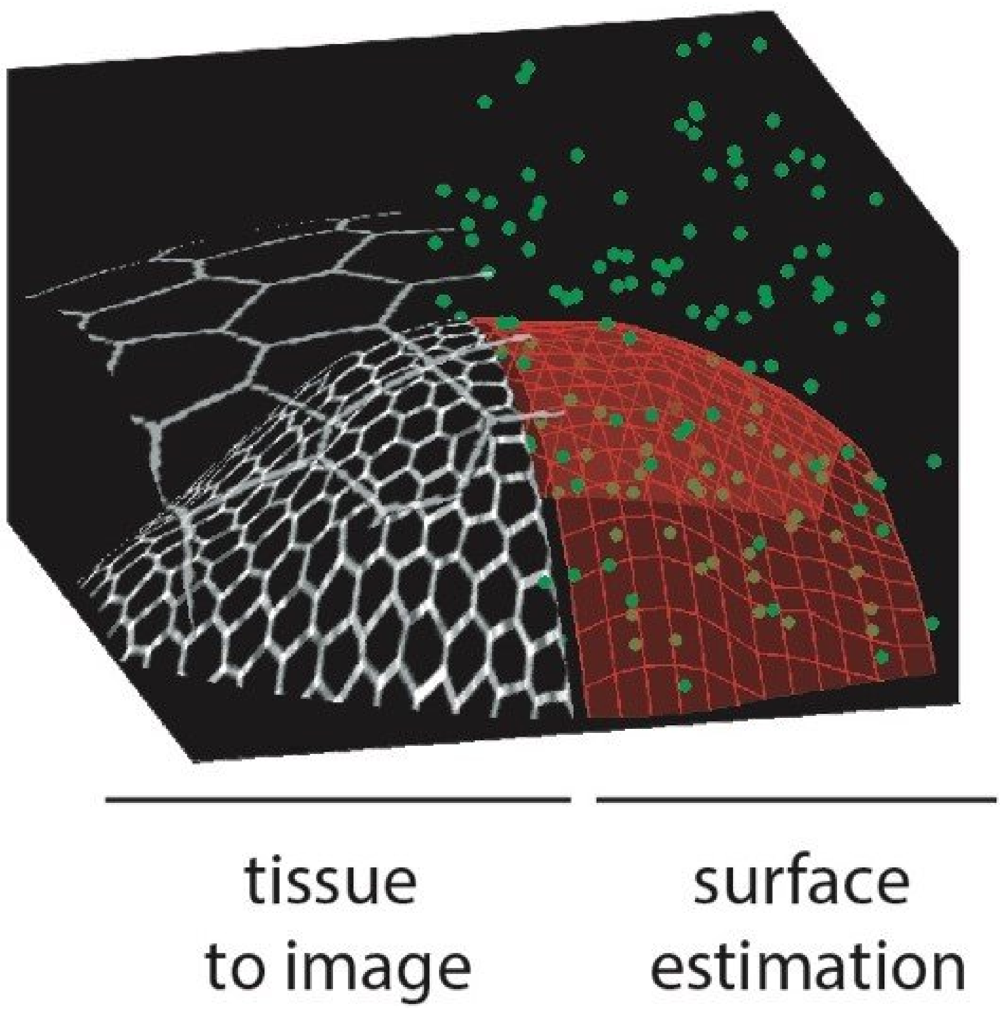
An adaptive microscope for the imaging of biological surfaces

October 12 2021



Left: Drawing of a curved biological tissue. The hexagons represent the fluorescent contours of the cells organized in a cell sheet. The tissue can be covered by a second epithelium which can be ignored by the imaging process.

Right: From a few acquisitions (green dots), the microscope automatically estimates the surface of the tissue (red mesh) and can then concentrate the acquisitions on this surface, or even only on the fluorescent cell contours thanks to a propagative acquisition algorithm. Credit: Faris Abouakil et al.

Modern biology relies on our ability to observe living cells using microscopes. The latest advances in optical microscopy allow cellular and sub-cellular imaging within model organisms such as the vinegar fly, zebrafish and mouse.

One of the fundamental limitations of current techniques is the toxicity associated with illumination, which compromises the biological processes studied. So far, there was not much solution to this problem except for reducing the light level, which leads to a loss of image quality.

In a new paper published in *Light Science & Application*, a team led by Drs. Loïc Le Goff and Frédéric Galland, both of Institut Fresnel at Aix Marseille University, France, has developed a new smart microscope that automatically calculates where to send the light to image the structures of interest in the sample in the most efficient way using learning strategies.

The starting point of this project was the observation that most biological tissues have a well-characterized architecture. In particular, most embryos are organized as surfaces—sheets of cells—curved in space. Microscopes do not adapt their operation to this architecture: they scan a laser focused in the whole 3D space that contains the embryo, which is very inefficient both in terms of speed and quantity of light irradiating the sample. The microscope developed at the Fresnel Institute automatically adapts its scanning pattern to the morphology of curved biological surfaces, without prior knowledge of the surface. On the tested samples, our smart scanning microscope has reduced the irradiation up to 100 times compared to a conventional confocal microscope.

This breakthrough technology was the result of a close collaboration between data scientists, physicists and biologists altogether at Institut Fresnel. The method opens a new way to image over long periods the behavior of very fragile objects such as embryos and organoids. Interestingly, the technology could be very simply adapted on many of the comercial microscopes that are found in the imaging facilities in biology institutes.

More information: Faris Abouakil et al, An adaptive microscope for the imaging of biological surfaces, *Light: Science & Applications* (2021). DOI: 10.1038/s41377-021-00649-9

Provided by Chinese Academy of Sciences