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News

World's fastest camera

Speedy snapshots captured using laser light.

Geoff Brumfiel

The new camera can take snaps every 163 nanoseconds.T.Sato

A team of physicists has built the world's fastest camera using off-the-shelf electronics from the fibre-optics industry.

The camera technique, known as serial time-encoded amplified microscopy (STEAM), can take an image every 163 nanoseconds — a rate roughly six times as fast as the best digital video cameras on the market. Although its current resolution is only about 2,500 pixels, that can probably be improved, says Keisuke Goda, a researcher at the University of California, Los Angeles, and one of the authors on the paper, which appears today in Nature[1].

The camera could be used for studies of combustion, laser cutting and any system that changes quickly and unpredictably. "I would imagine that STEAM would be useful for any scientist," Goda says.

The trouble with chips

Conventional digital cameras use charge-coupled devices (CCDs) to take a picture. The devices contain semiconducting chips that that produce electrons in response to light. The electrons are read off the chip and their signals are then electronically amplified and encoded as a digital image.

The team captured pictures of tiny beads moving through microfluidic channels.Nature

All this processing takes time. A conventional digital camera can only take images at the rate of about 30 frames per second, and even the best devices can only image about a million frames per second. Above those speeds, lack of light and electronic noise make images blurry and dim, Goda says.

STEAM gets around these problems by reducing a 2-D image into a stream of light. First, researchers spread pulses of light from an infrared laser to form a spectral pattern. They then shine this light onto the object they want to photograph. This means that different parts of the object are illuminated by different

wavelengths of light. The reflected light is fed through a special fibre-optic cable that makes different wavelengths travel at different speeds. Longer wavelengths move to the front of the line, while shorter ones fall to the rear. The stream of light is amplified and then read out by a single photodetector (see video). By recording the times at which different wavelengths arrive, the researchers can reconstruct an image of whatever was illuminated by the spectral pattern.

One dimension better than two

The system can beat a CCD camera because the electronics processing is much simpler, Goda says. Rather than reading out from millions of pixels, the STEAM camera's electronics need only worry about the signal from its single photodetector. That allows it to read out images far quicker than a normal camera can.

Goda and his colleagues used their camera to image minute spheres flowing along a thin tube of water in a microfluidic device. Using the STEAM camera they were able to image the spheres at a frame rate of 6.1 megahertz — in other words, the camera took a picture once every 163 nanoseconds.

The STEAM technique is impressive because it uses equipment that's commercially available to do something new, says John Dudley, a physicist at the University of Franche-Comté in Besançon, France. "What they're doing is taking advantage of the fact that high-quality optical components are available off the shelf," he says. "It's elegance in the finest sense of the word."

Dudley believes that, with further development, the camera could be used for studies of combustion and laser cutting — two industrial processes that are not well understood.

First, the resolution of the camera will have to be improved. At present it is a thousand times lower than that of most mobile phone cameras. Goda says that switching from infrared to shorter-wavelength light should allow them to dramatically increase their performance. "At this stage, it's still a proof-of-principle demonstration," he says.

- ## References

1. Goda, K., Tsia, K. K. & Jalali, B. Nature 458, 1145–1149 (2009). | Article |