ePetri PLATFORM FOR CONTINUOUS ON-CHIP MONITORING OF MICROORGANISMS

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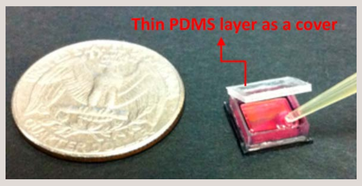
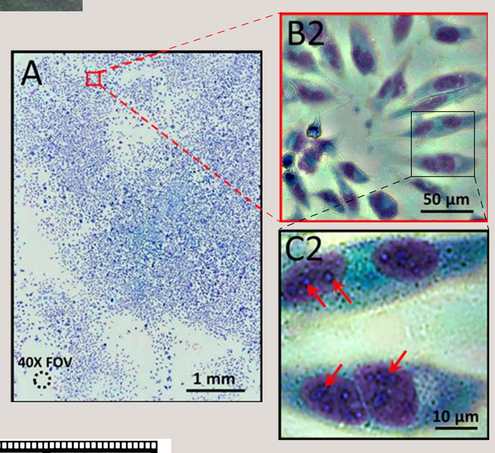
ePetri-DISH SYSTEM

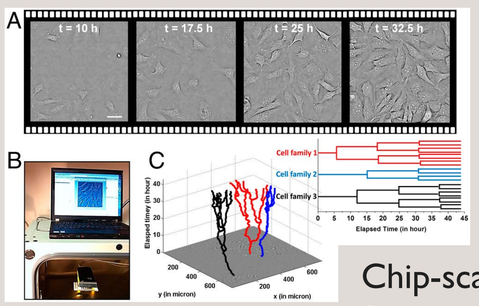


Compact and lensless imaging system using low-cost CMOS image sensors

Wide field of view (6mm x 4mm)

High resolution (660nm ≈ 40x, 0.65NA obj. lens)

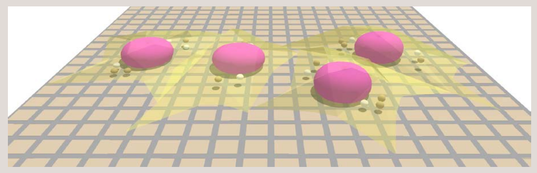




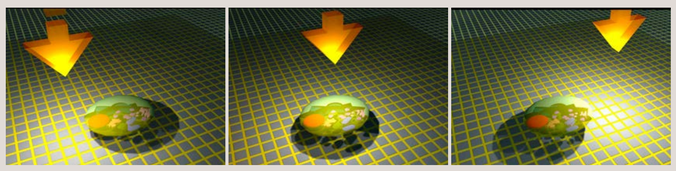
Non-invasive long-term imaging for culture monitoring

Chip-scale imaging platform for microTAS systems

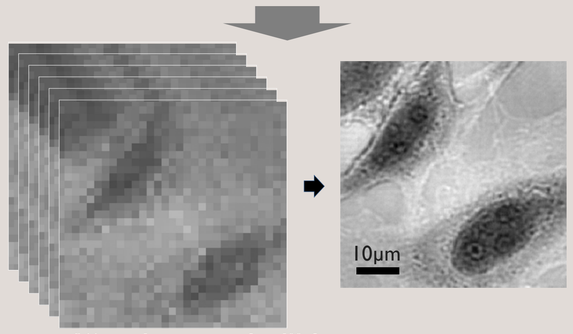
IMAGING ADHERENT CELLS



Cells cultured on the surface of CMOS image sensor

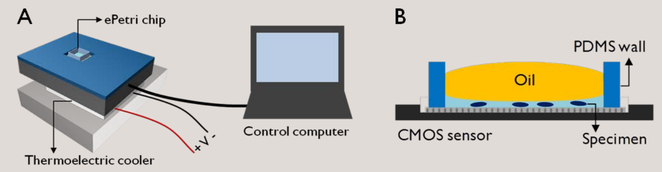


"Shadows" of cells collected through the sensor with varying illumination angle

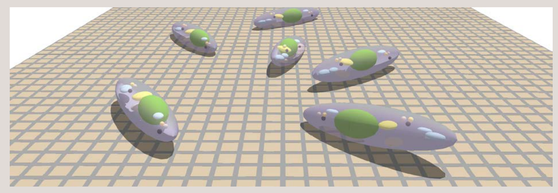


A set of "undersampled" low-res transmission images combined into a single high-res image via pixel superresolution reconstruction algorithm

