COMPUTATIONAL BIOIMAGING GROUP

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Idiap Innovation Day
Thursday 1 September 2016
Meet the team:

- Michael Liebling, Senior Researcher
- Kevin Chan, Idiap trainee (15–16) & UCSB PhD student
- Christian Jaques, PhD Student
- Olivia Mariani, PhD Student
Computational Imaging

Image Processing vs Computational Imaging

Image Processing: 
Input: Image → Output: Image

Computational Imaging: 
Input: Signal data + sensing models → Output: Image

Computational Bioimaging
Computational imaging applied to bio-related systems:
- develop hardware-software systems with applications in biological sciences
- quantitative image analysis of bioimaging data (2D, 3D, 4D, 5D)
The imaging-space in biology is high-dimensional

Bottlenecks that limit resolution and breadth
• optical resolving power, data bandwidth
• available time
• sample integrity (keep the sample healthy!)

Can we perform high-dimensional imaging without sacrificing resolution or image quality?

- engineering (optics, image processing)
- developmental biology
- bio-physics
Day 22 (Human)  Adult (Human)

Congenital Heart Defects:
occur in 0.8% of newborn infants,
are the leading cause of birth defect related deaths
Advantages:

- zebrafish are vertebrates
- reproduce externally and rapidly
- relatively transparent embryos
- may be genetically engineered to express fluorescent markers in specific tissues [e.g. Tg(gata1:GFP)]

48 hpf (hours post fertilization)
mb: midbrain
ot: otocyst
e: eye
h: heart
yolk: yolk mass
Fast 4D: Measure slices over multiple heartbeats
4D in vivo, Fast Confocal Microscopy is Possible

Before synchronization

After synchronization

A.S. Forouhar, ML
[Tg(cm1c2:GFP) 38 hpf zebrafish, Huai-Jen Tsai, National Taiwan University]
liveHeart: Heart shape influences blood flow and vice-versa!

Time-lapse of valve development and function gain from 84hpf to 110hpf

open valve

closed valve

anterograde flow

retrograde flow

valve length

J. Ohn (UCSB); Collaborators: J. Vermot, W. Supatto, N. Mercader
Key idea: Combine multiple (time-offset) low temporal resolution movies to create high temporal resolution movie.

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Main result: Temporal resolution increase by factor $1.5 \times$

Christian Jaques, Olivia Mariani, Kevin Chan

**Fast imaging to:**

- boost limited camera frame rate
- overcome low light situations
- improve spatial resolution by limiting motion blur

**Future developments:**

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Idiap
Christian Jaques
Olivia Mariani
Kevin Chan

UCSB
Kevin Chan
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Michael Lee (PhD’15)
Sandeep Bhat (PhD’13)
Jungho Ohn (PhD’13)

Hard- and Software
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BCM Houston (Mouse)
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Mary E. Dickinson

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