

Minimally invasive imaging of microstructure and function in living subjects Opportunities for real-time informatics

LIANG Kaicheng

Team Leader and Senior Research Scientist

Institute of Bioengineering & Bioimaging (IBB)

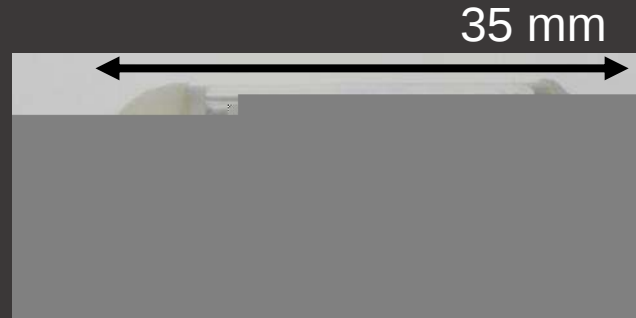
Bioinformatics Institute (BII)

NTU Lee Kong Chian School of Medicine

My background

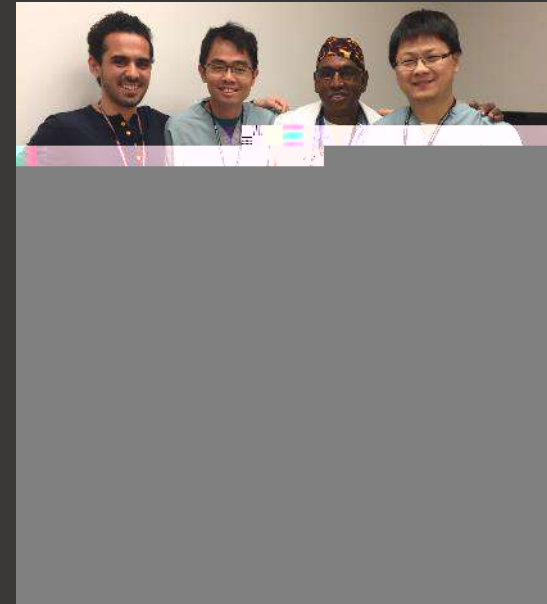


Fiber optic imaging system



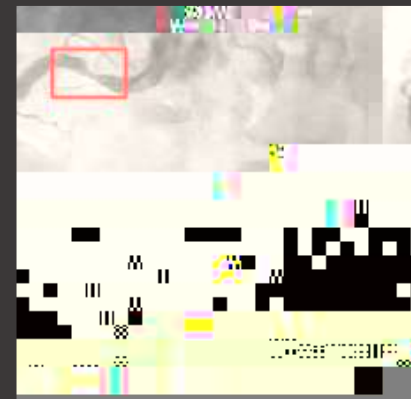
Medical device design
and pre-clinical validation

Electrical engineer (photonics and
optical imaging at MIT)



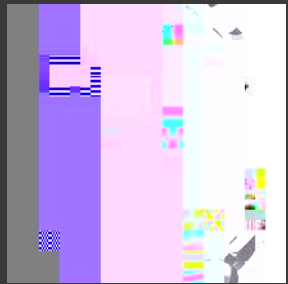
Clinical imaging
team at VA Boston
(Harvard teaching

Clinical researcher (assisted in >200
endoscopies)

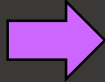


Machine learning postdoc at BII

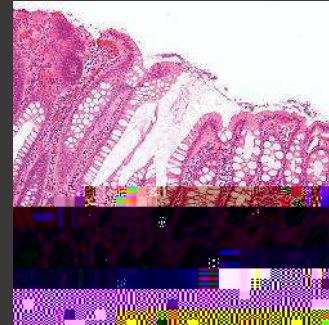
Small samples of excised tissue are assessed, down to cell nuclei
In surgery, must ensure malignant tissue is all removed



Biopsy/Resection



Fixing, embedding,
sectioning



H&E-stained tissue



Pathologist reading

Slow! Usually 1-2 days. For some surgeries, wait 30-60 min. for frozen sections

Biopsies can miss areas of disease

Limited amounts of tissue can be removed

My specialty Ultra-high speed OCT

Optical Coherence Tomography (OCT): non-invasive, $\sim 10\text{ }\mu\text{m}$ resolution

Real-time 3D endoscopic imaging *in vivo*. Millions of depth scans per second!

