Event detection using mixture models and independent component analysis

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Motivation

Training and Test Data

Experiment 1

Experiment 2

Results

Conclusions and Future Work

Shamsa, A., and Paydayesh, M., 2019, Applications of independent component analysis and Gaussian mixture models in micro-seismic signal detection, Geoconvention Partnership, Geoconvention 2019.

Shamsa and Paydayesh used GMMs and ICAs to detect micro-seismic signal from three-component geophones.
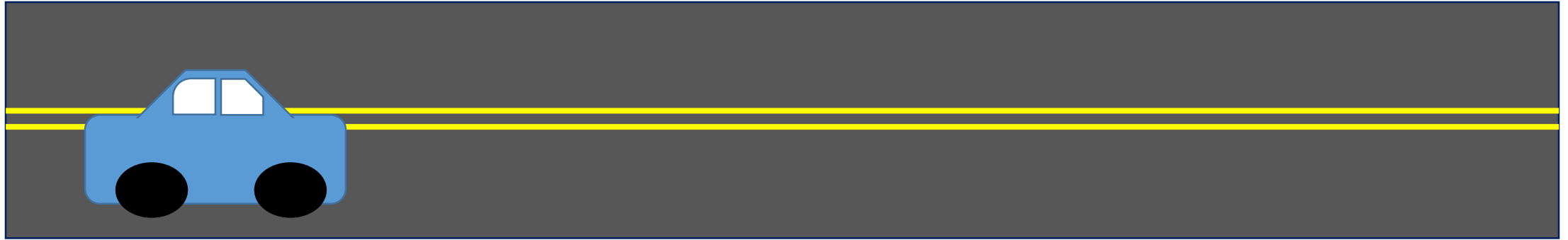
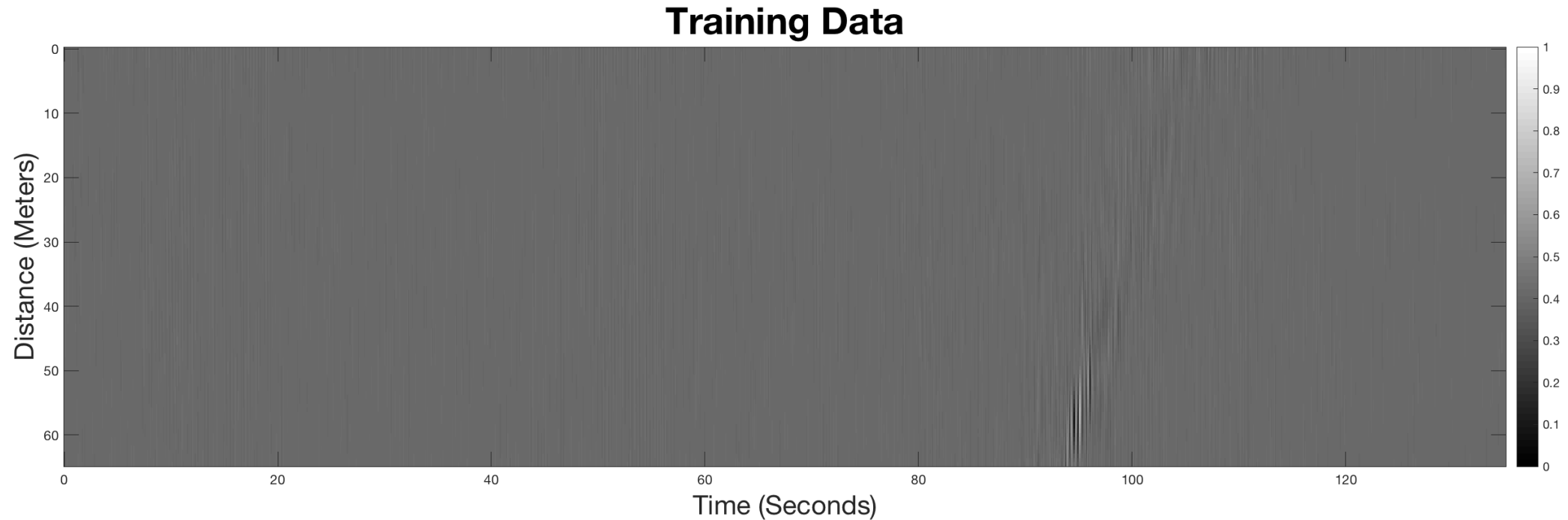The data is of a car driving down a road with a DAS system set up next to the road.
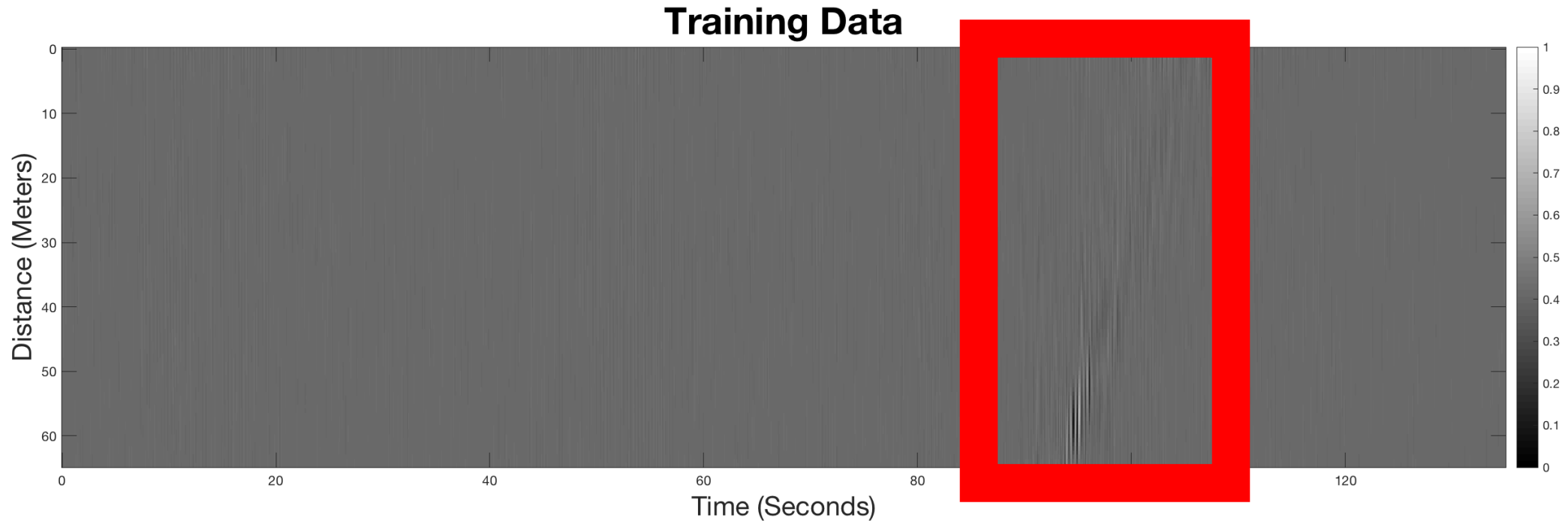
Figure 1: The training data set: A 65 meter section of fibre with a vehicle driving along a road next to a DAS system. The vehicle starts at 90 seconds and goes to 105 seconds.

