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Nutrichip RTD 2010

FNSNF

Quantification of Sub-Resolution Sized Targets in Cell Fluorescence Imaging

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Objectives

Quantifying and evaluating the amount of fluorescent targets from epi-fluorescence microscopy images.

In this work [1], we aim at developing two methods that are able to extract quantitative measurements in order to monitor a group of cells through a target surface receptors.

- AFIM (Average Fluorescent Intensity Method): Using the intensity of the fluorescent signal
- NFPM (Number of Fluorescent Pixels Method): Using the size of the fluorescent signal

Scope

The Nutrichip project proposes to study the impact of dairy products ingestion by human through the use of a Lab-on-Chip platform.

Fluorescently stained biomarkers such as the toll-like receptors 2 and 4 (TLR2-4) are used to get a measurement of the cell immune response.

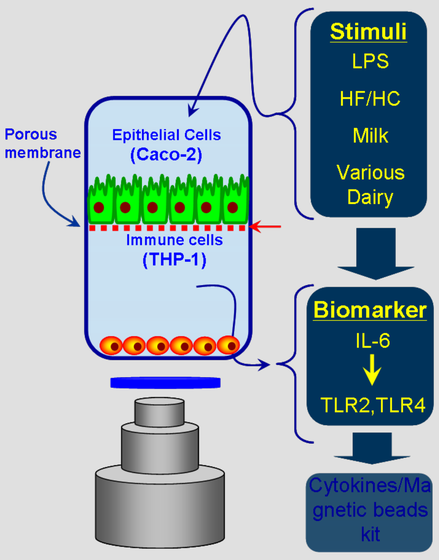


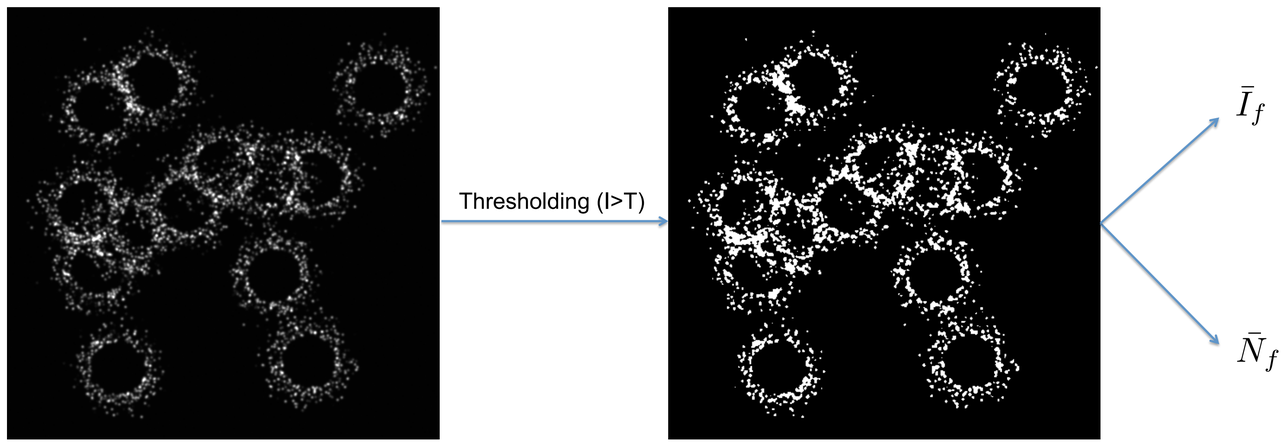
Image courtesy of Qasem Alramadan, EPFL

Methodology: Image generation and processing

Goal: Estimate the number of fluorescent targets N_r

Processing: Adaptive image thresholding
- Fluorescent pixels $I > T$
- Average fluorescent pixel intensity $\bar{I}_f = f(\tilde{N}_r)$
- Amount of fluorescent pixels per cell $\bar{N}_f = g(\tilde{N}_r)$

Image generation: Generating synthetic images [2] with various amount of objects (cells) and various amount of fluorescent targets (known input to the simulation that we want to recover).

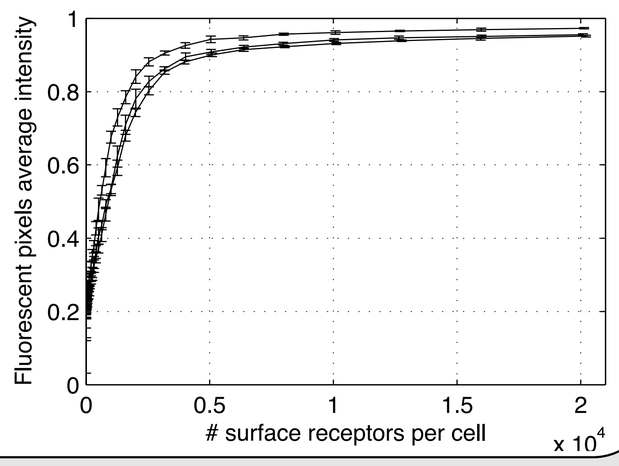


AFIM

AFIM is linking the number of fluorescent targets per cell with the average fluorescent pixels intensity.

Two regions:
- **Non-saturated**: The fluorescent pixels have not reached their maximum intensity. Linear behavior.
- **Saturated:** no estimation possible.

$$\bar{I}_f = f(\tilde{N}_r) = \alpha\tilde{N}_r + \beta$$



NFPM

NFPM is linking the number of fluorescent targets per cell with the amount of fluorescent pixels per cell.

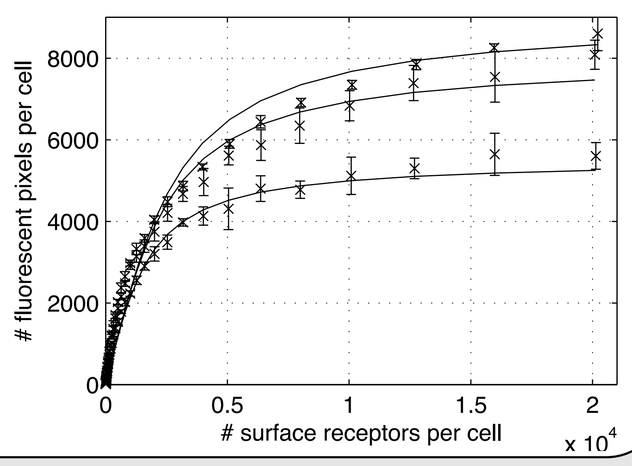
Exhibits non linear behaviors that can be modeled using an arctangent function.

$$\bar{N}_f = g(\tilde{N}_r) = \gamma \arctan(\delta.\tilde{N}_r)$$

Limit conditions:

$$\frac{dg(0)}{d\tilde{N}_r} = \gamma\delta$$

$$\lim_{\tilde{N}_r \to +\infty} g(\tilde{N}_r) = \frac{\gamma\pi}{2}$$



References

1. J. Ghaye, G. De Micheli, S. Carrara, “Quantification of Sub-resolution Sized Targets in Cell Fluorescence Imaging”, submitted to PRIME 2012.
2. J. Ghaye, G. De Micheli, S. Carrara, “Simulated Biological Cells for Receptor Counting in Fluorescence Imaging”, BioNanoSci., Springer, 2012, in press.