Urban Power Cable Monitoring Using DAS & AI

Serbia

Project Overview

AP Sensing, together with our partner Crony, completed a project in Serbia aimed at monitoring underground, urban HVAC power cables and detecting activities that pose a risk to power cables, such as road construction. Transmission System Operators (TSOs) are typically in need of a suitable and feasible solution that accurately detects and classifies Third Party Interference (TPI) events close to power cables. Often these power cables are buried within urban areas, under streets, bridges, and near construction sites.

AP Sensing's Distributed Acoustic Sensing (DAS) is designed and well-suited to detect TPI events by measuring small vibrations (strain changes) along the power cable. However, detecting TPI is a challenging task, as data from mechanical activities varies strongly depending on ground conditions and the tools that are used for, e.g., digging or hammering. Additionally, signals from other background events that look very similar to TPI signals may trigger unwanted alarms. To overcome these challenges, in this project AP Sensing utilized a combination of DAS technology and data processing based on Artificial Intelligent (AI)/ Deep Neural Networks (DNN) for signal analysis and classification.

Background

- The customer required an accurate and practical solution for monitoring TPI events
- The detection and classification of digging activities and construction work helps avoid cable damage and reduce the risk of power outages and costly repairs

Solution & benefits

- AP Sensing's DAS provides 24/7 monitoring of acoustic events along the power cable
- Additionally, this project utilizes Deep Neural Network (DNN) models for better detection and classification of TPI events
- The DNN models, trained to recognize excavator and jackhammer activities, demonstrated high detection accuracy with very low nuisance alarms

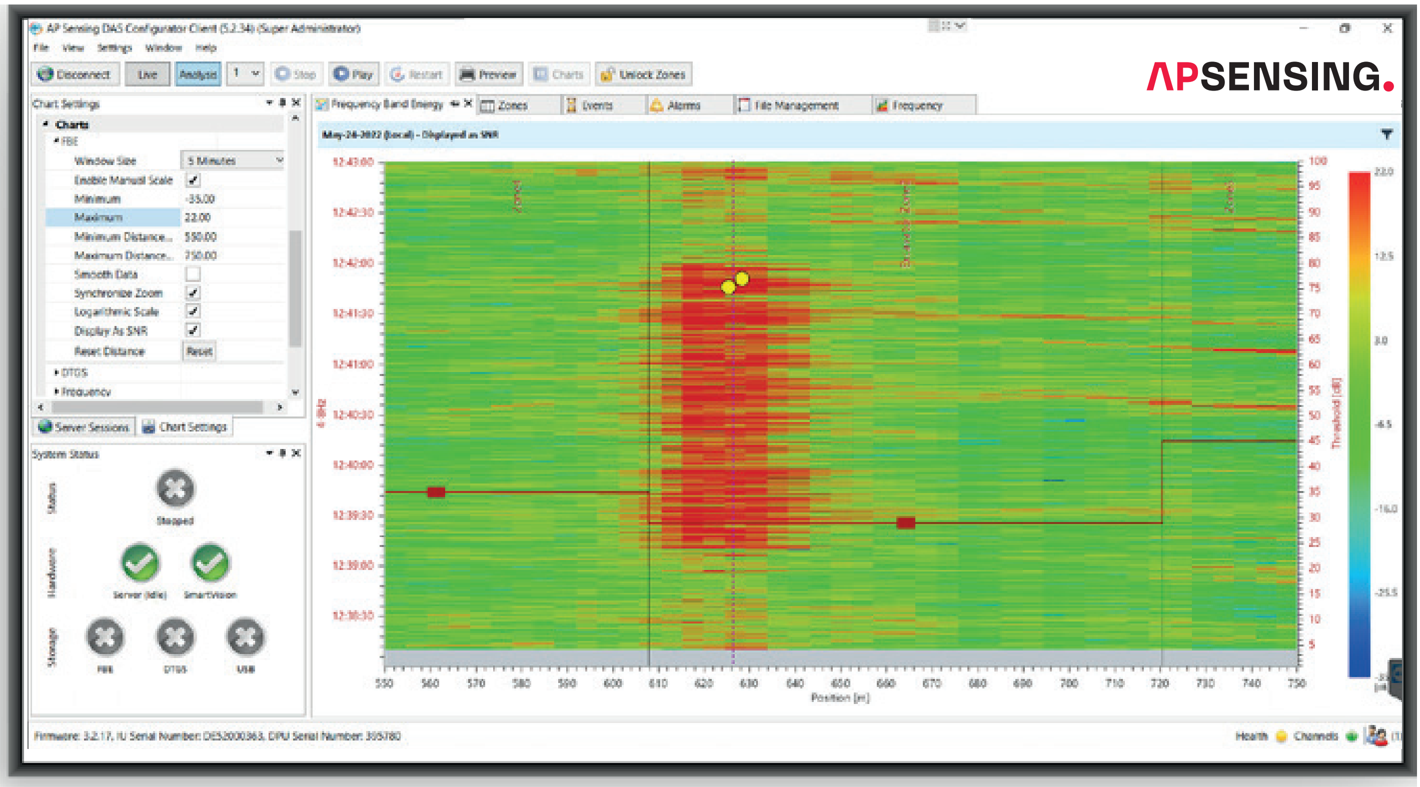

Figure 1: SmartVision screenshot of alarm from machinery digging

Solution

AP Sensing's N5225B DAS system was deployed for this project and utilized a fiber optic cable that was installed along the power cable.

