Capturing images in non-traditional way may benefit AF

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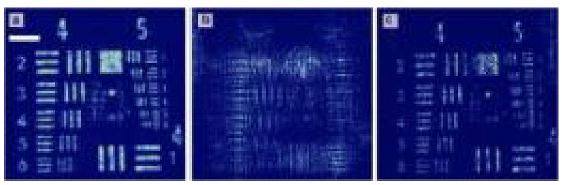

This is an image of a resolution chart through a nonlinear material. (a) This is the original image. (b) This is a distorted image after passing through nonlinear crystal. (c) This is a numerically-reconstructed image. Credit: Courtesy of Christopher Barsi and Princeton University.

New research in imaging may lead to advancements for the Air Force in data encryption and wide-area photography with high resolution.

Lead researcher Dr. Jason W. Fleischer of Princeton University and his team used a special optical device called a nonlinear crystal, rather than an ordinary lens, to capture an image. Every image is made up of a collection of light waves, and a lens bends (refracts) the waves towards a detector. In contrast, in the nonlinear material, these waves "talk" to each other and interact, generating new waves and distorting themselves in the process.

"The mixing is a form of physical (vs. numerical) encryption, but it would be useless if the process could not be reversed. Our algorithm provides a way of undoing the image and thus recovering the original signal. If the signal itself is encrypted from the beginning, then our method would provide another layer of protection," he said.

The reversing algorithm also allows the researchers to capture information that is lost in other imaging systems. Experimentally, the method relies on imaging both the intensity and travel direction of the waves. This is done by taking a standard photograph of the object alone and then one with the object and an added plane waves. The result, called a hologram, is then fed into the numerical code.

The researchers obtained photos of various objects by using the image-capturing equipment, and in every instance, their images consistently have a wide view with a high resolution. They used an Air Force resolution chart, which is designed to check the quality of imaging systems.

Imaging applications include optical systems that maintain their field of view as they zoom, sharper microscopes, improved lithography, and dynamical imaging of 3D objects.

Fleischer and his team are now searching for new materials to increase the level of wave mixing for stronger, faster interactions at lower light levels.

Fleischer noted, "Light travels nearly instantaneously from one end of the crystal to the other, but it takes about a second for it to respond nonlinearly. It takes less than 10 seconds to capture multiple pictures of the output and another minute or so of computer time to put them together and run the code backwards to re-construct the images."

In the future, the multiple pictures may be taken simultaneously and reconstructed faster than the current processing time it takes on a normal computer.

Source: Air Force Office of Scientific Research