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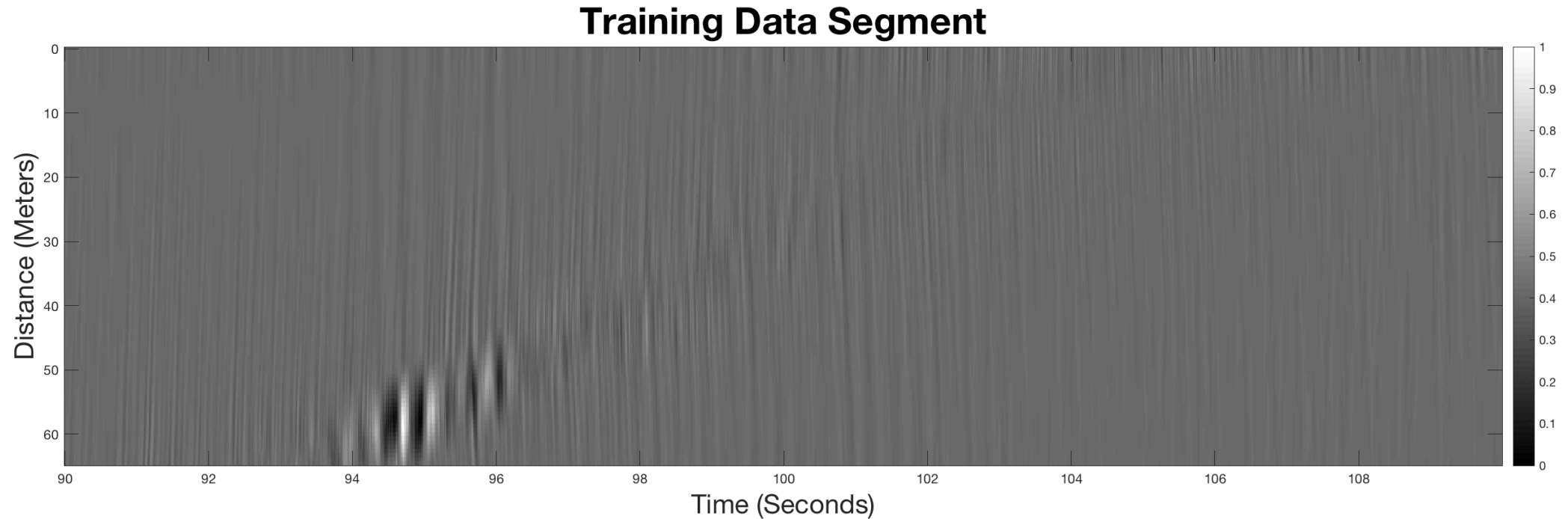
Figure 2: We show a 30 second segment of the training set seen in Fig. 1, focusing on the data between 90 seconds to 110 seconds where the vehicle is located in the training set.
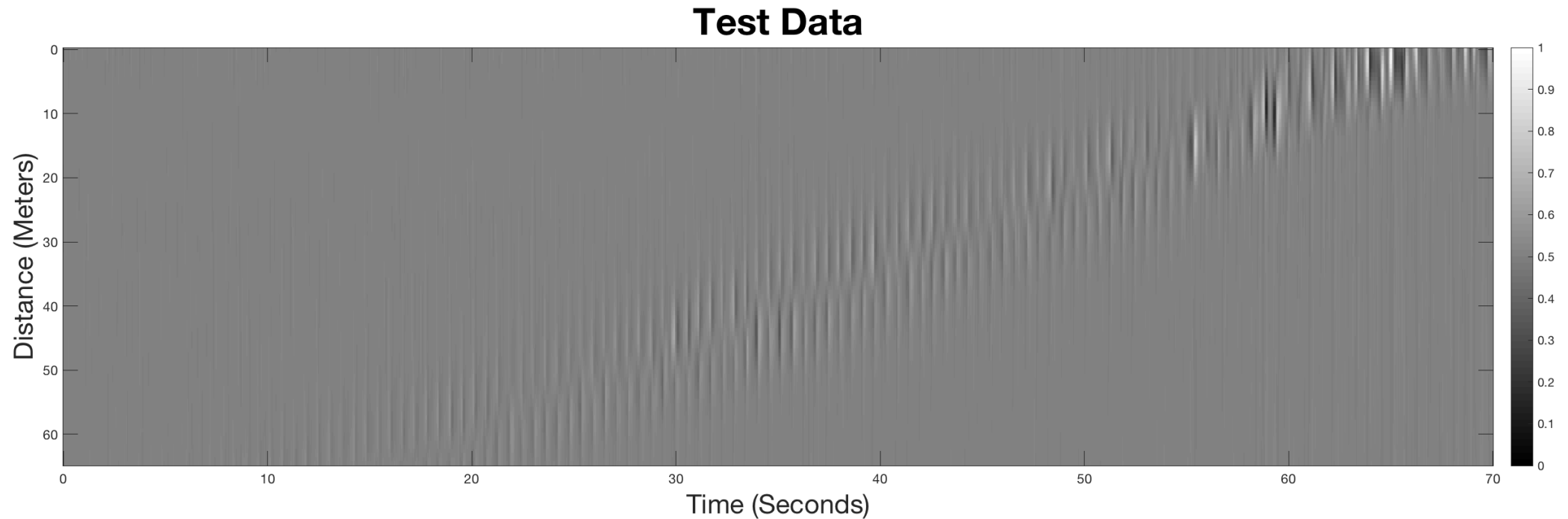
Figure 3: The test data set: A 65 meter section of fibre with a vehicle driving along a road next to a DAS system. The vehicle starts at 10 seconds and goes to 70 seconds.

Apply ICA to non-overlapping 5 second windows from 20 data sets to get two independent components per segment.

