OPTICAL SOLUTIONS FOR HEALTHCARE

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Outline

- *In vivo* optical imaging for surgery and diagnosis
  - *In vivo* molecular fluorescence imaging
    - Image guided surgery
    - Prostate Cancer Detection
  - Diffuse Reflectance Spectroscopy
    - Imaging of Cutaneous Inflammation

- Optical Imaging for *biological analysis*:
  - Cells – Bacteria – Viruses imaging
In vivo optical imaging for surgery and diagnosis
Fluorescence Molecular Imaging

- To **detect**, To **localize**, To **quantify**

**Advantages:**
- Non ionizing
- Low cost

**Challenges:**
- Strong attenuation of light by biological tissues
- Diffusion of light in the tissues

![Graph showing haemoglobin and water attenuation](image-url)

**Graph:**
- Strong haemoglobin attenuation
- Strong water attenuation

<table>
<thead>
<tr>
<th>Wavelength (nm)</th>
<th>Attenuation (cm⁻¹)</th>
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<tbody>
<tr>
<td>450</td>
<td>0.01</td>
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<tr>
<td>650</td>
<td>0.1</td>
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<td>850</td>
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Image Guided Surgery

Vascular Imaging

Tumor Resection

Sentinel Node
Guided Surgery of Liver Metastases

Adenocarcinomas
• not stained by ICG
• surrounding tissues in contact with the tumors are intensively labeled.

Hepatocarcinoma
• tumor is intensively labeled,
• not the surrounding stroma.

Fluorescence molecular imaging **improves surgical resection**
• for two patients fluorescence molecular imaging has shown *stained margins confirmed by microscopy*
• *intraoperative ultrasounds* did not clearly delineate the tumor margins

“A Miniaturized Fluorescence Imaging System for Optical Guided Surgery of Human liver Metastases”, WMIC 2012, P817
Roadmap for image guided surgery

Towards minimally invasive surgery ...

Pre-clinical (FRI)

Open surgery imaging probe

Endoscopy

Laparoscopy

Miniaturization

Fluostic

2012

color + fluo
Prostate cancer diagnosis: limitation of US

- Ultrasound **lacks contrast** to localize early stage tumors and differentiate benign/malignant tumors
- Biopsy are performed **randomly**
- **10 to 12** biopsies/exam, 1 to 3 exams
  - Risk of false negative
  - Risk of dissemination
  - Complications
    - (hematuria, rectal bleeding, vasovagal episode,...)
Optical Imaging for prostate cancer

Bimodal TR probe

- Illumination fiber
- Detection fiber

US transducer: 128 points; 6.5 MHz

Ultrasound system + TR image acquisition

Co-registration of Fluorescence yield in US image

Depth 2 cm Resolution 1 mm
Imaging of Cutaneous Inflammation

Diffuse Reflectance Spectroscopy:
- a tool for characterizing evolution of epidermis/dermis composition in response to a stimulation (inflammation, injection or application of substances)
- for diagnosis or therapy following

Diffuse Reflectance Spectroscopy:
- acquisition of spectra by diffuse reflectance spectroscopy
- quantification of tissue composition
Optical Imaging for biological analysis
A NEW FRAMEWORK FOR BIO IMAGING

A small and cheap imaging system for bio opening the gate for:

• **wide field imaging**

• **multiscale imaging**

+ **dedicated acquisition protocol**
+ **holographic reconstruction**

• **dynamic imaging**
Wide field imaging of life

- seldom events detection
- large statistics for characterization of a sample

C.P. Allier  2012
N. Picollet-d’Hahan
M. Pyzalska
Multiscale imaging of life

**100μm** Acllnl

LENSFREE IMAGING
24 mm² FOV.

Control experiment
Confocal x20

**20μm** Fibroblast cell

LENSFREE IMAGING
24 mm² FOV.

Control experiment
Microscope x20

**2μm** *E. coli* Bacteria

LENSFREE IMAGING
24 mm² FOV.

Control experiment
Microscope x5

**200 nm** Toward viruses

LENSFREE IMAGING
24 mm² FOV.

Control experiment
Microscope x20

- Lumen
- Spheroid
- Without dye
- DAPI Fluo
- *E. coli*
- DS-red Fluo
- 200 nm beads
Dynamic imaging of life

S. Vinjimore 2012
CONCLUSION

Optical imaging setup associated to dedicated protocols and processing methods provides innovative optical imaging systems for healthcare.

- for In vivo imaging:
  - guiding surgery
  - diagnosis of prostate cancer
  - cutaneous inflammation characterization
    ⇒ non ionizing and cheap tools for diagnosis and surgery

- for Bio imaging:
  - bacteria detection and phenotyping
  - vaccine and viral based therapeutics development
  - pharmaceutical and toxicity study
Thank you for your attention