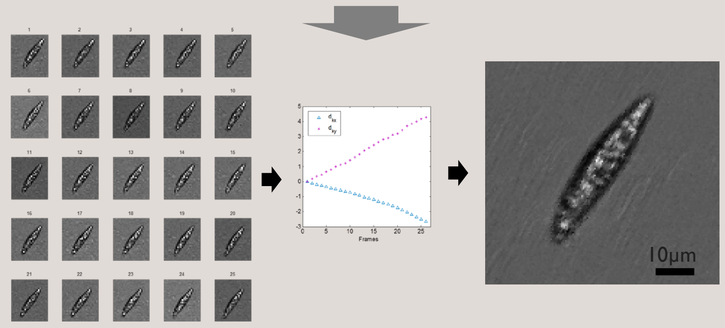
IMAGING MOTILE CELLS



Microorgamisms cultured in an ePetri setup



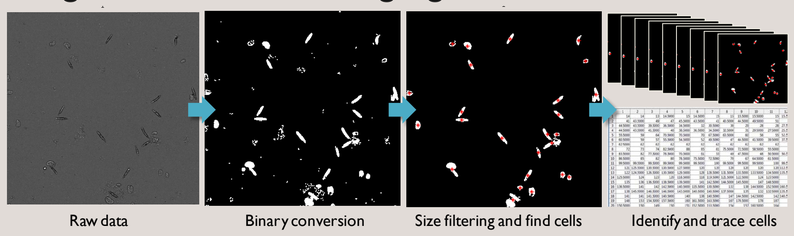
Low-res movie of swimming microorganisms on a CMOS image sensor taken at high frame rate



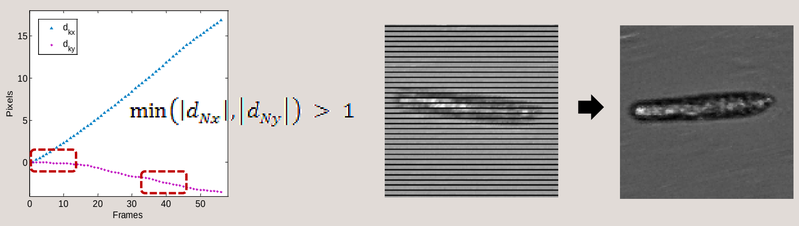
Trajectory of each cell is traced and the images are combined into a single high-res image via pixel superresolution reconstruction algorithm