Awake Endoscopy

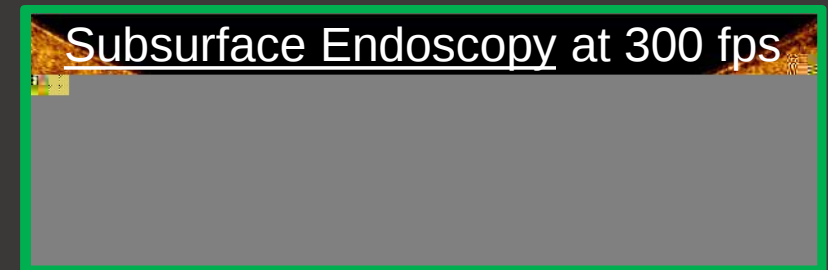
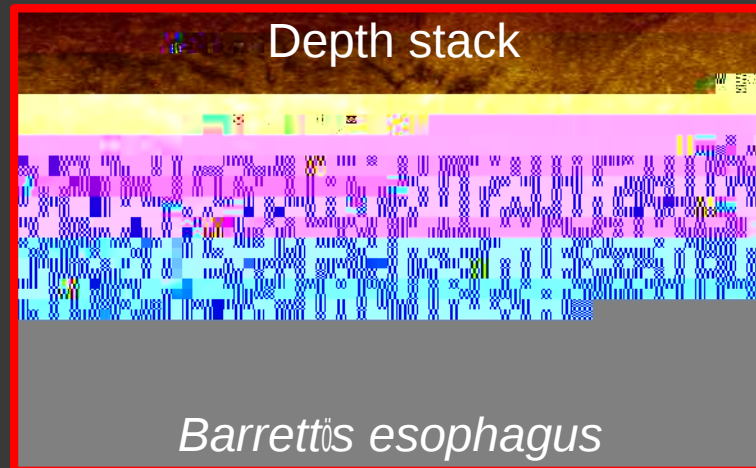
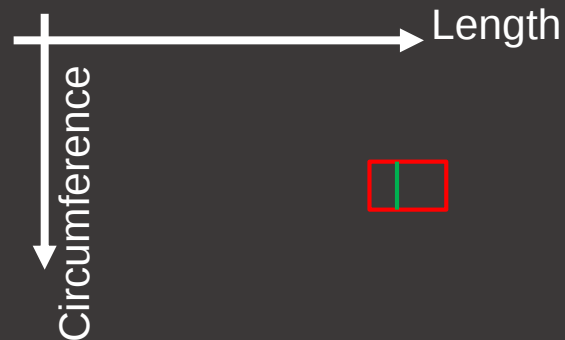
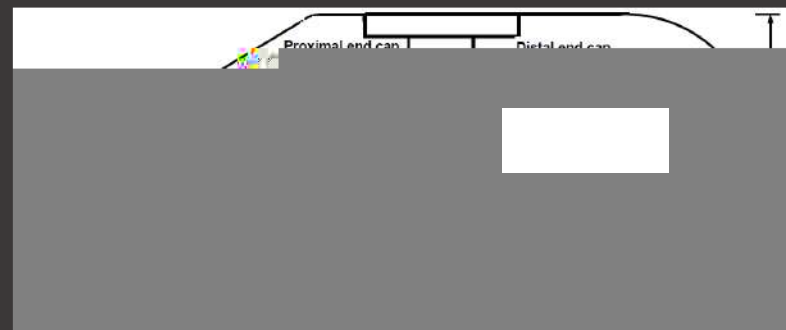
without sedation