1. 20 data sets

2. 5s segments of 20 data sets

3. Calculate two IC for each 5s segment.

4. Group by IC1 and IC2 for training.
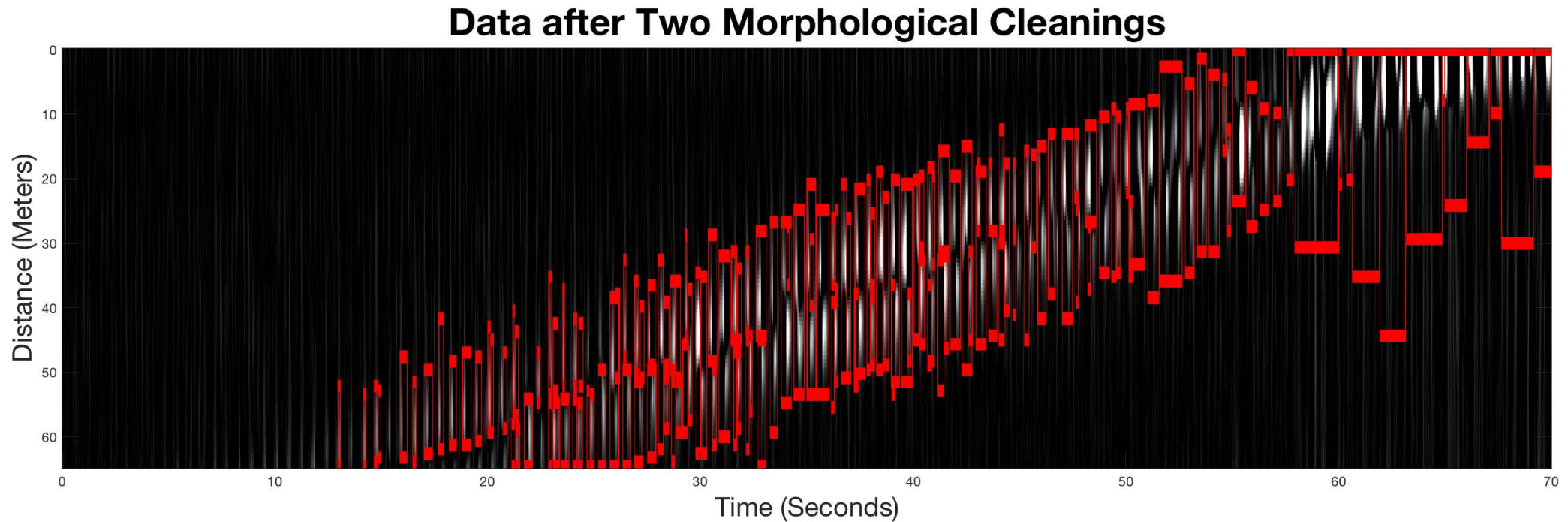
Data after Two Morphological Cleanings
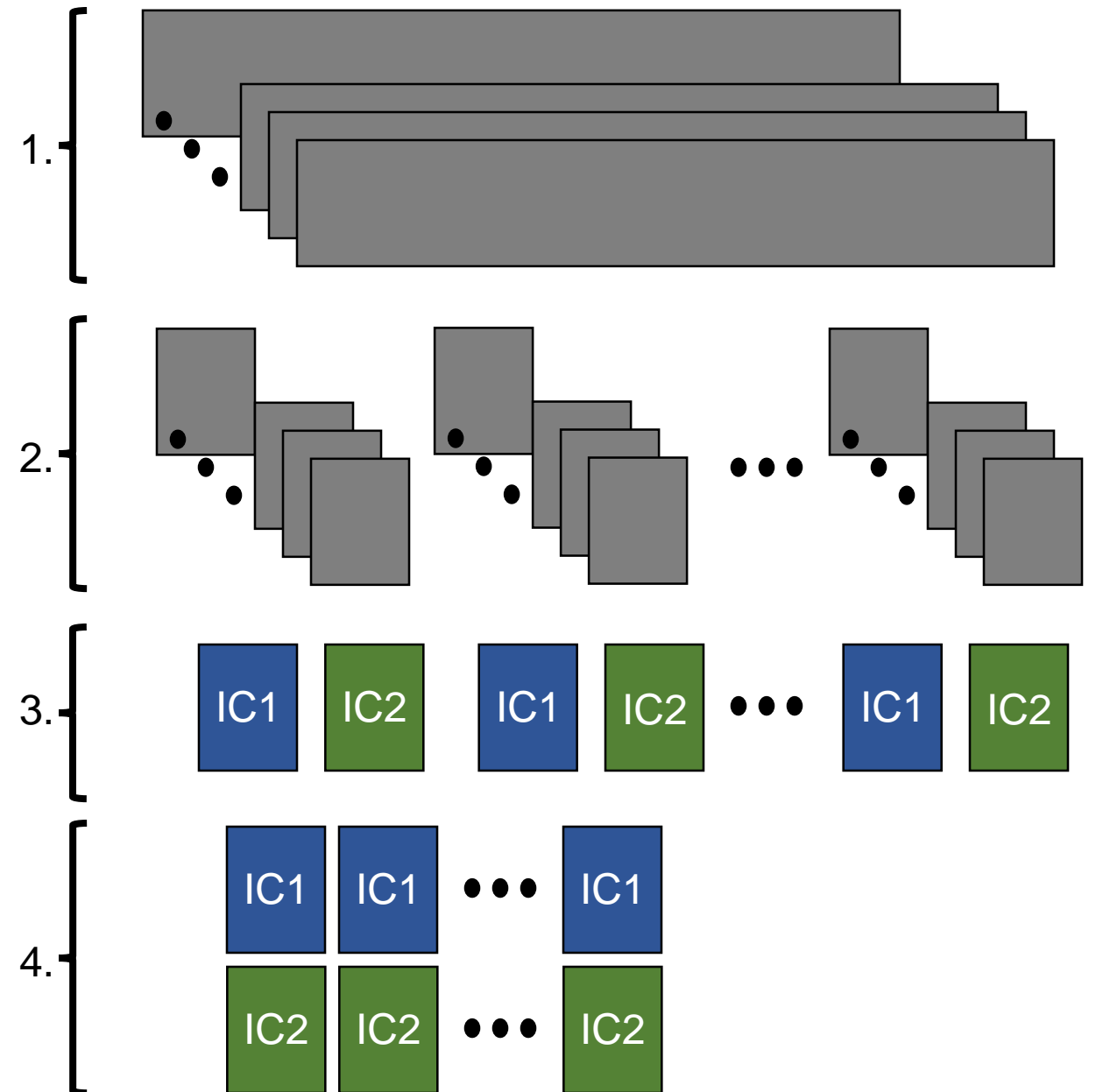
Figure 4: The vehicle detector trained on the training data applied to the test data after two morphological cleanings.
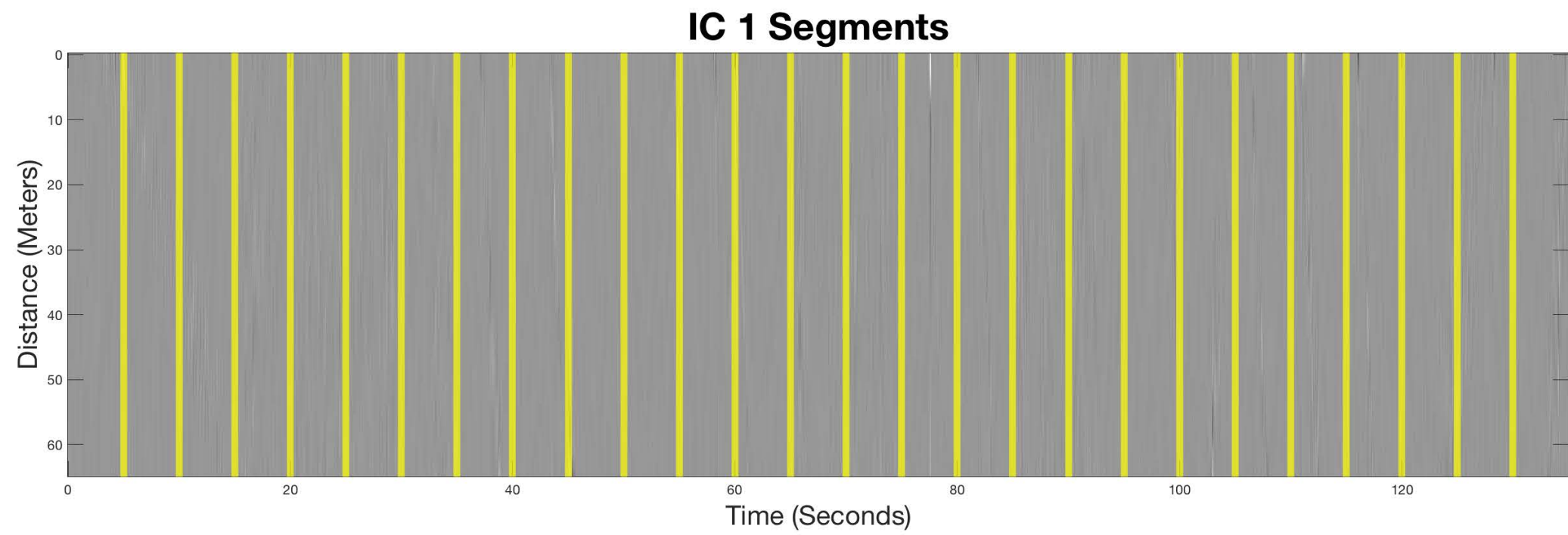
Figure 5: The 27 segments of the first independent component generated by performing ICA on segments from 20 data sets containing the same 65m segment of fibre over 135 seconds.
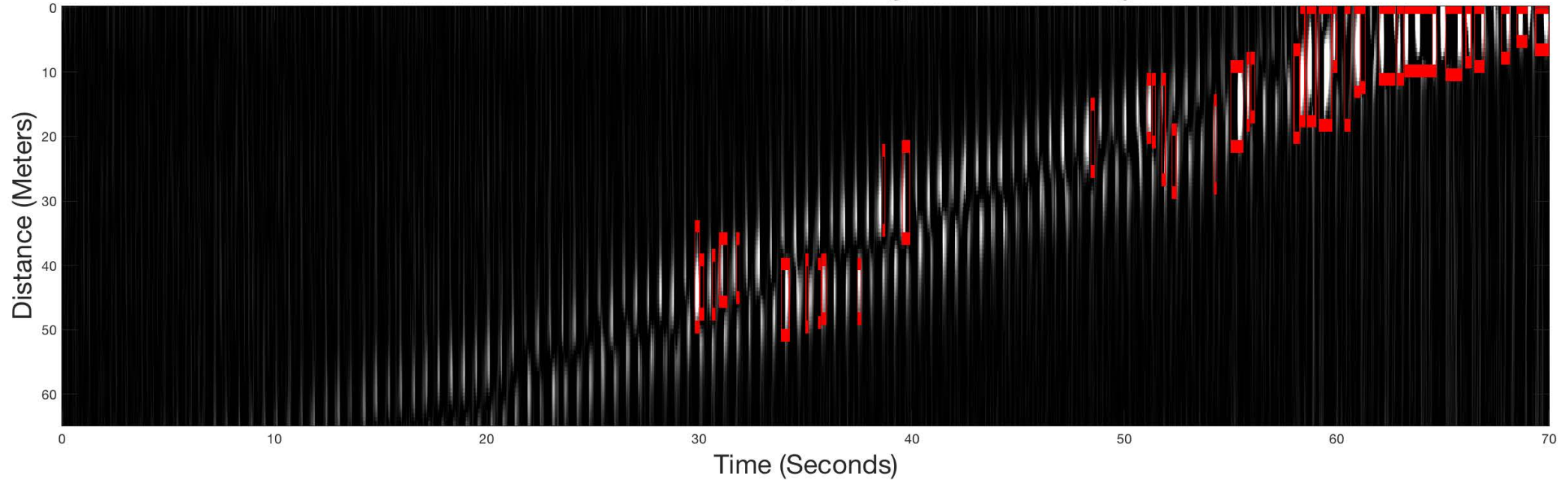
