Geometrical Characterization of Surfaces from Noisy 3D Fluorescence Microscopy Data

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BRIEF DESCRIPTION

A fully automated algorithm to determine the location and curvatures of an object's surface from 3D fluorescence images.

BACKGROUND

There has been an increase of 3D imaging in fluorescence microscopy applications that has allowed for the acquisition of large amounts of 3D data in both biological and physical systems. Due to this increase, a myriad of customized image segmentation and analysis methods have been developed and used to analyze these 3D fluorescence microscopy images. While the accuracy of these methods is suitable for most visualization purposes, some quantitative analyses, including morphology and curvature measurements, require considerably higher accuracy in the measurements. While some software programs are able to detect surfaces of data obtained by fluorescence microscopy and measure geometrical quantities of the surface, they can only do so at a qualitative level and do not enable precise, quantitative measurements.

DESCRIPTION

Researchers at the University of California, Santa Barbara have developed a fully automated algorithm to determine the location and curvatures of an object's surface from 3D fluorescence images. Data shows that the algorithm can detect the location of fluorescently labeled surfaces with sub-pixel resolution, and relative errors, below 2% for typical imaging conditions and even in the presence of substantial noise. The ability to characterize the geometry of surfaces at high resolution is relevant for many applications in several disciplines. A specific application of this method is the measurement of cell-generated mechanical forces in 3D multicellular environments, from in vitro multicellular aggregates (including embryoid bodies and organoids) to living developing tissues and organs. Using this algorithm to reconstruct the surface deformations of microdroplets injected between cells, it is possible to quantify cellular forces. No other technique exists to perform these measurements and there is a large and fast growing community interested in performing measurements of cellular forces in these living systems. This work allows quantitative measurements in the presence of high-level noise, enabling a wide range of applications.

ADVANTAGES

▸ Works in the presence of substantial noise

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OTHER INFORMATION

KEYWORDS

fluorescence, microscopy, 3D fluorescence images, algorithm, indansens

CATEGORIZED AS

▸ **Imaging**
  ▸ 3D/Immersive
  ▸ Software

RELATED CASES

2017-619-0

- ▶ High resolution
- ▶ Increased accuracy in measurements

APPLICATIONS

- ▶ Soft-matter physics
- ▶ Biological sciences
- ▶ Medical sciences
- ▶ Measure variations in surface curvature of microscopic objects such as cells, emulsion droplets, vesicles, etc.

ADDITIONAL TECHNOLOGIES BY THESE INVENTORS

Double Emulsion Droplets as Osmotic Pressure Sensors in Soft Materials and in Living Biological Cells and Tissues

Ferrofluid Droplets to Locally Measure the Mechanics of Soft Materials