100 cm² area



1cm

20 sec imaging time

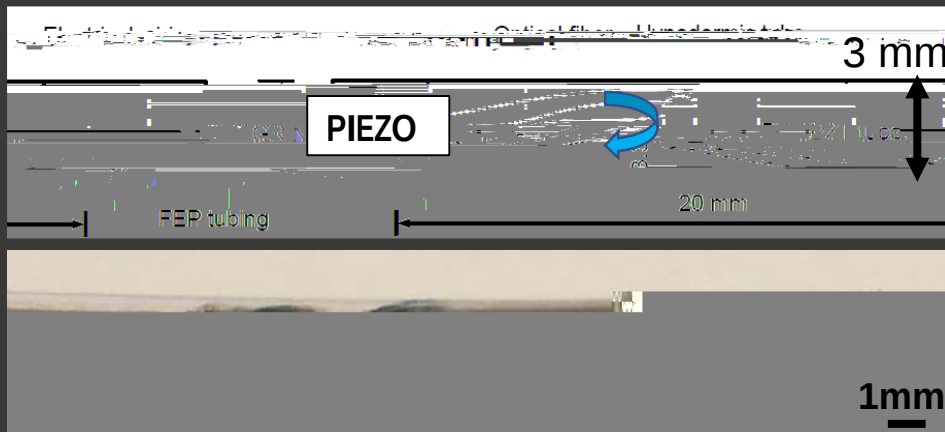


K Liang et al, *Am. J. of Gastro.* 2016,
BMJ Open Gastro. 2020
MIT Helen Carr Peake Research Prize 2017
Am. Gastro. Assoc. Certificate of Recognition

Technologies Microscanning

Competitive edge: ultracompact scanners for all-modality endoscopic microscopy

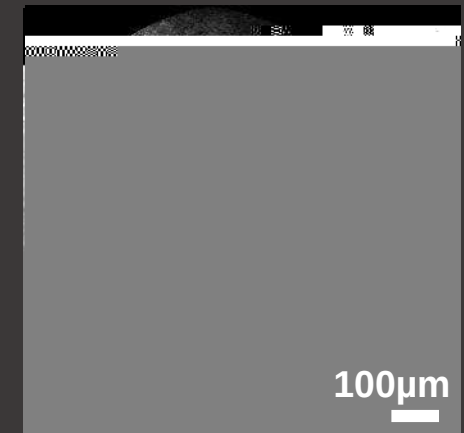
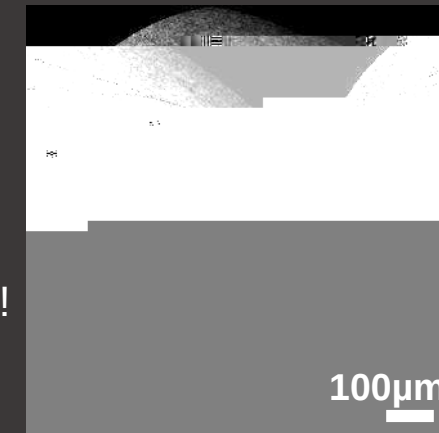
In a **forward viewing** fiber optic probe (w/ piezo actuator)