Figure 6: The vehicle detector trained on the first independent component for each segment of data applied to the test data after two morphological cleanings.
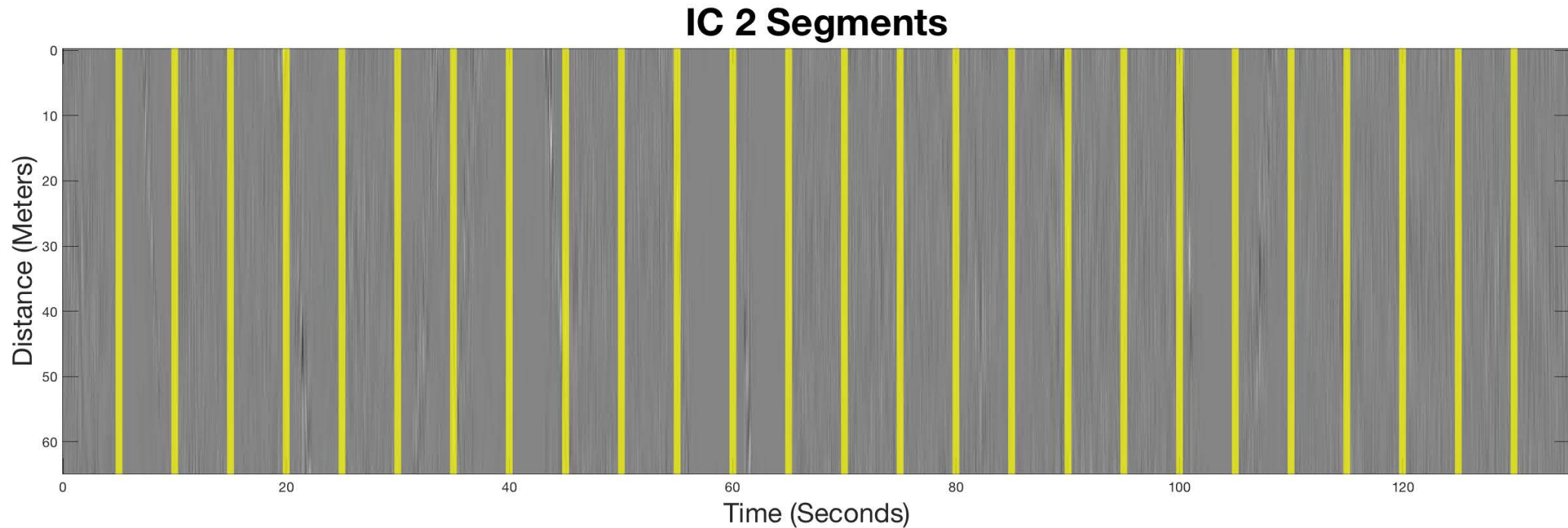
Figure 7: The 27 segments of the second independent component generated by performing ICA on segments from 20 data sets containing the same 65m segment of fibre over 135 seconds.
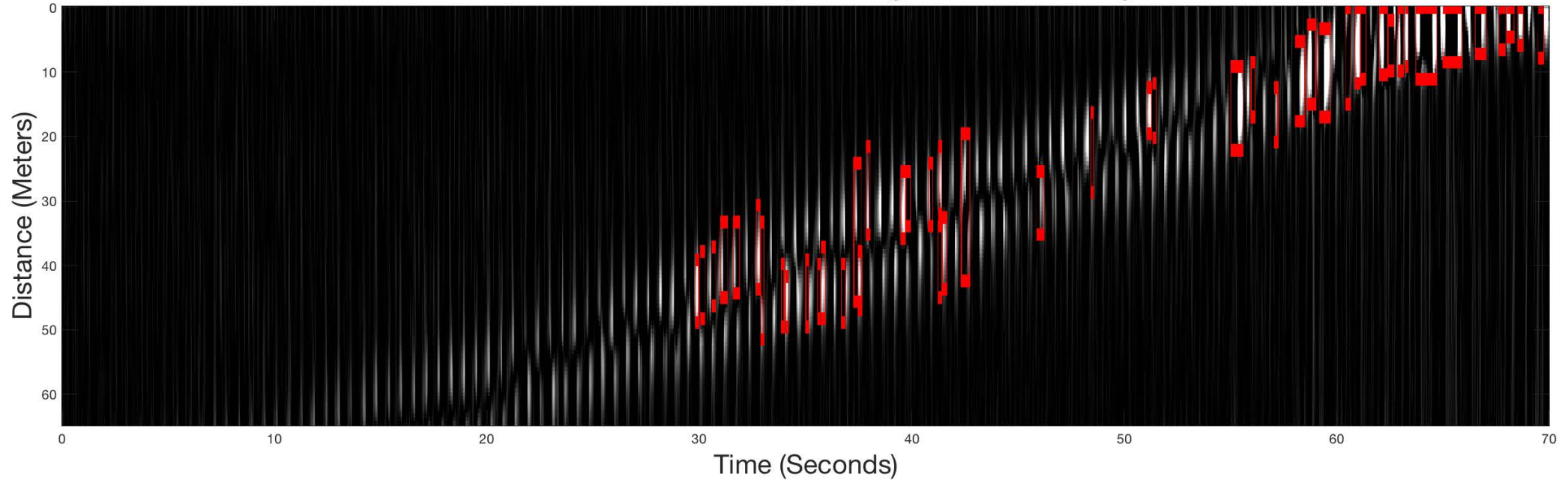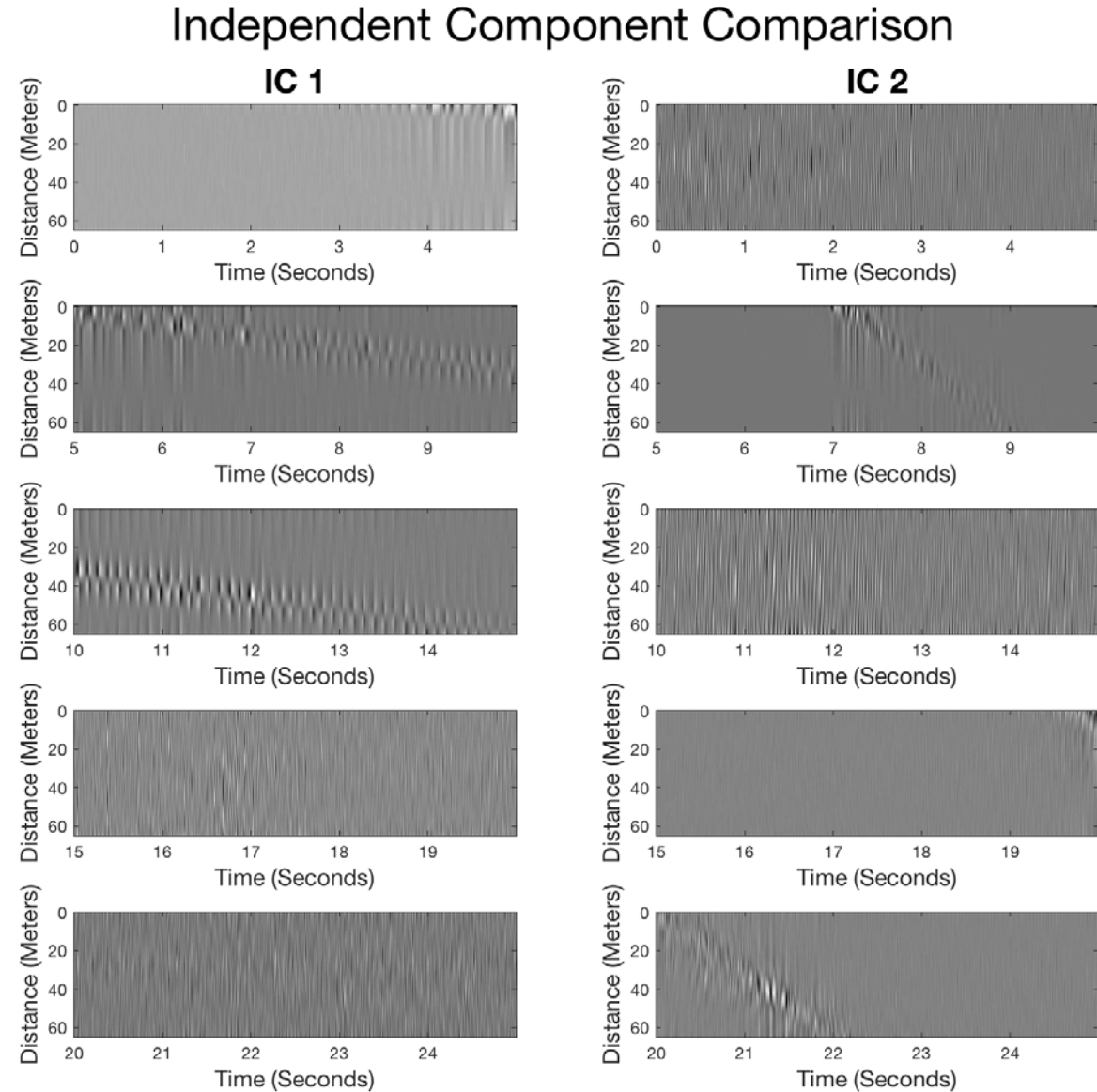
Figure 8: The vehicle detector trained on the second independent component for each segment of data applied to the test data after two morphological cleanings.

