Title: Microrheology analysis and visualization toolbox

Authors:
Kaisa Liimatainen, Janne Koivisto

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Abstract

Hydrogels are used to model the extracellular matrix for better understanding of cell functions, from cancer progression to wound healing. Characterization of hydrogel viscoelasticity demonstrates how variably prepared hydrogels are formed, and how cells affect them. In microrheology, these complex biomaterials are analyzed using tracer particles.

In this research, we develop a toolbox for characterization and visualization of hydrogels, designed for passive multiple particle tracking microrheology. The characterization is based on particle movement, captured in time-series data from wide-field fluorescence microscopy.

The toolbox is developed using Unreal Engine, a game engine powerful in e.g. simulation. We combine traditional computational methods with Unreal's advanced functions for accurate and efficient particle tracking. Based on particle movement, hydrogel microstructure is classified into viscous and elastic areas. We are currently studying various visualization approaches utilizing 3D graphics tools of Unreal.

Currently, our toolbox classifies particles based on Brownian motion and visualizes the results in various ways. Different motion patterns can be detected by visualizing tracks of single particles, while the movement-based class counts are useful for detecting hydrogel microstructure changes during incubation.

Our toolbox for microrheology is useful for analyzing the structure of hydrogels and the effect cells have on it. Both detailed study of single particles and comprehensive analysis of whole area are possible. We continue developing the toolbox based on our analysis needs. We are interested in visualizing the changes in hydrogel structure and detecting cells to better define their relation to these changes.