New technology allows cameras to capture colors invisible to the human eye

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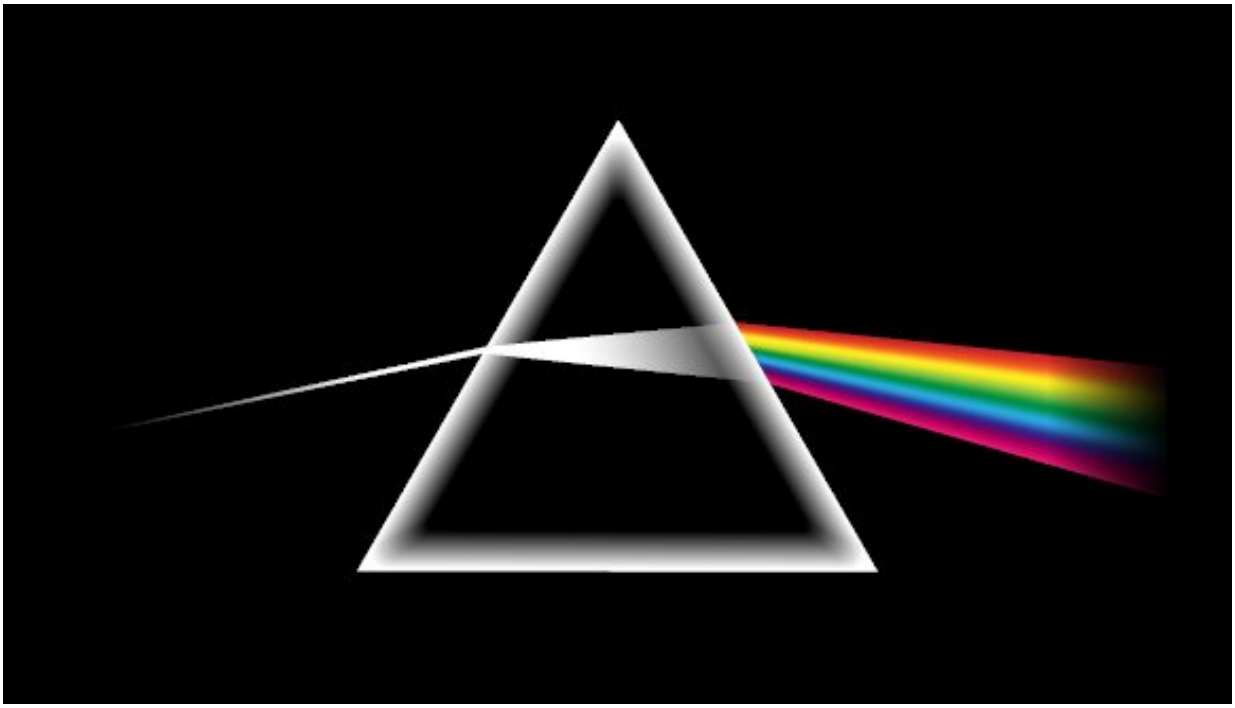

Credit: Tel Aviv University

New research from Tel Aviv University will allow cameras to recognize colors that the human eye and even ordinary cameras are unable to perceive.

The technology makes it possible to image gases and substances such as hydrogen, carbon and sodium, each of which has a unique color in the

infrared spectrum, as well as biological compounds that are found in nature but are 'invisible' to the naked eye or ordinary cameras. It has groundbreaking applications in a variety of fields from computer gaming and photography as well as the disciplines of security, medicine and astronomy.

The research was conducted by Dr. Michael Mrejen, Yoni Erlich, Dr. Assaf Levanon and Prof. Haim Suchowski of TAU's Department of Physics of Condensed Material. The results of the study were published in the October 2020 issue of *Laser & Photonics Reviews*.

"The human eye picks up photons at wavelengths between 400 nanometers and 700 nanometers—between the wavelengths of blue and red," explains Dr. Mrejen. "But that's only a tiny part of the electromagnetic spectrum, which also includes radio waves, microwaves, X-rays and more. Below 400 nanometers there is ultraviolet or UV radiation, and above 700 nanometers there is infrared radiation, which itself is divided into near-, mid- and far-infrared.

"In each of these parts of the electromagnetic spectrum, there is a great deal of information on materials encoded as 'colors' that has until now been hidden from view."

The researchers explain that colors in these parts of the spectrum are of great importance, since many materials have a unique signature expressed as a color, especially in the mid-infrared range. For example, cancer cells could be easily detected as they have a higher concentration of molecules of a certain type.

Existing infrared detection technologies are expensive and mostly unable to render those 'colors.' In medical imaging, experiments have been performed in which infrared images are converted into visible light to identify the cancer cells by the molecules. To date, this conversion

required very sophisticated and expensive cameras, which were not necessarily accessible for general use.

But in their study, TAU researchers were able to develop cheap and efficient technology that could mount on a standard camera and allows, for the first time, the conversion of photons of light from the entire mid-infrared region to the visible region, at frequencies that the human eye and the standard camera can pick up.

"We humans can see between red and blue. If we could see in the infrared realm, we would see that elements like hydrogen, carbon and sodium have a unique color," explains Prof. Suchowski. "So an environmental monitoring satellite could 'see' a pollutant being emitted from a plant, or a spy satellite would see where explosives or uranium are being hidden. In addition, since every object emits heat in the infrared, all this information could be seen even at night."

After registering a patent for their invention, the researchers are developing the technology through a grant from the Innovation Authority's KAMIN project, and they have already met with a number of both Israel-based and international companies.

More information: Michael Mrejen et al, Multicolor Time-Resolved Upconversion Imaging by Adiabatic Sum Frequency Conversion, *Laser & Photonics Reviews* (2020). DOI: 10.1002/lpor.202000040

Provided by Tel Aviv University