$\sim 1 \text{ mm}^2$ field of view
20x more than commercial instruments

K Liang et al,
Optics Letters 2017

Normal colon vs polyp in human patient

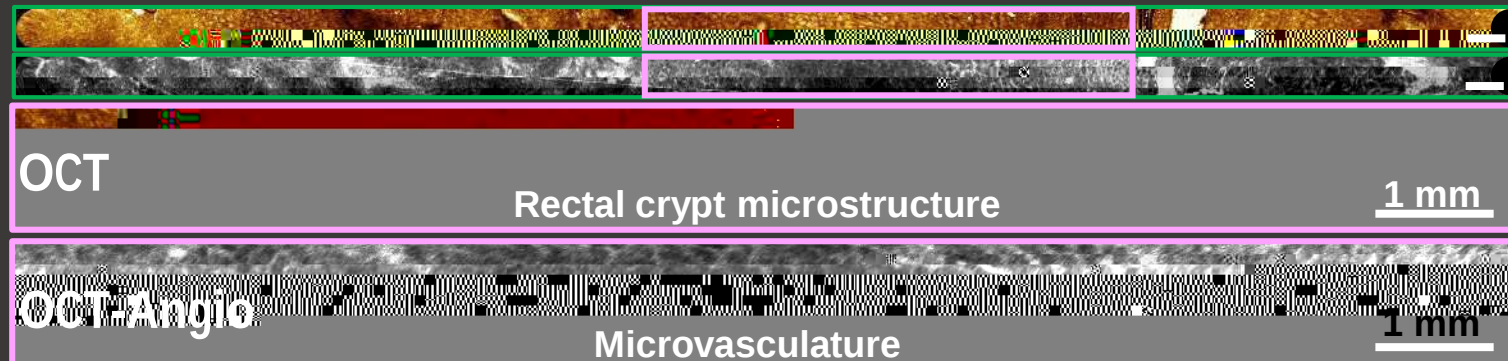


Then a **tethered capsule** with larger field of view (piezo + motor)