Figure 9: A comparison of the first five frames of the two independent components. (Left column) The first five frames of the first independent component, covering the time between 0 and 20 seconds. (Right column) The first five frames of the second independent component, covering the time between 0 and 20 seconds.
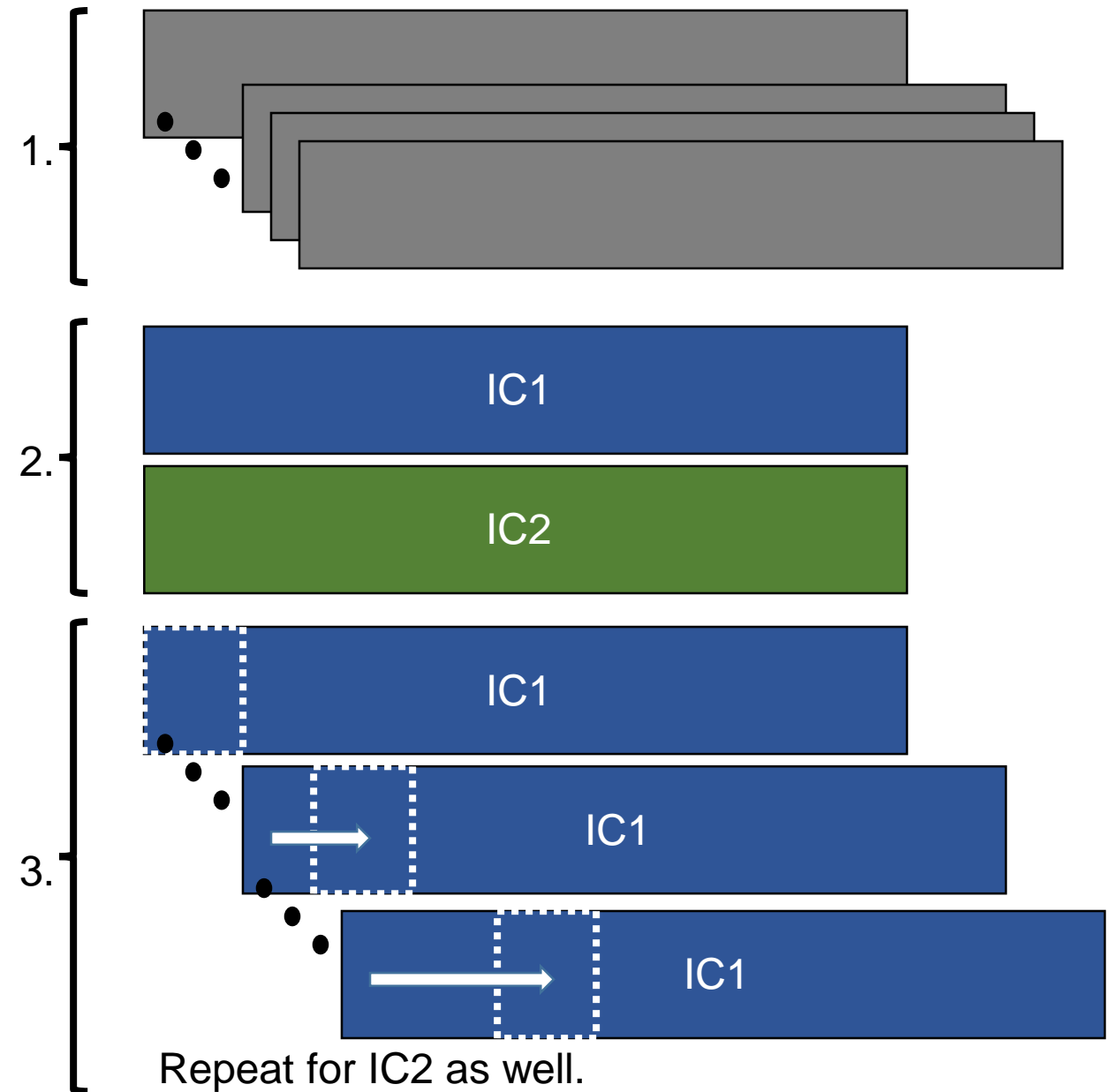
Apply ICA to the entire data set of the 20 data sets to get two independent components.

