Photonics World

ETH Zurich fiber-optic network aids earthquake detection

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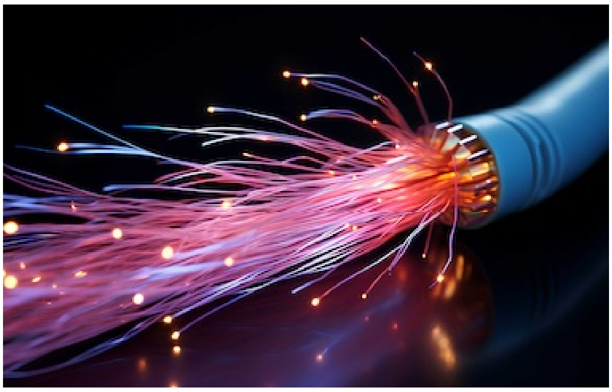
Monitoring phase noise improves assessment of ground deformations.

A project at **ETH Zurich**'s **Institute of Geophysics** has demonstrated a way to enhance the ability of fiber-optic networks to sense deformation.



Ground swell: earth movements registered by fibers

Based on active phase noise cancellation (PNC), the approach could help optical fiber sensors to quantitatively detect and characterize earthquakes or other geophysical events.

PNC involves assessing the inherent ambient noise or external interference in an optical fiber and applying a suitable inverted signal to cancel it out, analogous to way noise dampening systems counteract extraneous sounds.

This is primarily used to stabilize the frequency of light transmitted through the fiber, and the extent of phase change involved in the operation is not usually considered to be useful information in itself.

As described in **Nature Scientific Reports**, the ETH Zurich project realized that monitoring the phase error was effectively a means to monitor the deformation on the fiber, since mechanical disturbances affect the propagation of light down the fiber and hence the correction needed.

To test the approach, ETH Zurich investigated the noise suppression system already installed in the fiber-optic communication of Switzerland's atomic clock infrastructure. It found that the deformations of interest could easily be read from the corrections made by the atomic clock system to its time signals as part of its normal operation, in which a terahertz signal is actively modified by a few hundred hertz as required.

Taking advantage of existing infrastructure

Optical fiber networks have been attractive ways to monitor geological events for some time, especially since such networks are now widely embedded in the ground across large areas of the world for data communications. Previous approaches have included taking advantage of **impurities in undersea optical fibers** to monitor changes in reflection, or adding **extra hardware** to monitor physical movement of the fibers.

The new approach could now offer the same facility but in a more straightforward way, according to Andreas Fichtner from the ETH Zurich Institute of Geophysics.

"We are taking advantage of a function that existing fiber-optic infrastructure already performs," commented Fichtner. "We obtain the vibration data from the active noise suppression system, which has the job of increasing the accuracy of the signals in optical data communication. All that is required is to store the active noise suppression data and evaluate it."

Checking the PNC needed by the existing fiber-optic link between Basel and the atomic clock site at the Swiss Federal Institute of Metrology (**METAS**) in Bern, ETH Zurich found the data had tracked every wave of a magnitude 3.9 earthquake that occurred in the Alsace region.

A model of the quake generated from the PNC data corresponded accurately to the measurements taken by the Swiss Seismological Service, according to the project.

"This nearly exact match shows that the PNC data can be used to determine an earthquake’s location, depth and magnitude with a high degree of accuracy," noted Fichtner. "This is particularly interesting for comprehensive tsunami warnings or for measuring earthquakes in less developed regions of the world."