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INTEGRATED METHODOLOGIES AND APPLICATIONS

MONASH University

Spatiotemporal Object Detection from multi-spectral, time-sequenced data

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The Problem

Distributed Acoustic Sensing (DAS) is applied to fibre optic intrusion detection. Optical fibre cables are either installed on fences or buried under perimeter lines. They are used to sense disturbances at the perimeter. A laser sends pulses through the fibre at a rate of 2500-5000 pulses/s. Scattered light is reflected back and sampled at every 0.5m. The pattern of scattered light is changed by disturbances. They are detected and located through the use of **object detection models** on images generated by first creating **a power spectrum** with a Faster Fourier Transformation and then **mapping frequency band intervals to image channels**.

The mapping of frequency band intervals to image channels poses a non-trivial problem. Currently, the frequency band intervals are handcrafted to generate **3 channel images** but preliminary results have shown that **multi-channel images** yield a better model performance.

Frequency band intervals are binned into intervals of 50Hz from 0Hz to 2100Hz with no overlap. Each bin is mapped to one image channel. Each generated image contains 42 channel. Darknet with Yolov4, **a state-of-the-art object detection model**, is trained on a small dataset from a fence installation. Preliminary results show two main conclusions:

1. **The selection of frequency band intervals is relevant**
2. **Multi-spectral data improves model performance**

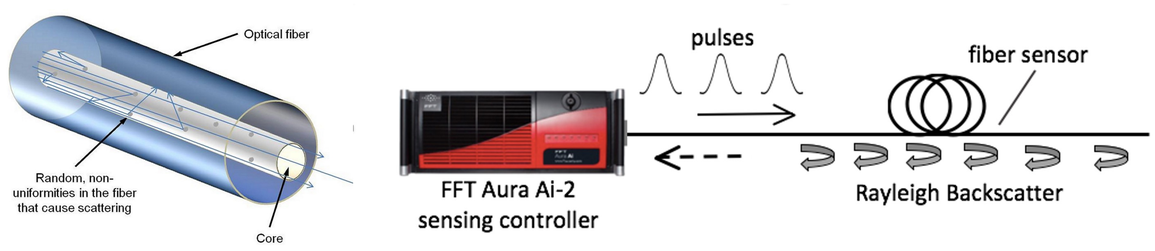

Figure 2: From left to right: Schematic interior of a fibre optic cable and setup of a DAS system.