1. 20 data sets

2. Calculate two IC from all 20 data sets

3. Train vehicle detector on overlapping windows in time.

1.

2.

IC1

IC2

3.
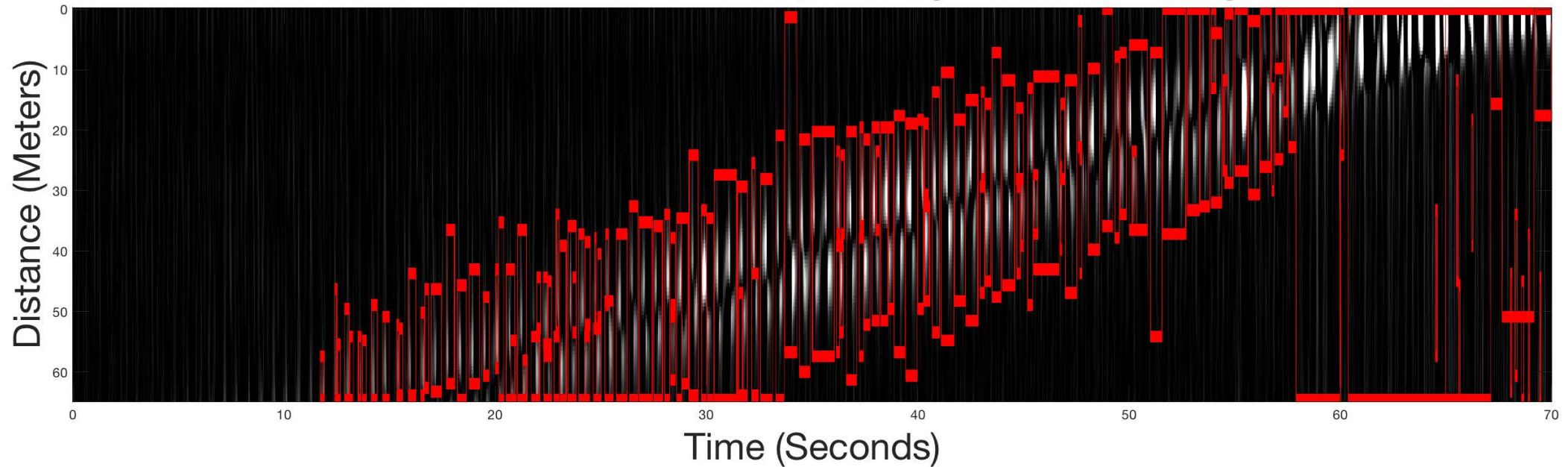
IC1

IC1

IC1

Repeat for IC2 as well.

