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USING EDGE AI

CONTINUOUS MONITORING OF CRITICAL INFRASTRUCTURE

Many of our critical infrastructures are old and heavily used, including bridges, roads, and utility systems. The traditional approach of inspecting and maintaining these infrastructures via fixed maintenance intervals is often outdated. Predictive maintenance, which is based on the evaluation of raw data, can increase maintenance efficiency, as continuous monitoring enables a faster response to changes in structures. There is a significant discrepancy between the current state of technological knowledge and the actual technological equipment of such structures. The project presented here aims to close this gap by using modern measurement technology, edge AI processing, and autonomous data evaluation. This should offer significant benefit to inspectors and operators by providing them with additional information and resources to save labor and costs while increasing safety. waste streams.

Sensor data fusion for predictive maintenance

In the collaborative project “ImaB-Edge”, Fraunhofer IZFP, along with infrastructure construction

companies, research partners and infrastructure operators are developing a modular, configurable electronic system designed to facilitate the on-site assessment of engineering structures.
Our efforts in infrastructure monitoring and data security leverage edge AI concepts to conduct data processing proximal to the data source. This offline edge computing, executed directly at the site, obviates the need to transmit raw data over the internet, thereby safeguarding sensitive information against various attack vectors. The decentralized fusion of sensor data integrates multiple data sources to deliver a comprehensive load measurement directly at the monitored structure.

A series of highly sensitive vibration sensors continuously monitor road vibrations. This data is integrated into a local database alongside other sensor values, such as asphalt temperature, environmental data, and camera images. Using advanced AI processes, a load measure per vehicle is determined. This information is stored in the database and made available to the operator. The concept demonstrated here aims to provide maintenance-relevant information about the structural condition in the future. By integrating multimodal inspection methods into a single inspection system in conjunction with the BIM model, a unique evaluation basis is created, enabling inspectors and operators to identify necessary actions more quickly, by providing highly localized information about load and building state.
A living laboratory at Fraunhofer IZFP in Saarbrücken is utilized to evaluate and advance the technology to transfer the system and the acquired knowledge to both new and existing infrastructure frameworks.

Enhancing Infrastructure Safety

Operators can achieve long-term cost savings through early fault detection and the implementation of preventive maintenance measures. Users benefit from increased infrastructure safety, as the likelihood of catastrophic failures is mitigated. Furthermore, this technology can serve as a paradigm for other domains where continuous monitoring is essential. Lastly, the deployment of such technologies fosters innovation and competitiveness by enhancing system reliability and efficiency. Additionally, the development of a modular system adaptable to various testing scenarios allows for flexible and application-specific use. With very few constraints on performance or sensor technology, versatile and scalable deployment is ensured.

> **“Operators can achieve long-term cost savings through early fault detection”**

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