TECHBRIEF

NETL Ref. No: 23N-16

Multi-Parameter Fiber Optic Monitoring for Oil and Gas Pipelines

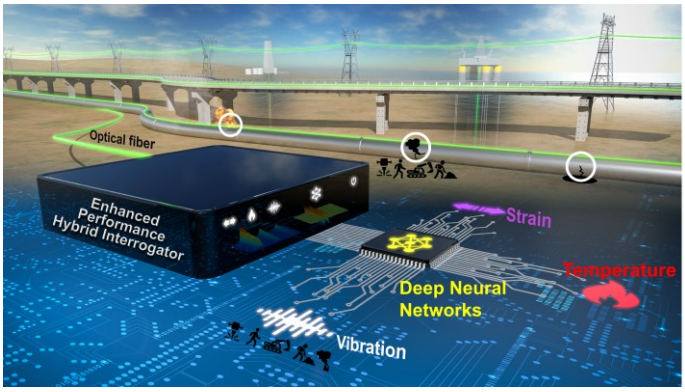

Diagram of NETL multi-parameter fiber optic monitoring

Opportunity

Monitoring the integrity of pipelines, power grids and other critical infrastructure remains a major challenge because existing sensor systems are costly, limited in range, and typically measure only a single parameter at a time. To address this need, the U.S. Department of Energy's National Energy Technology Laboratory (NETL) has developed a new type of distributed optical fiber sensor that can measure multiple parameters at once, including temperature, strain and vibration over long distances. The system combines two complementary sensing methods with a wavelength diversity approach to improve accuracy and reduce errors, delivering reliable measurements across 25 kilometers of fiber. A specialized optical interrogation enables multi-parameter monitoring and long-range performance. Unlike conventional systems that require separate fiber cables and interrogators for each type of measurement, this invention consolidates multiple sensing functions into a single platform, significantly lowering costs and complexity. Capturing several critical data streams simultaneously improves safety and decision-making for operators by providing a more complete picture of infrastructure conditions. This invention offers a comprehensive solution for monitoring energy infrastructure and is available for nonexclusive licensing and/or collaborative research.

Problems Addressed

- Single-parameter limitation: most existing fiber sensors typically measure only one parameter, requiring separate interrogators and fibers for each measurand, increasing system complexity and cost.
- Accuracy issues: noise, cross-sensitivity and limited range reduce reliability and cause false alarms.
- Adoption barriers: high system complexity and cost restricts widespread deployment for long-distance oil and gas pipeline monitoring..

Potential Commercial Applications

- Oil and gas pipeline monitoring: real-time remote detection of leaks, ground movement and third-party intrusion.
- Power grid monitoring: continuous assessment of transmission lines and transformers to prevent outages.
- Wellbore and subsurface monitoring: ensuring structural integrity and safety in drilling and production.

Competitive Advantages

- Multi-parameter capability: simultaneously measures strain, temperature, vibration and chemical changes with one system.
- Extended range: monitors up to 25 km with high accuracy, reducing false alarms and improving reliability.
- Simplified deployment: uses a single fiber and interrogator unit lowers installation costs and complexity.

Intellectual Property Status

A nonprovisional patent application has been filed in the United States.

Publications

N. Lalam, S. Bukka, et al. (2024) Achieving precise multiparameter measurements with distributed optical fiber sensor using wavelength diversity and deep neural networks. *Commun. Eng.* https://doi.org/10.1038/s44172-024-00274-5

Licensing

Partnerships@netl.doe.gov

Inventors

Nageswara Lalam, Ruishu, Wright, Michael Buric, Sandeep Reddy Bukka and Hari Bhatta