ITEA 4

Project Results

AI FORSchung

Enabling the next generation of fibre-optic sensing

By bringing together experts, data and application knowledge from the healthcare, civil infrastructure and utilities sectors, the ITEA project AI FORSchung (AI for fiber-optic remote sensing) has developed data-driven models and a unified framework for advanced fibre-optic sensing (FOS) applications.

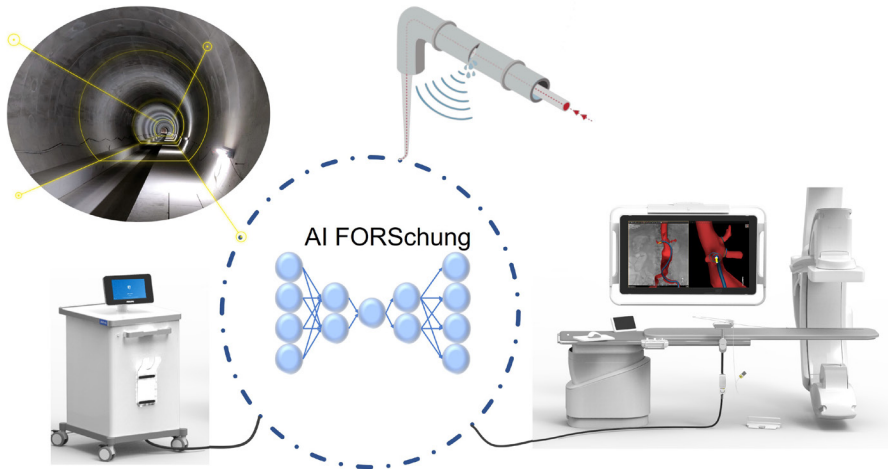
Although FOS can be adapted to a wide variety of measurement requirements, especially in domains in which anomalies must be detected extremely quickly, the technology faces challenges. Large amounts of data are generated by this process, bringing high storage and service demands, and key events may still be missed or detected too late. With the introduction of artificial intelligence (AI), including the importance of fibre-optic cables to AI data centres, the FOS market has become highly dynamic, providing opportunities for companies that can overcome such challenges.

To help bring about the next generation of FOS applications, AI FORSchung has developed a scalable, AI-based data analysis framework that enables both intelligent FOS data compression and fast, robust anomaly detection for life-critical alerts. With a consortium combining large companies, SMEs and academic institutions, the project brought together a strong mix of domain knowledge and market demand in healthcare, civil infrastructure and utilities. As a result, their models could be demonstrated across three distinct use cases: (1) navigating wires and catheters of 2-3 metres in minimally invasive therapies, (2) leak and intrusion detection in water pipelines of 10 metres to 50 kilometres, and (3) monitoring of large-scale civil infrastructure of 30 metres to 60 kilometres.

Technology applied

AI FORSchung's main innovation lies in a variety of data-driven models, unified in a framework that allowed partners to share knowledge across diverse domains. For data compression, the solutions developed focus on discrete cosine transform (DCT), sparse coding, and polynomial functions. Instead of a generic approach, these algorithms could be optimised according to the data being targeted. In the healthcare use case, for example, a compressor was developed for Philips' Fiber Optic RealShape (FORS) platform, where position signals are 3D curves that change over time. These FORS positions can now be modelled with a spline function, which is a piece-wise polynomial that better fits the data. Rather than compressing by blindly subsampling the signal, sampling occurs at points that minimise reconstruction error.

This reduction in errors following decompression is complemented by the project's models for anomaly detection, such as leak detection in pipelines or crack detection in infrastructure. For the latter, a notable achievement is the capacity to assess the dynamic reaction of bridges due to traffic load. This approach uses machine learning to train an algorithm on annotated video data and combines it with distributed acoustic sensing (DAS) data that provides strain information. By annotating the DAS data with an image classifier and using a DAS detector to identify flaws in the image classifier, the detection process becomes partially automated.



AI FORSchung focuses on the use of AI in three FOS applications: leak detection, shape sensing for minimally-invasive interventions, and structural health monitoring of civil infrastructure.

Making the difference

In each of its focus areas, AI FORSchung has already achieved success. For data compression, the use cases are united in their need to store large amounts of strain data but may benefit from different algorithms according to the application.

For both pipeline and infrastructure monitoring, the project examined DCT and sparse coding and, regardless of the method selected, was able to achieve a 5-10 compression rate. In practice, this means that 100 TB of data (such as one month of raw strain data for a 100-kilometre pipeline asset) could be reduced to as low as 12.5 TB. In healthcare, the storage gains are even higher: using still splines, a compression rate of over 20 has been demonstrated.

Crucially, these results have been achieved without introducing the kind of errors typically associated with decompression. For pipeline monitoring, AI FORSchung has sharpened the detection capabilities, allowing for quicker and more precise anomaly identification, while significant accuracy has been demonstrated for crack detection – all of which represent new methods with a starting point of zero. In combination, the project's results allow data to be continuously recorded, stored for longer, and even analysed off-site, presenting an attractive proposition to large asset owners for which leaks or cracks carry high financial, operational and reputational risks. In the process, partners can benefit from cost savings due to reduced storage, automated annotation, and the option to use cheaper hardware on-site.

Future outlook

For the commercial partners, steps are currently underway to incorporate the models into their own offerings, allowing them to expand their share of the highly dynamic FOS market. The diversity of the use cases also provides ample opportunity for growth beyond them: Thunderbyte.AI is now in the process of applying AI FORSchung anomaly detection techniques to WeFitter's lifestyle wearables, with a potential value of a million euros per year for hybrid AI solutions after 2028. Longer-term benefits will also be felt in healthcare, where Philips aims to engineer longer and thinner wires. This is expected to increase utilisation in endovascular aortic aneurysm repairs and new application areas, broadening the addressable market from thousands of procedures per year to millions. Such results represent perhaps the biggest impact of all: improved human safety and wellbeing, which AI FORSchung has worked to safeguard across life-critical domains.

Major project outcomes

Dissemination

- 5 publications
- More than 10 presentations at conferences, workshops, and innovation events

Exploitation (so far)

Healthcare:

- Data-driven, state-of-the-art compression for shape sensing in minimally invasive interventions
- Fast shape position analysis to determine shape sensing system anomalies and their correction

Pipeline monitoring:

- Sparse coding-based compression of DAS (distributed acoustic sensing) data for pipeline monitoring
- AI-based anomaly detection in DAS monitoring of intrusion events in pipelines

Civil infrastructure monitoring:

- Automated, AI-enhanced crack monitoring solution
- Multi-modal, video and DAS-based, ground truth data collection method for bridge monitoring

ITEA is the Eureka RD&I Cluster on software innovation, enabling a large international community of large industry, SMEs, start-ups, academia and customer organisations, to collaborate in funded projects that turn innovative ideas into new businesses, jobs, economic growth and benefits for society. ITEA is part of the Eureka Clusters Programme (ECP).

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AI FORSchung

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Partners

Austria

- ACI Monitoring GmbH
- Graz University of Technology

Belgium

- Fluves NV

The Netherlands

- Eindhoven University of Technology
- Philips Medical Systems Nederland BV
- Thunderbyte.AI

Project start - end

September 2022 - August 2025

Project leader

Ahmet Ekin, Philips

Project email

ahmet.ekin@philips.com

Project website

https://itea4.org/project/ai-forschung.html