OPTICAL MANIPULATION OF BIOLOGICAL OBJECTS AND STRATEGIES FOR FINDING EFFICIENT TRAPPING TRAJECTORIES

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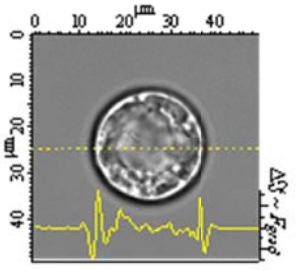
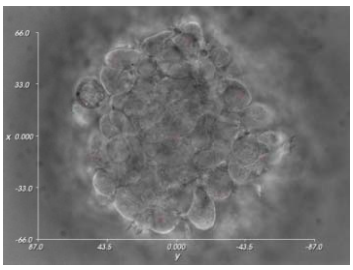
In cell biology and biotechnology, optical tweezers are the first choice for optical manipulation such as sorting or orientation of biological objects, since they offer contactless, non-damaging, and flexible forces on a specimen. If cells are very different in size or if clusters of cells have a non-regular shape, strategies for finding points where optical forces can be exerted efficiently have to be pursued. Depending on the kind of manipulation, trajectories of the optical tweezers displacements must ensure stable trapping and high displacement velocities.

We present strategies to find well-suited tweezers trajectories automatically. For sorting of single, arbitrary-sized suspension cells in a microfluidic channel, bright field camera images are evaluated. We present a direct relationship between the intensity change in the cell's bright field image on the CCD, the gradient of refractive index, and the optical gradient force (Fig. 1). A tweezers trajectory which moves cells reliable and fast to another stream line of the channel is determined for every single cell, independent of its size and shape.

For orientation of large cell clusters instead, scattered trapping light can provide additional information about appropriate trapping points (Fig. 2). An experimental setup implementing holographic optical tweezers is presented, which allows manipulation of cell clusters in 3D.





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