Photoshop filters for safer bridges (w/ Video)

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How can we constantly monitor the stability of a bridge or detect a leak in a gas pipeline in real time? A method based on optical fibers has become the norm in recent years. By carefully measuring the path of light in fibers up to 100 kilometers long, we can glean information on the temperature, pressure and intensity of magnetic fields along the entire length of the fiber. It's similar to a nerve, which tells us the intensity and location of a stimulus.

But this method is nearing its limits. Depending on the planned use, it's necessary to sacrifice length, accept a lower resolution or add more equipment - a costly undertaking.

One hair, a million measurements

Thanks to the work done by EPFL's Group for Fibre Optics (GFO), it will now be possible to maintain an extremely fine resolution even when the fiber gets longer. "We have no trouble getting a million measurement points from one optical fiber the width of a hair, for a resolution of one centimeter over 10 kilometers," said Luc Thévenaz, the director of GFO. That's 100 times more precise than current techniques.

Measurements made with this type of instrument have to be processed, because they include 'parasites'. But the ratio between useful signals and noise cannot go below a certain threshold, otherwise the measurements will not be reliable.

Graphic arts to the rescue

The EPFL researchers were able to boost this ratio significantly by borrowing a technology from an entirely different field: graphic arts. "The values collected from these measurement points on the fiber can be represented as a matrix of pixels - a two-dimensional image," said Dr. Thévenaz. "By applying standard graphic filters to this image, like those found in Photoshop, we were able to reduce the noise inherent in this measurement technique very effectively and identify the desired values more precisely."

Pursuing this logic further, his teams also transformed more complex measurements, which take into account several parameters simultaneously, into video sequences. Here again, the magic of 'standard' video filters was at work.

In Dr. Thévenaz's view, these advances, which are described in articles appearing simultaneously in *Light: Science & Applications* - *Nature* and *Nature Communications*, bring the field of distributed optical fiber sensors into a new era simply by using software techniques. This approach is, by definition, less expensive than adding more measuring devices.

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