Tubular strip 40 mm^2 field of view
800x more than commercial instruments

First-in-human study

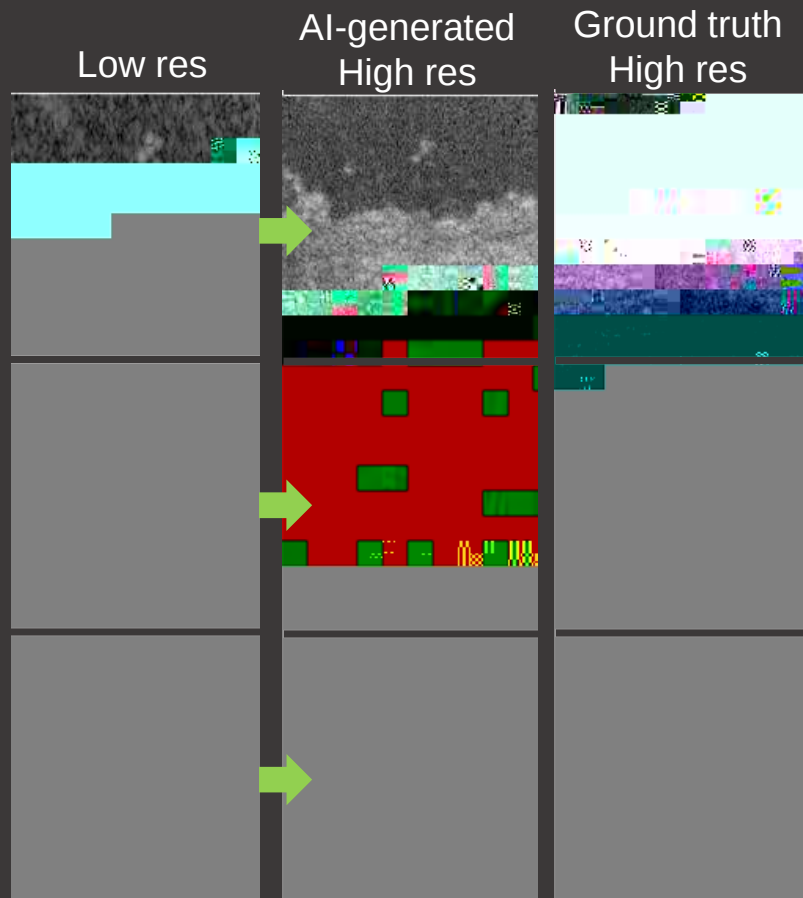


K Liang et al, *Optica* 2018, *Biomedical Optics Exp.* 2015, Two US Patent Apps

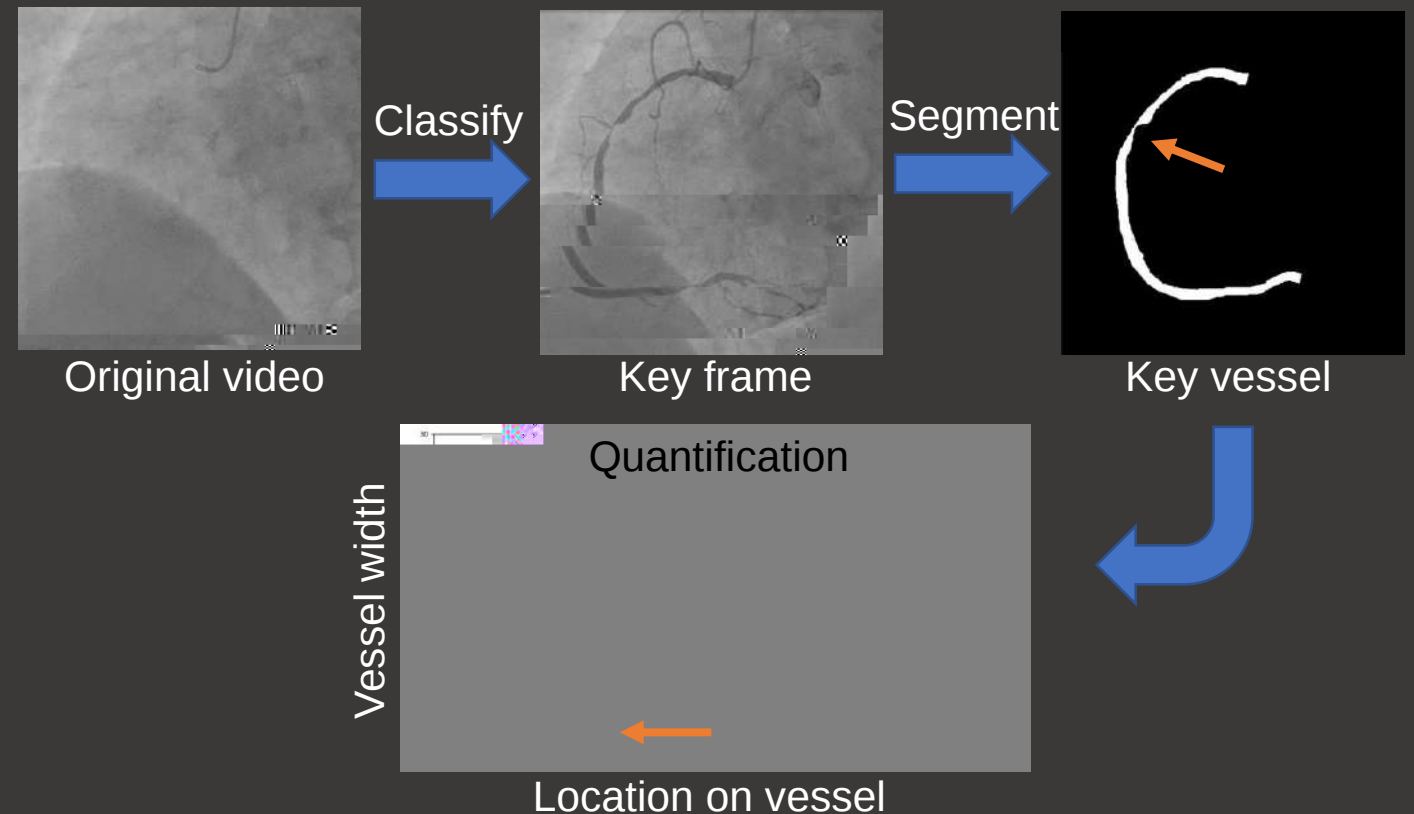
Technologies AI for imaging

Deep learning for optics and medical imaging

Enhancing OCT resolution



Analyzing coronary artery imaging video sequences



Ongoing projects

Challenge: *margins of surgical resections are qualitatively assessed on the macro-scale, often requiring repeat surgeries*

Extreme miniaturization of endoscopic microscopes

<1.5mm diameter with few-micron resolution, compatible with keyhole surgery and laparoscopy (and pre-clinical imaging!)

Use case: identifying margins of invasive brain glioblastoma at cellular level (collaborator: Dr. Aaron Foo, NUH Neurosurgery)

Algorithms and optical tech for quantitative fluorescence at the margins

Objective real-time assessment of uptake of clinical fluorescence dyes

Use case: liver cancer margins with indocyanine green (collaborator: Dr. Alvin Tan, Sengkang Hospital General Surgery)

Emerging topics

OCT as non-

Thank you!
liangkc@ibb.a-star.edu.sg
liangresearch.com