High Resolution Endoscopes As Thin As Human Hair?

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A new kind of endoscope technology with a factor of four image improvement over any previous design has recently been demonstrated by researchers from Stanford University. It may lead to flexible endoscopes producing about 80,000 pixels at a resolution of three-tenths of a micron, as compared to 10,000 pixels at three micron resolution for current state of the art. To achieve this the researchers developed a technique that uses a multi-mode fiber (MMF) to image the field under controlled illumination delivered through a spatial light modulator (SLM). An SLM is basically a liquid crystal display which can be used to modulate different features like the intensity, phase, or polarization of the light that is passing through each of its pixels.

Current endoscopes typically employ either a bundle of optical fibers, or a single fiber outfitted with a scanning head. The Stanford device, which has just a single MMF, can be much more compact — at two tenths of a micron, it is just thicker than a human hair. Previous MMFs, which conduct light via many different fiber paths, or modes, were unable to resolve more features in their field of view than the number of modes they possessed. This was due to the scrambling of the light along the way. By structuring the illumination with the SLM in a such a way that the modes could be unscrambled, so to speak, the number of resolvable features could be increased to four times the number of modes. The technique also borrows from the relatively new field of random sampling, which has also led to dramatic increases in the speed of image recording in MRI scans.

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