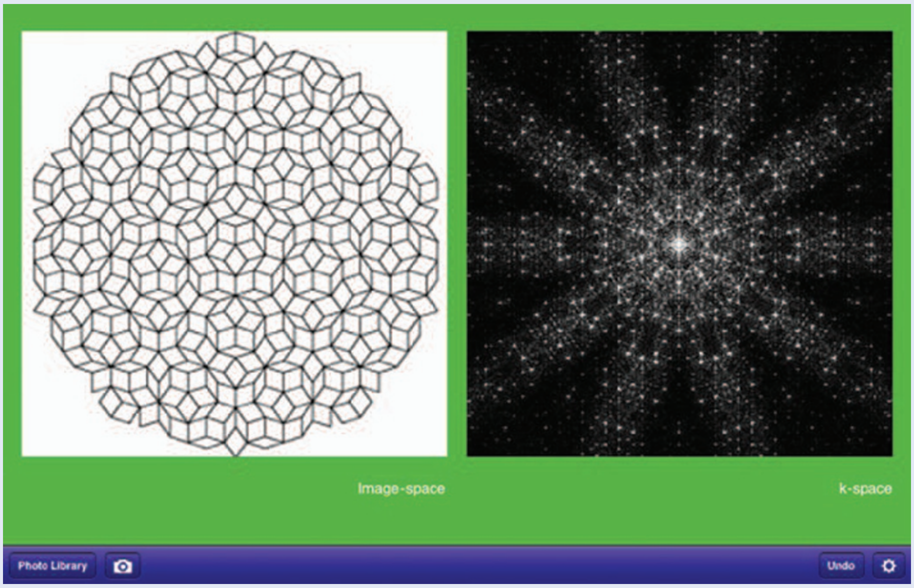
SCIENTIFIC APPS

Fourier transform on the move

It is now possible to calculate the Fourier transform of an image on your smartphone, thanks to a new app developed by two nanophotonics researchers in The Netherlands. "2D-Fourier" is available for free on the Apple store and runs on both the iPhone and the iPad. Versions for additional platforms may become available later.

The Fourier transform is a well-known mathematical tool that allows physical phenomena to be analysed in the inverse domain — a technique used throughout many areas of scientific research. As humans we are familiar with the concepts of hearing and seeing, whereby we 'measure' sound as a function of time and observe space in spatial coordinates. Many physical phenomena, however, are best analysed and understood in the inverse domain, where they are visualized in a world of reciprocal units. For example, in photonics, the Fourier transform links an optical pulse's temporal and spectral characteristics, makes it possible to analyse an image in terms of a distribution of spatial frequencies, and has inspired the field of Fourier optics and focal plane information processing.

Albert Polman, director of the FOM Institute AMOLF in Amsterdam, together with his PhD student Ernst Jan Vesseur, wanted to provide scientists with a means of calculating Fourier transforms on a mobile platform. The app is intended to provide a basic insight into the Fourier transform, rather than for use as a research tool. The user first takes a picture using the device's camera, after which the Fourier transform of this image is automatically shown on the screen. This gives direct insight into the distribution of two-dimensional spatial frequencies from which the image is composed. As a second feature, the user can draw over the original or Fourier-transformed image to explore what effect this has on the corresponding Fourier-transformed/original image. This provides additional insight into what spatial frequencies represent what part of the image.



The tool is meant for master students, PhD students and researchers who are learning about the Fourier transform in fields such as nanophotonics, photovoltaics or any other areas of physics that involve transforms between time and frequency, or between space and spatial frequency.

"The Fourier transform is complex, partly because the human brain has problems understanding the inverse of space and time," explained Polman. "This tool may help students to gain an insight into the Fourier transform, and also directly helps us in our nanophotonics research."

OLIVER GRAYDON

NONLINEAR OPTICS

Three-in-one microscopy

Using extremely broadband ultrafast near-infrared pulses, scientists have demonstrated simultaneous second-harmonic-generation, third-harmonic-generation and four-wave-mixing microscopy, enabling a range of different structures and functional groups in a biological sample to be imaged at once.

Brett Pearson and Thomas Weinacht

Over the past two decades, nonlinear optical techniques have transformed laser-based biological microscopy by introducing multiphoton excitation, which allows for increased depth penetration, three-dimensional localized excitation and reduced photodamage[1]. The most prevalent experiments have been based on two-photon fluorescence microscopy, which involves exciting a molecule to a higher-lying state by the simultaneous absorption of two photons from a laser beam. The high intensities required for two-photon excitation necessitate the use of short-pulse lasers as the light source, with typical pulse durations of less than 10^{-12} s (known as 'ultrafast' pulses). As in traditional microscopy, an image is formed

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