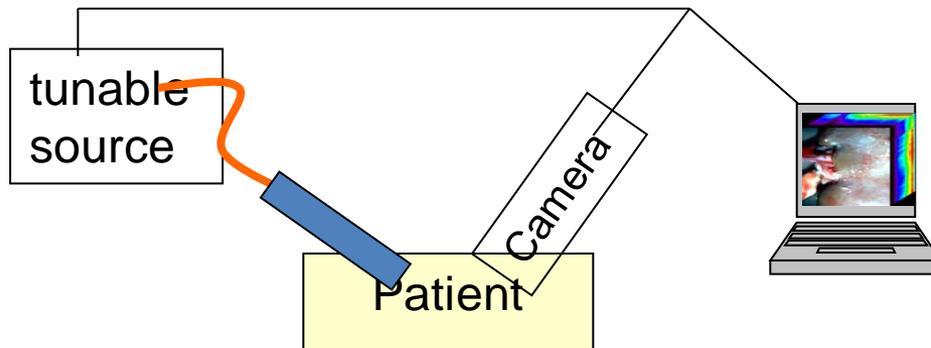- Non-mechanical scanning
- Many commercial sources

NIST OTD Metrology

Need spectral band characterization
(filter function)

Normalize images to standard reference
for reflectance

Corrections for spectral stray light

Using Tunable Sources
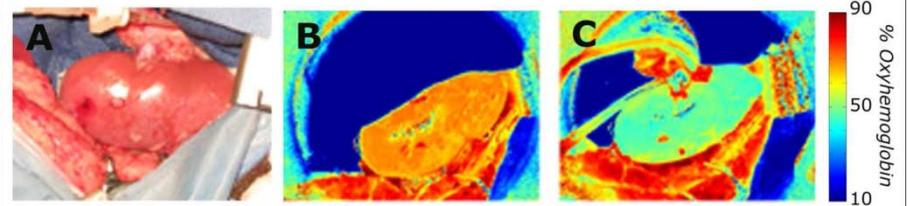

tunable source

Camera

Patient

Useful in laparoscopy

Faster acquisition

Metrology:
Characterization of slit function

Corrections for stray light

Dr. Karel Zuzak and Dr. Ed Livingston
UT Arlington/UT Southwestern Medical Center
DLP Surgical Utility
http://www.youtube.com/watch?v=Bz46ynbLrx0

Hyperspectral images (HSI) demonstrating real-time renal tissue oxygenation. A. In situ view of porcine kidney, B. Prior to occlusion of the renal artery and vein (AV), the renal parenchyma demonstrates a high percentage of oxyhemoglobin (% HbO2), C. After 55 minutes of ischemia, HSI detects a dramatic decrease in renal % HbO2.

# Illuminant Simulation for Visual Contrast Enhancement

CIELAB
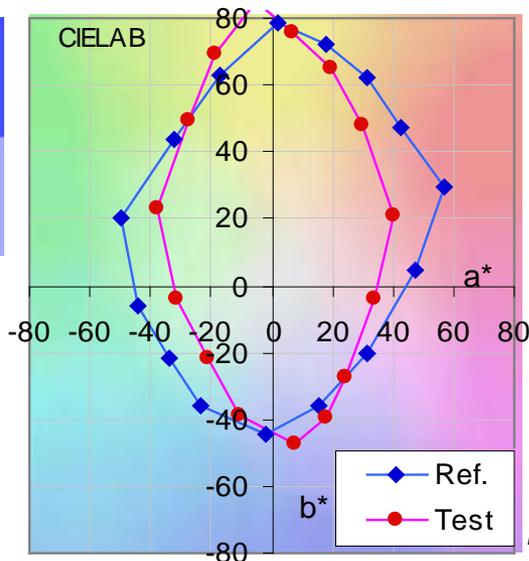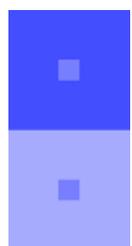
Ref lamp

Test lamp

$\Delta E^*ab = 19.4$

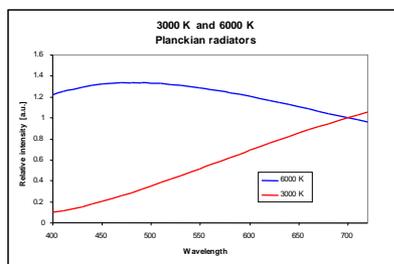*Ref on Color Quality Scale: Davis and Ohno, NIST*

Can we change the spectral distribution of the light source to enhance contrast between anatomically different but similarly colored features?

Provide a clinician another control besides brightness to aid in discrimination
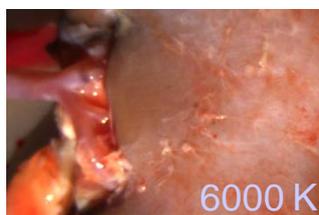
6000 K

3000 K

Clear perfusion sol'n

blood

Example: A normalized hyperspectral image of a perfused porcine kidney are presented using simulated Planckian radiators of 3000 K and 6000 K color temperature

Use CIE color contrast metrics
Simulate using image processing software
Realize using tunable source

Digital Tissue Phantoms for Imager Calibration

There is a need for a standard medical imager calibration phantom to reduce uncertainties in interlaboratory clinical comparisons
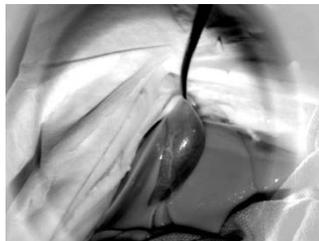
Phantoms used in medical imaging are tissue-mimetics made of soft materials with short shelf life and are non-portable

Technical Approach: use the HIP concept to project images as the calibration phantom

Standard Image Acquisition

Image acquired using a calibrated imager

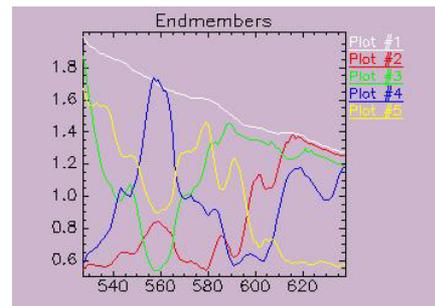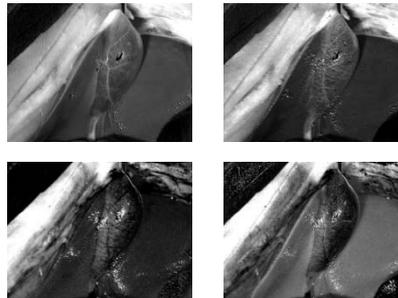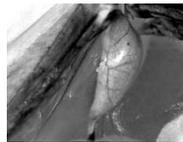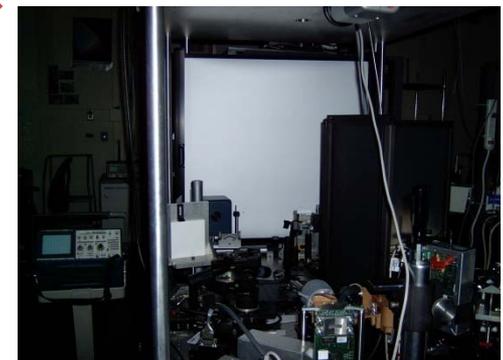hyperspectral image

Image Decomposition

Image Projection

HIP Ref: Rice and Brown, NIST

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