Applications of optical fibre for sensors

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Mikel Bravo-Acha's PhD thesis has focused on the applications of optical fibre as a sensor. In the course of his research, conducted at the NUP/UPNA-Public University of Navarre, he monitored a sensor fitted to optical fibre 253 kilometres away. "What is interesting is that the measurement was remote, all the information arrived through the fibre and we didn't need to fit any sockets to power the sensor. This would be very useful, for example, to monitor an oil pipeline crossing the desert where fitting electrical power supply systems for the sensors is not feasible."

The PhD thesis is titled "Contribution to the development of new photonic systems for optical fibre sensing applications". His supervisor was the Professor of electronic technology Manuel López-Amo Sainz of the NUP/UPNA's Department of Electrical and Electronic Engineering, and he was awarded a distinction cum laude.

In recent decades telecommunications have been revolutionised by optical fibre technology, thanks to the promising features of light transmission through this medium. Shortly after it was developed, researchers observed that there were variations in the propagation of the light with respect to the different physical and biochemical magnitudes, which indicated great potential for using optical fibre as a sensor. Mikel Bravo's PhD thesis has focussed on this aspect because compact, electrically passive sensors can be embedded in the fibre and, bar exceptions, they are immune to electromagnetic fields.

New systems

In the thesis various sensor networks were developed; they can be consulted locally and remotely, thus achieving the maximum distance at which an optical fibre sensor can be monitored without needing to be amplified: 253 kilometres.

In addition, new point sensors were presented to achieve more effective systems, plus an optoelectronic device, remotely powered and remotely controlled by optical fibre. As the researcher explained, "in simple terms we could say that this device is based on a small photovoltaic cell that receives our light remotely and turns it into electricity. That way we can obtain sufficient electricity to power these devices remotely." In the course of the thesis it was possible to power this device at a distance of up to 100 kilometres, "which is the greatest distance at which a piece of equipment of this type has been powered and monitored".

Finally, the laboratory experiments were transferred to a real environment in which optical fibre sensors were used to monitor the structural health of concrete and asphalt. Specifically, deformation and temperature sensors were fitted to a concrete beam on which a load was increased until it broke. "We monitored the information provided by our sensors, and comparing it with that of electrical sensors we found that the optical fibre ones offered much better resolution."

During his research internship in London, Mikel Bravo also measured corrosion in the reinforcement bars in concrete cylinders. "When corrosion sets in, these bars increase the volume and the concrete surrounding them ends up cracking. That is why it was a critical point to monitor these sensors." In the final phase of the thesis, tests were carried out on asphalt, even though the fitting of optical fibre sensors is more complex, and only preliminary results have been obtained so far.

More information: "Fully-Switchable Multi-Wavelength Fiber Lasers Based on Random Distributed Feedback for Sensors Interrogation."

Journal of Lightwave Technology. PP - 99, IEEE, 30/03/2015.

"Real-Time FFT Analysis for Interferometric Sensors Multiplexing." *Journal of Lightwave Technology*. 33 - 2, pp. 354 - 360. IEEE, 06/01/2015.

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