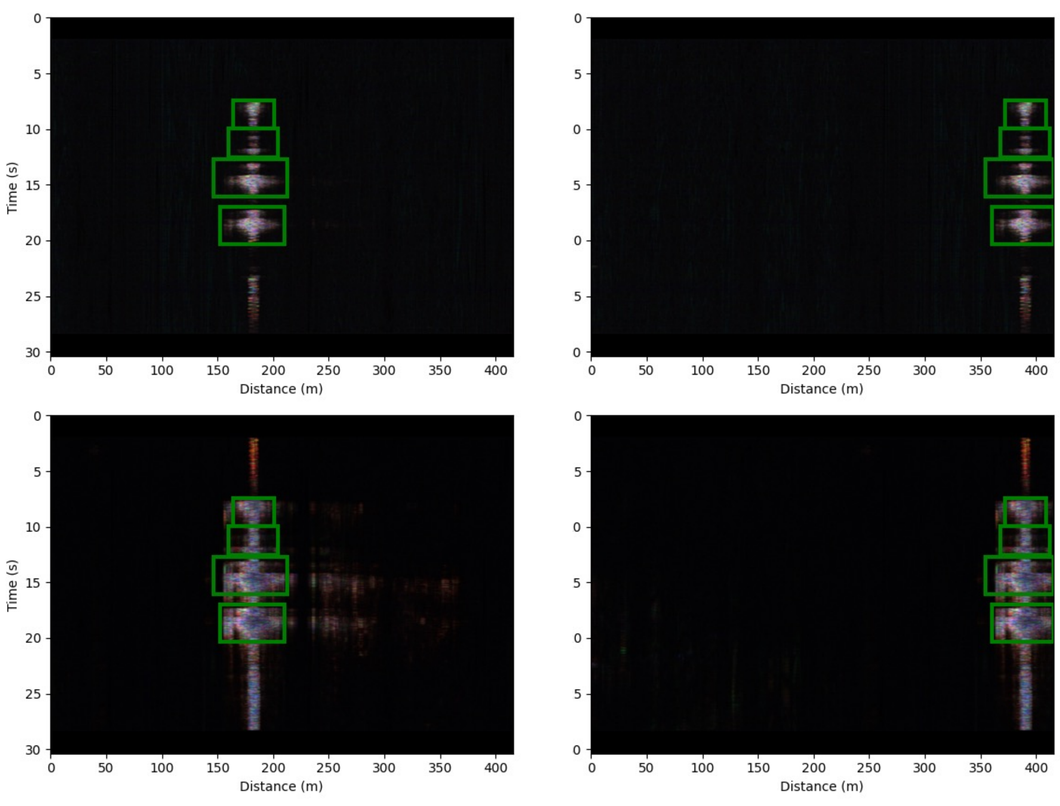

Figure 4: Images generated from a DAS system. First and second row show the same event but at a different point in time. First and second column show the same event but within different frequency bands. The first column includes the frequency band interval 850-900 Hz and the second 250-300 Hz.

Figure 1: Installation of Das system clockwise from top left corner: Schema of a fence installation, fence installation, schema of a buried installation, map of a buried installation.

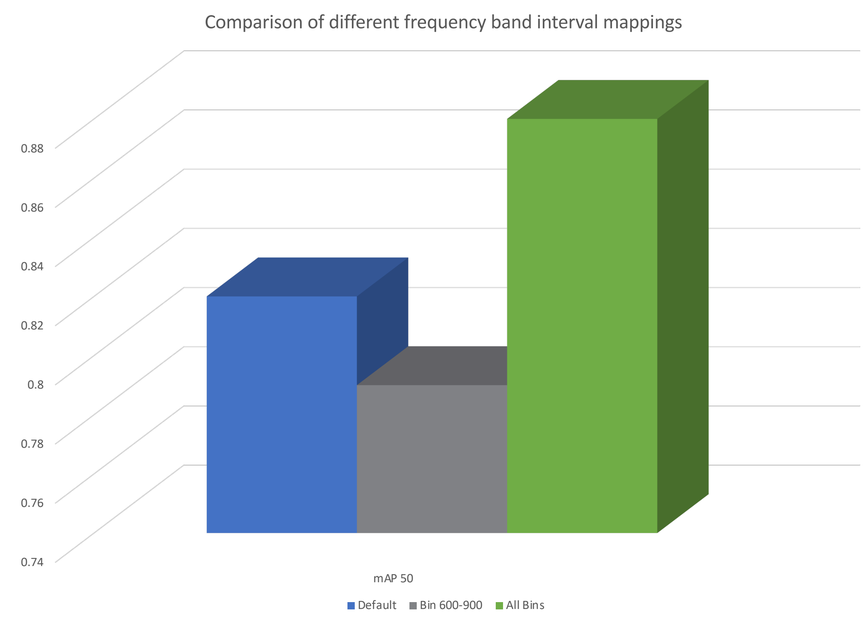

Figure 3: Preliminary experiment results from Darknet with Yolov4 on a small dataset from a fence installation. 3 mappings of frequency band intervals are compared with mean Average Precision (mAP).

The Challenges

We face the following three challenges:

- The selection of frequency band intervals because different frequency bands vary in how much **event information and noise** they contain
- Training a model to map frequency band intervals to image channels because the amount of data generated **exceeds** the amount of data a model can process
- **Differentiating** between event information and noise which can vary per installation

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FOR FURTHER INFORMATION

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