The DAS system captures micro vibrations near the cable, these are typically indicative of mechanical activities. These signals were processed and analyzed in order to classify and detect TPI activities using DNN models, specifically Convolutional Neural Networks (CNN). AP Sensing's DAS Configurator Client software was used to configure the DAS instrument, including the zoning, alarming and classification of the detected acoustic signals.

AP Sensing's SmartVision software accurately displays alarm positions on a map and also provides further features such as asset mapping and interfacing as well as advanced data analysis.

Deep Neural Networks

A DNN learns to detect signals of TPI activities based on data recorded from the past and takes advantage of pattern recognition to classify activities.

To train the DNN models, data from various installation sites different from the evaluation site were used, ensuring diverse ground conditions and burial depths of the fiber optic cable which ultimately leads to the DNN models' ability to perform accurately in new installation scenarios without retraining.

The DNN models were trained to recognize two types of TPI activities: excavator digging and jackhammer activity, as both are performed by heavy machines that may cause real damage to a power cable. The models were optimized through a gradient descent algorithm, minimizing classification errors during the training phase.

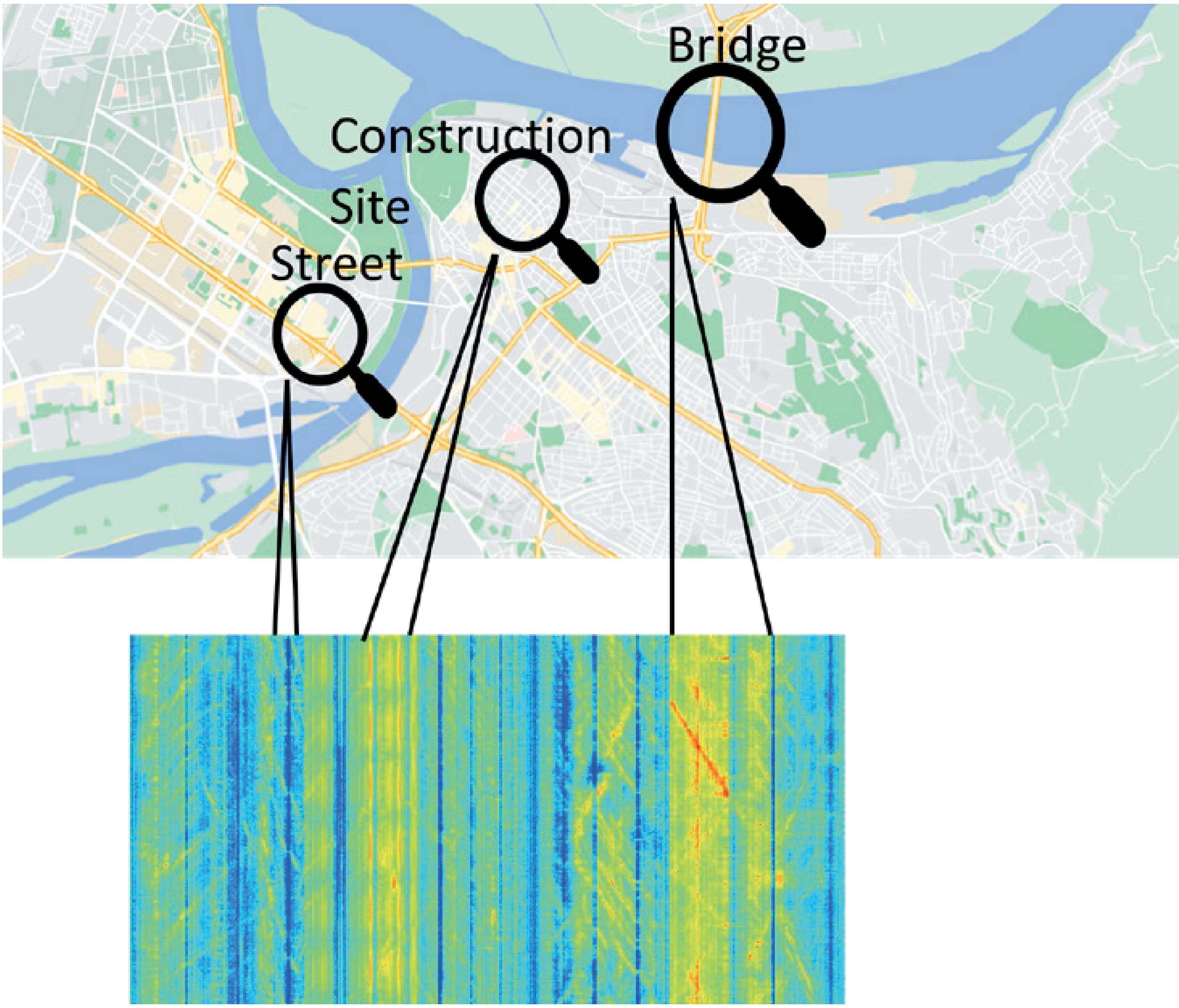

Figure 2: Urban area as viewed with DAS

Results

During the test period, the excavator DNN model achieved an accuracy of 97.7% while the jackhammer DNN model achieved an accuracy of 98.1%. These are excellent results as the evaluation site is located in a challenging urban environment with lots of background noise.

Additionally, considering that the models have been evaluated using data from a different installation site than the sites used for the training data, the test results indicate that the developed models not only work well for this project, but can also be successfully adapted and used for other site conditions.

Conclusion

AP Sensing successfully completed this project using a combination of DNN models and DAS technology to detect mechanical threats to power cables in a busy and noisy urban environment. The convincing results show that the combination of DNN and DAS can effectively protect power cables, minimize risks and reduce costs.

Further projects with the end customer and further development in DNN are underway at AP Sensing.

www.apsensing.com
info@apsensing.com