

# Researchers develop world's fastest bar code reader

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(PhysOrg.com) -- Building on a series of recent breakthroughs in ultrafast analog-to-digital conversion, UCLA engineers have designed a bar code reader that is nearly a thousand times faster than any device currently in use.

The new imaging technique, developed by researchers at the UCLA Henry Samueli School of Engineering and Applied Science, enables the detection of ultrafast, non-repetitive transient phenomena in real time and can produce one-dimensional bar codes with a frame rate on the order of 25 million frames per second. Their research appears in the Sept. 29 edition of the journal *Applied Physics Letters*.

Bar codes — which are currently used in the management of everything from retail inventory and mail distribution to blood banks — are read by optically scanning the code's alternating light and dark bars and then using a computer program to convert the resulting image into digital form, essentially "decoding" the information stored within the code.

Conventional bar code readers use one of two approaches to acquire an image of the bar code. In one, a laser beam is scanned over the code to measure the intensity of the light reflected back by the black-and-white pattern. In such devices, the activity of the mechanical scanner limits the image-acquisition speed to less than 1,000 frames per second. In the second type, a digital camera, such as a CCD- or CMOS- based device, takes a picture of the code, which is then recognized by the computer. The frame rate of these devices is limited to about 1,000 frames per

second by the refresh rate of the CCD or CMOS image sensor.

The new imaging technique reported by UCLA postdoctoral fellow Keisuke Goda, graduate researcher Kevin K. Tsia and electrical engineering professor Bahram Jalali uses a phenomenon known as amplified dispersive Fourier transform to read bar codes at a frame rate of 25 MHz — about a 1,000 times faster than current technology.

The new technology, dubbed the CWEETS Scanner (chirped wavelength electronic encoded time domain sampling), first maps the one-dimensional bar code image onto the spectrum of an ultrashort laser pulse and then maps that into an amplitude-modulated waveform that is captured with a single optical-to-electrical converter. This is in stark contrast to typical camera-based bar code readers, which require many optical-to-electrical converters — in other words, an array of pixels — to capture the image. The new imager requires only a single pixel and is free of mechanically moving parts.

Dispersive Fourier transformation was originally developed by the UCLA team for ultrafast spectroscopy and has been used to demonstrate real-time spectroscopy with nanosecond time resolution.

The development of a bar code reader using this technology was motivated by the fact that the volume of information in bar codes is increasing and they are becoming integrated into real-time sensor networks. Similarly, there is a need for high-speed scanners for non-contact position and displacement sensing, as used in real-time inspection and monitoring in industrial applications.

The new UCLA scanner also achieves high sensitivity by amplifying the laser beam that is reflected by the bar code while the signal is still in the optical domain.

This technique prevents the inherent loss that the signal would otherwise experience during spectrum-to-time transformation. It also overcomes the thermal noise of the optical-to-electrical converters, a chronic problem that limits the sensitivity of virtually all scanners.

"This is more than a fast scanner," Goda said. "It can detect ultrafast transient phenomena in real time that have not been observed by conventional techniques in the past. Therefore, it is not only useful for industrial applications, but also has much application to basic science."

"Eliminating the CCD camera and the mechanically steered mirrors from bar code scanners can prove valuable in applications that demand high-throughput bar code reading, such as industrial monitoring and retail supply line management," said Jalali, the principal investigator on the research. "The next step is to see whether the new scanner can be produced in a cost-effective manner."

To view an animated film illustrating the concept of amplified dispersive Fourier-transform imaging, see [goda.bol.ucla.edu/barcode](http://goda.bol.ucla.edu/barcode) (Windows Media).

Provided by UCLA

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