IMAGE RECONSTRUCTION

Cell segmentation and tracing algorithm

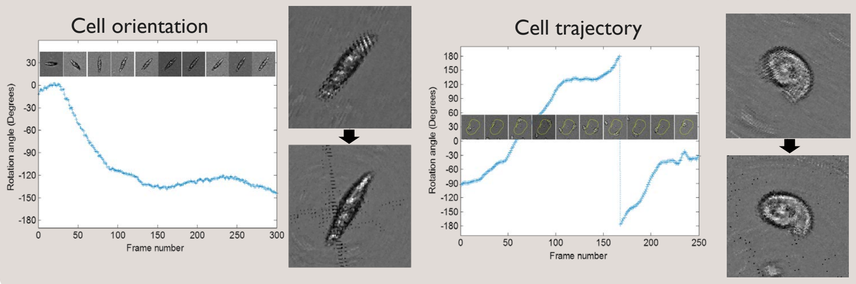


Speed and direction of the motion



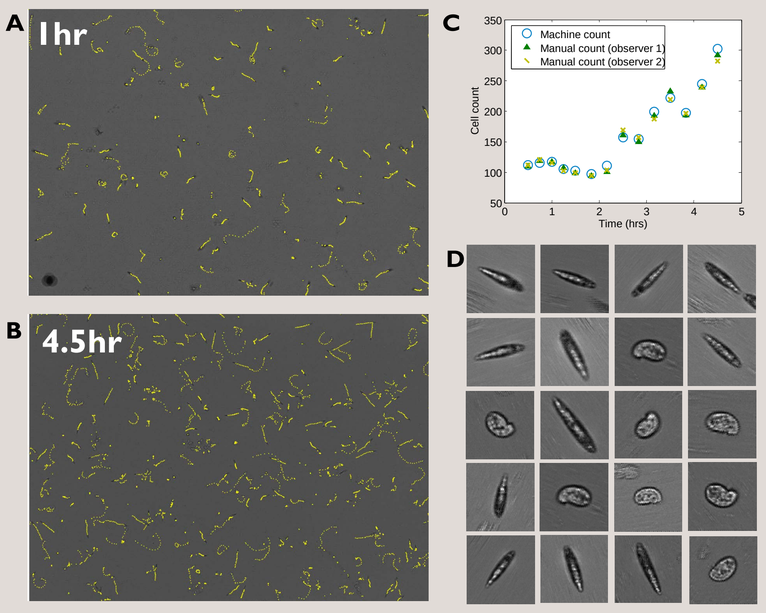
Rotation compensation

$$i_{kr}(l_x, l_y) = i_k(l_x \cos\theta_k - l_y \sin\theta_k + nd_{kx},\ l_x \sin\theta_k + l_y \cos\theta_k + nd_{ky})$$



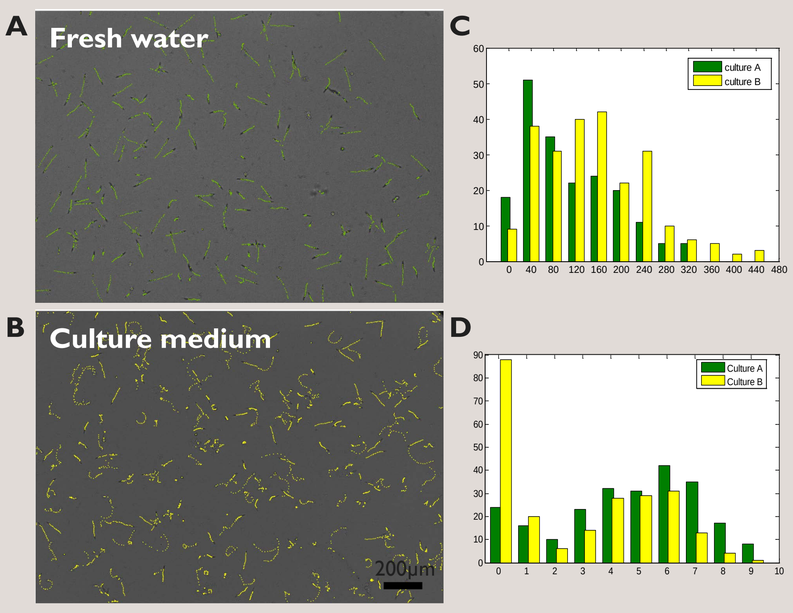
LONG-TERM MONITORING OF MICROORGANISMS

Longitudinal imaging of e. *gracilis* protozoa



- *euglena gracilis* cultured and monotored for 5h
- Large FOV video (low framerate) and small FOV video (high framerate) alternatively taken every 20min for cell counting and high-res imaging
- Exponential growth with <3% cell counting error

Imaging-based differential culture experiment



- Cell motility (speed) and shape (aspect ratio) distribution analyzed for two different culture environment
- ePetri can perform various image-based microbilogical assay

SUMMARY

- ePetri is a low-cost compact imaging system with large field of view and high resolution, particularly advantageous for long-term monitoring of cell growth.
- Inherent motion of the motile micro-organisms allows for high-res imaging without any additional light source requirement.
- Long-term monitoring and image based culture analysis can streamline various microbiological assay experiments.

REFERENCES AND ACKNOWLEDGEMENTS

[1] G.. Zheng, S.A. Lee, Y. Antebi, M.B. Elowitz, and C. Yang, *The ePetri dish, an on-chip cell imaging platform based on subpixel perspective sweeping microscopy (SPSM),* Proc. Natl. Acad. Sci. U.S.A., 108 (41), 16889-94, 2011.
[2] S.A. Lee, G. Zheng, N. Mukherjee, and C. Yang, *On-chip continuous monitoring of motile microorganisms on an ePetri platform",* Lab Chip., 12 (13), 2385-90, 2012.

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