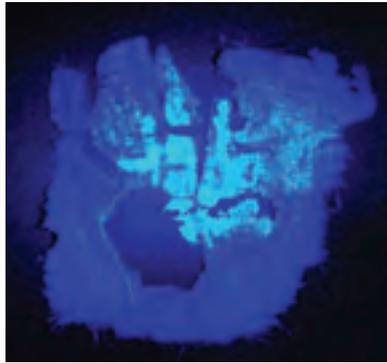




Christel Baldia

From C.M. Baldia and K.A. Jakes. *J. Archaeological Sci.* 34(4), 519-25 (2007). Reprinted with permission from Elsevier.

Left: The burial-mound fabric, photographed in ordinary incandescent light. Middle: UV reflectance image reveals previously invisible views of lighter patterns near the center of the textile. Right: IR light exposes darker patterns in sharp contrast to lighter decorations.

Multispectral Photography Aids Archaeologists

Ancient cloth can tell us a lot about the people who made it. Just as archaeologists look at the tools and other gear left behind by earlier cultures, textiles also have their stories to tell.

But textiles pulled from archaeological digs are discolored and sometimes degrade very quickly. Two researchers at Ohio State University are using visible, infrared, ultraviolet and fluorescence imaging to tease information from pieces of prehistoric cloth (*J. Archaeological Sci.* 34, 519).

Christel Baldia was a doctoral student when she and Professor Kathryn Jakes developed and tested protocols for photo-

graphing textiles in different parts of the spectrum in order to study dyes and pigments used on fabric recovered from Seip burial mounds in southern Ohio. These mounds were built by the Hopewell, a prehistoric Native American people that flourished about 1,600 years ago.

Coloring cloth can be chemically complex. Small-molecule dyes and larger-molecule pigments can come from mineral or plant sources, not to mention the mordants, chelating agents and pH-altering agents that may have been added to better bind the colorants to the fibers.

Typically, archaeologists remove fibers from the cloth at random for further test-

ing, which damages the fabric. Photography offers a means of gleaning information from the entire piece of cloth, and perhaps a way to choose which fibers will provide the most information and the least damage when removed.

To find patterns in textiles, Baldia and Jakes simulated daylight—by using UV light between 254 and 365 nm, and IR light between 800 and 900 nm—and then photographed the artifacts with film and filters designed for the appropriate spectrum. The photographs helped them see undetected motifs and markings in some of the artifacts they examined.

“The materials we examined from Hopewell burial mounds show gradations of color under different light sources,” Jakes said. “When artifacts have non-random changes in color like that, it indicates to us that there has to be dye or pigment. That’s significant for ancient textiles because it reveals technologies that prehistoric Native peoples were capable of.”

Jakes and Baldia, who is now an assistant professor in textiles at Florida Institute of Technology, got the idea to photographically analyze textiles from museum painting conservators. “Art museums use it to see if a painting has been painted over, if it’s a forgery, and so on,” Baldia said. “We thought: ‘Why aren’t we doing this with ancient textiles?’ Just like other art, fabrics are dyed and painted, and this is an inexpensive way to gather important information.”

— Yvonne Carls-Powell

[Did You Know?]

A chemical color sensor could provide an inexpensive breath test for lung cancer. The disposable sensor incorporates 36 spots that change color in the presence of certain volatile organic compounds (VOCs).

Peter Mazzone and co-workers at the Cleveland Clinic in Ohio knew from previous studies that people with lung cancer have a distinctive pattern of VOCs in the breath, although specific marker compounds have not yet been determined. The sensor they studied looks for these patterns.

The breath of 143 people was tested, and the researchers used the results from 70 percent of the participants to develop a predictive model. Then, they tested the accuracy of the sensor on the remaining 30 percent. It predicted the presence of cancer in almost three out of four of those with lung cancer.

Lung cancer, which is the leading cause of cancer death in the United States, generally does not cause symptoms until it is advanced—which is one reason why its survival rate is so low. Earlier detection could help turn this around. Although gas chromatography-mass spectroscopy can detect breath VOCs, a cartridge sensor could be much smaller, cheaper and easier to use.



Cleveland Clinic

Digital Holography Measures Health of Cells

A digital holography system developed by David Nolte and others at Purdue University in West Lafayette, Ind., has been used to record the response of cancerous cells to anticancer drugs, and could possibly provide a method for high-throughput screening of cell health. At the March meeting of the American Physical Society, Nolte described the digital speckle holography system.

The system is very sensitive to motion. Nolte, Kwan Jeong and John Turek are

image the organelle movements, however, the field of view of the image must be relatively small—maybe only several microns. In contrast, the holographic imaging method—which is not, Nolte points out, microscopy—can detect these nanometer-scale movements inside cells as part of a field of view as large as 1 mm in diameter.

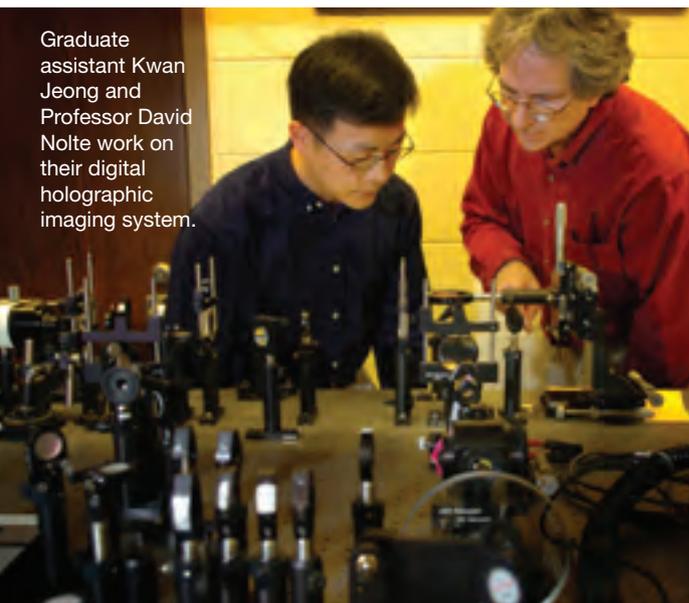
The experimental setup is surprisingly simple. A short-coherence-length pulsed laser source is divided by a beam splitter.

The reference beam reflects from a mirror and combines with the backscattered light from the sample (in this case, tissue), providing a speckle pattern at the CCD camera. The position of the mirror can be used to select the imaging depth. The system provides phase information from the entire field of view. Because multiply scattered light is statistically incoherent, it is ignored.

The speckle at the sensor changes rapidly with the movement within the cells. “We’re using motion as our imaging

contrast agent,” explains Nolte. From the image, the researchers can construct a 3D map of sub-cellular motion in the tissue.

Thus far, the system has been used to measure the response of cells to anti-cancer drugs. Specifically, anti-mitotic drugs (such as Taxol) affect the microtubules along which organelles travel. This method could be used to measure dose and time response of cancerous tissue to the drugs. With such a wide field of view, the system also has potential for applications such as high-throughput tissue screening.



Graduate assistant Kwan Jeong and Professor David Nolte work on their digital holographic imaging system.

David Umberger, Purdue News Service

using this sensitivity to map the amount of movement of organelles inside cells. (In most types of holography, motion is the enemy.)

In healthy cells, organelles move a lot; however, in unhealthy ones, the movement slows down. The speed of the movements in the cell range from about 0.1 to 1 $\mu\text{m/s}$. Using statistics, the researchers can detect when an organelle in a cell moves as short a distance as 10 nm.

There is active research in motility assays, which use microscopic methods to determine organelle motility. In order to

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