Figure 10: The vehicle detector trained on the training data applied to the test data after two morphological cleanings.
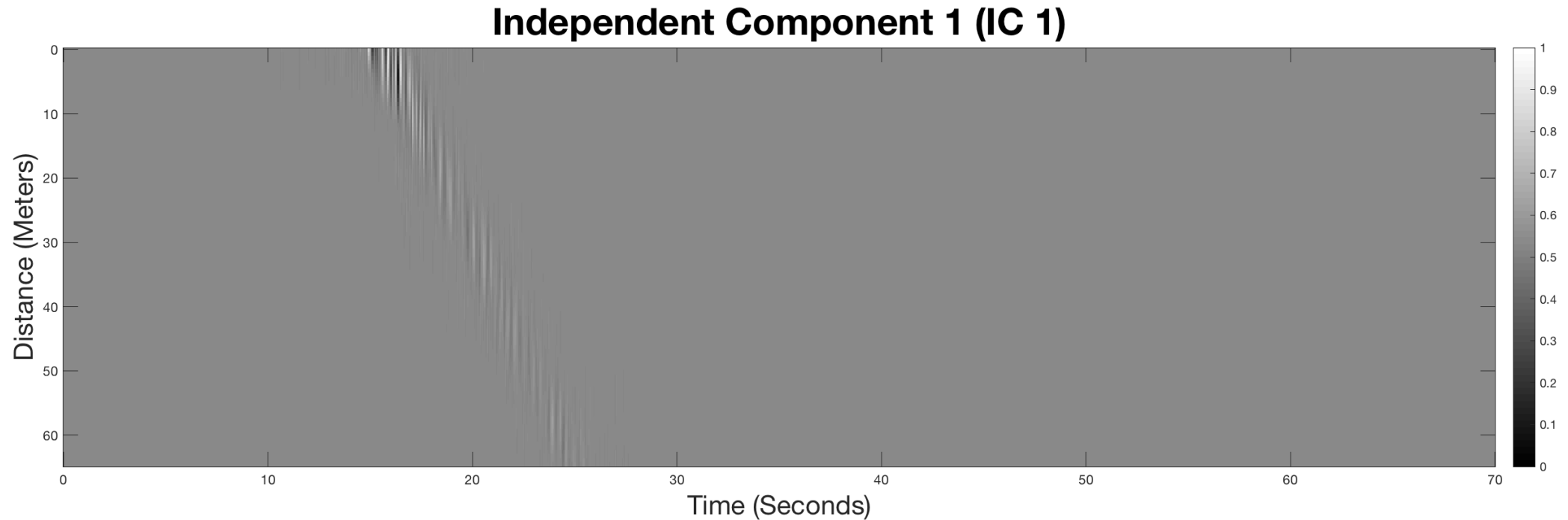
Figure 11: The first independent component produced by conducting an ICA on a large segment of twenty data sets generated by the same section of fibre.
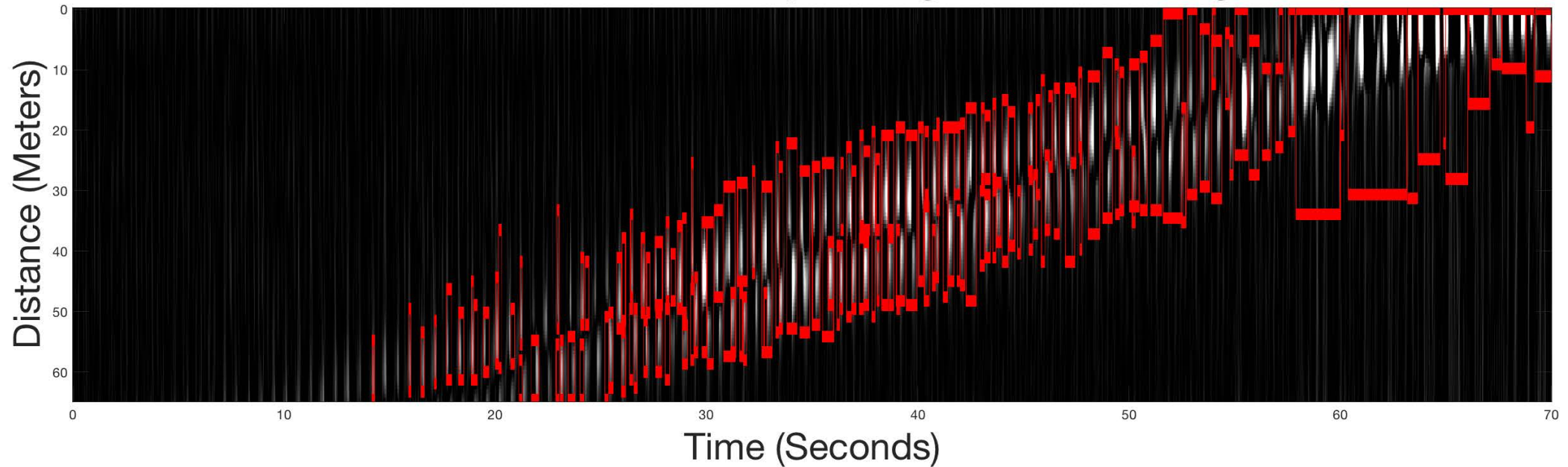
Figure 12: The vehicle detector trained on a window moving over the first independent component applied to the test data after two morphological cleanings.
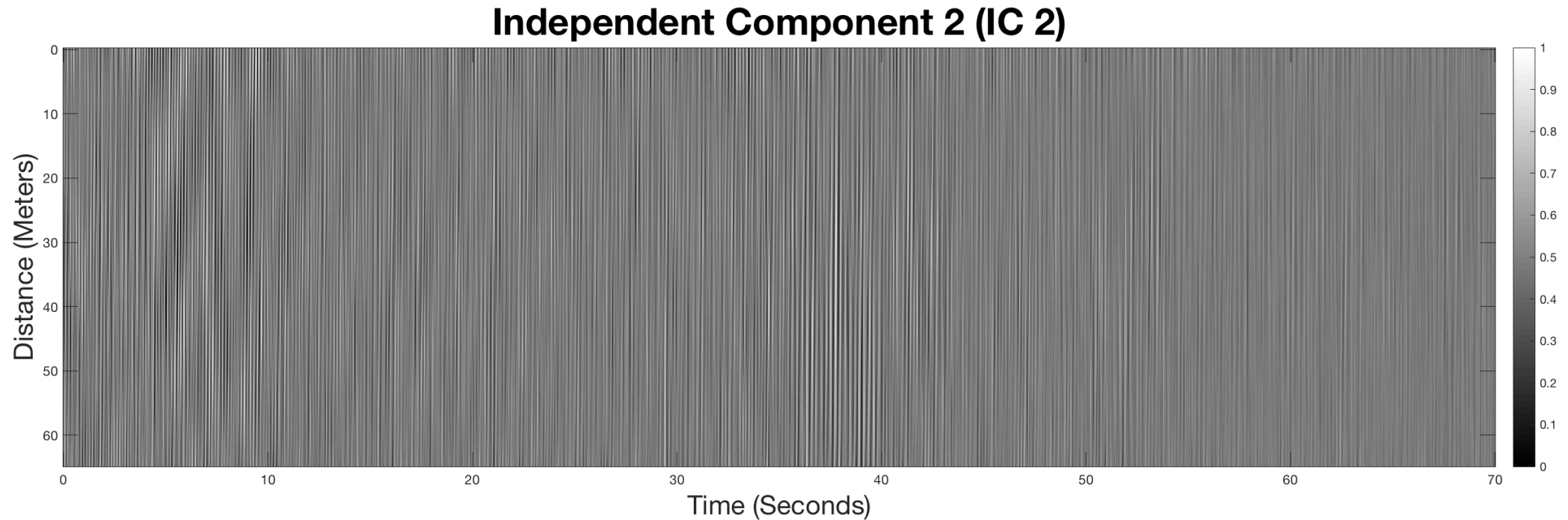
Figure 13: The second independent component produced by conducting an ICA on a large segment of twenty data sets generated by the same section of fibre.
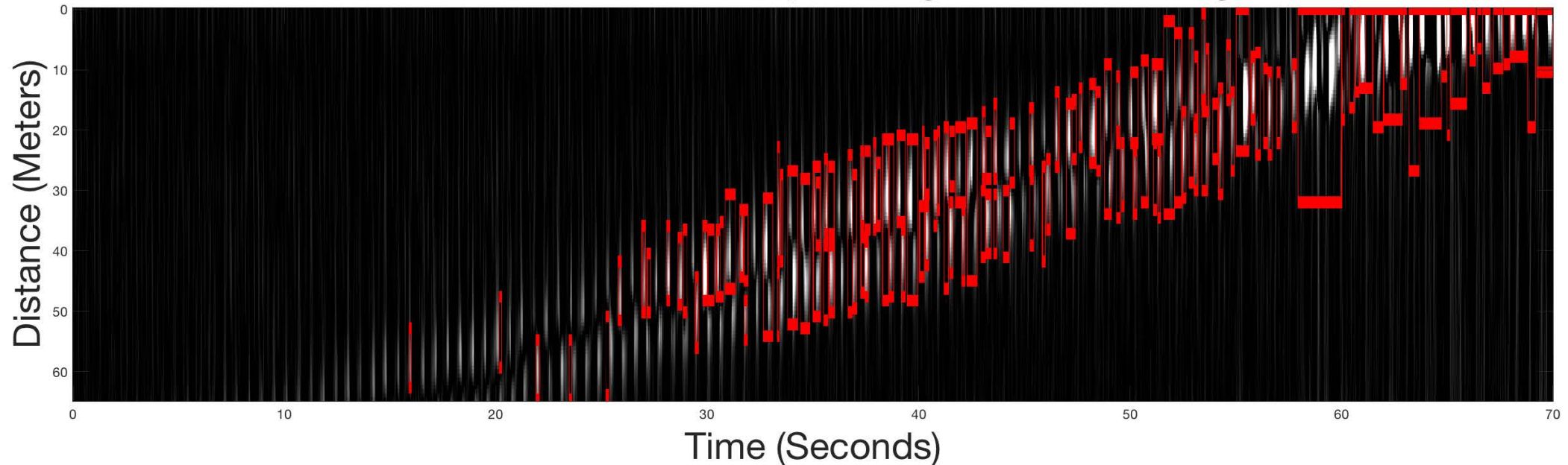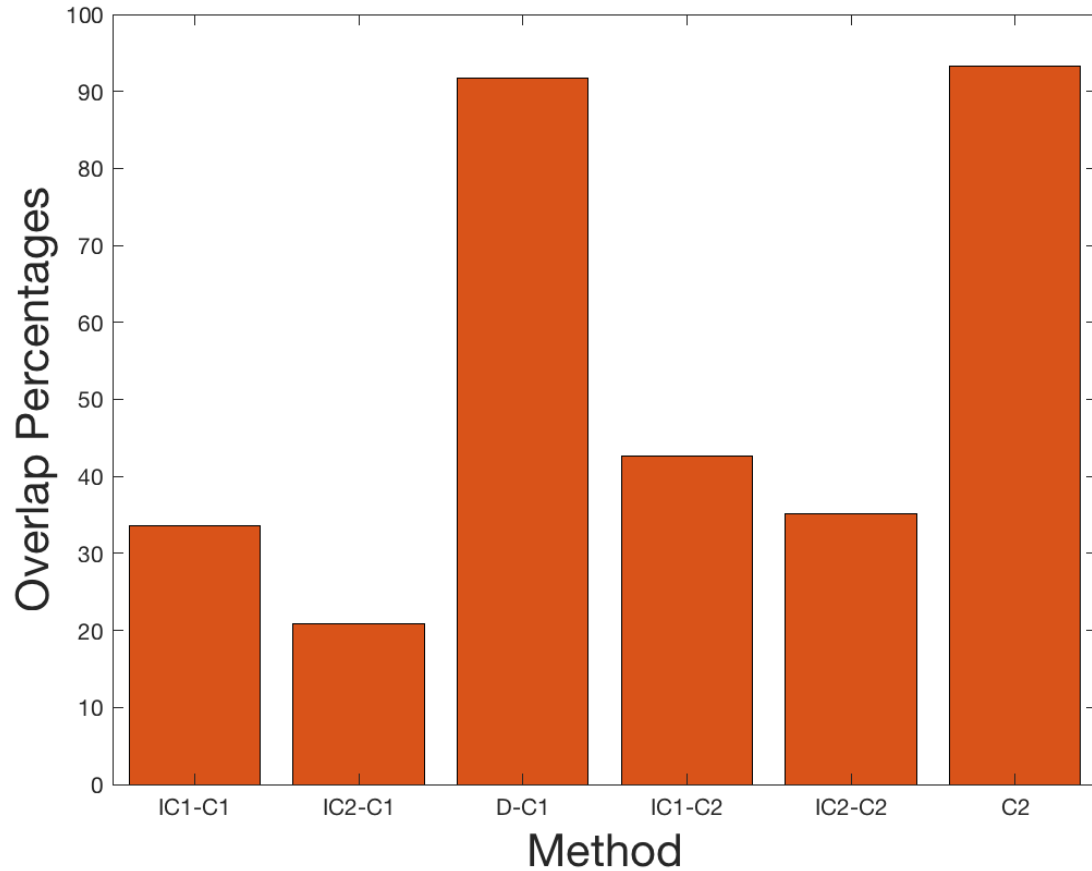
Figure 14: The vehicle detector trained on a window moving over the second independent component applied to the test data after two morphological cleanings.
