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Surpassing the Diffraction Limit by Structured Illumination Microscopy

Structured illumination microscopy (SIM) is a powerful imaging technique that has revolutionized the field of superresolution microscopy. This talk aims to provide an overview of SIM and highlight its numerous benefits over other superresolution methods.

SIM utilizes patterned illumination to overcome the diffraction limit posed on resolution in optical microscopy, enabling the visualization of fine structures in vivo with high temporal resolution. By illuminating the specimen using a harmonic pattern, in contrast with simple uniform illumination, SIM aliases higher frequencies into the sensed image that would not be captured otherwise due to the cut-off frequency of the transfer function of the optical setup. A reconstruction of a high-resolution image is then enabled using multiple acquisitions illuminated with different parameters of the harmonic.

Compared to other superresolution techniques, SIM offers several advantages, including its compatibility with conventional fluorophores and the possibility of employing different microscopy modalities. Its simplicity and a low requirement on the number of low-resolution image acquisitions enable fast acquisition times and reduced phototoxicity also due to its photon efficiency. SIM provides an accessible alternative to superresolution techniques that, in general, require a complex optical setup and owing to this, it became very popular in recent years also considering its further benefits in the common aspects and requirements of biological sensing in modern research.

This talk will delve into the concepts that SIM uses in order to surpass the diffraction barrier and outlines the conventional reconstruction technique as well as some prospects for future improvement.

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