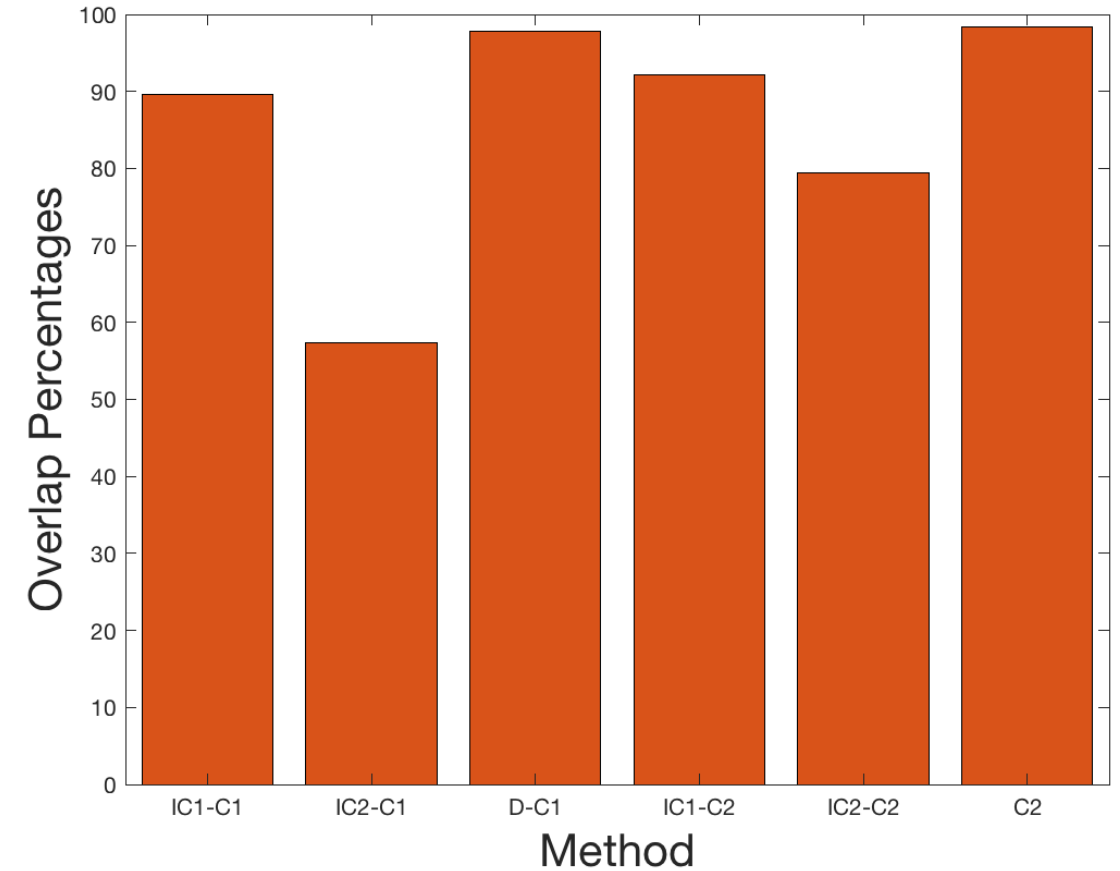
Figure 15: The percentage of points in the foreground which are contained by a bounding box for (left) Experiment 1 and (right) Experiment 2. The higher bar indicates how well the method did compared to the others.

The vehicle detector trained on the training data statistically performed better than the detectors taught using the independent components.

Performing ICA on 5 second segments of data provided the worst results in every case.

We plan to explore how well this method works when multiple signals are present in the data; such as, data containing multiple vehicles or a vehicle and pedestrians.

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Colleagues at CREWES and Fotech Solutions

Thank you for listening! Any questions?