



**Detecting anomalies in railway infrastructure
with advanced data analysis techniques**



Why

Efficiency

Performance

Maintenance

Serviceability

A photograph of two young women leaning out of a train window, smiling and talking. The woman on the left has long brown hair and is wearing a white t-shirt. The woman on the right has short dark hair and is wearing a grey t-shirt. The train is white with a red and yellow stripe at the bottom. The word "Safety" is written in white text across the middle of the image.

Safety

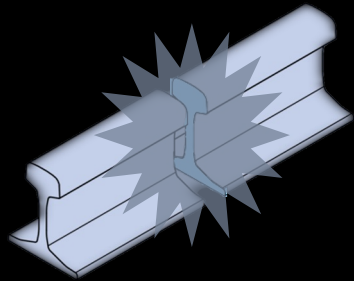
Anomalies

Rails

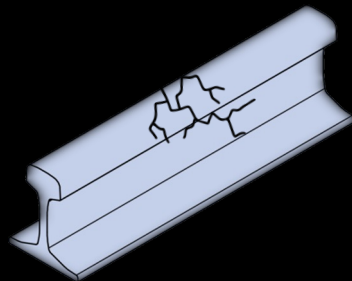
Ballast

Fasteners

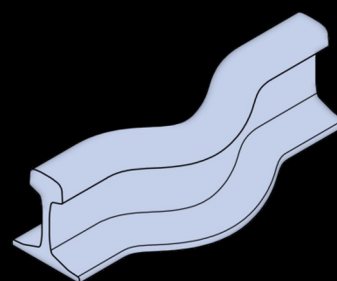
Rails



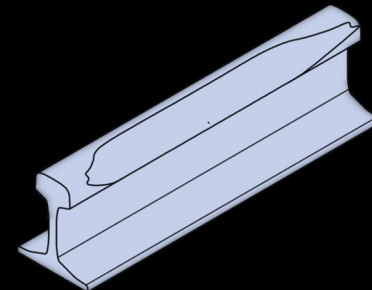
Fracture



Cracks



Bend



Head checks

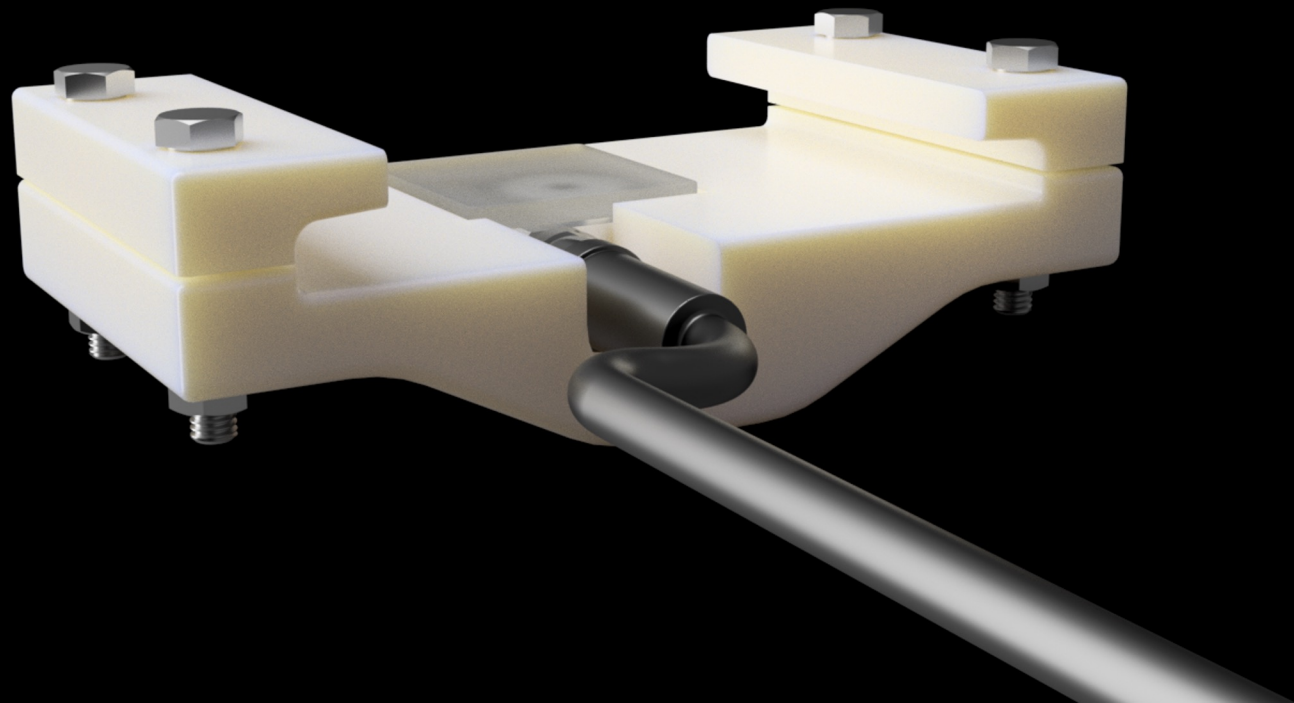


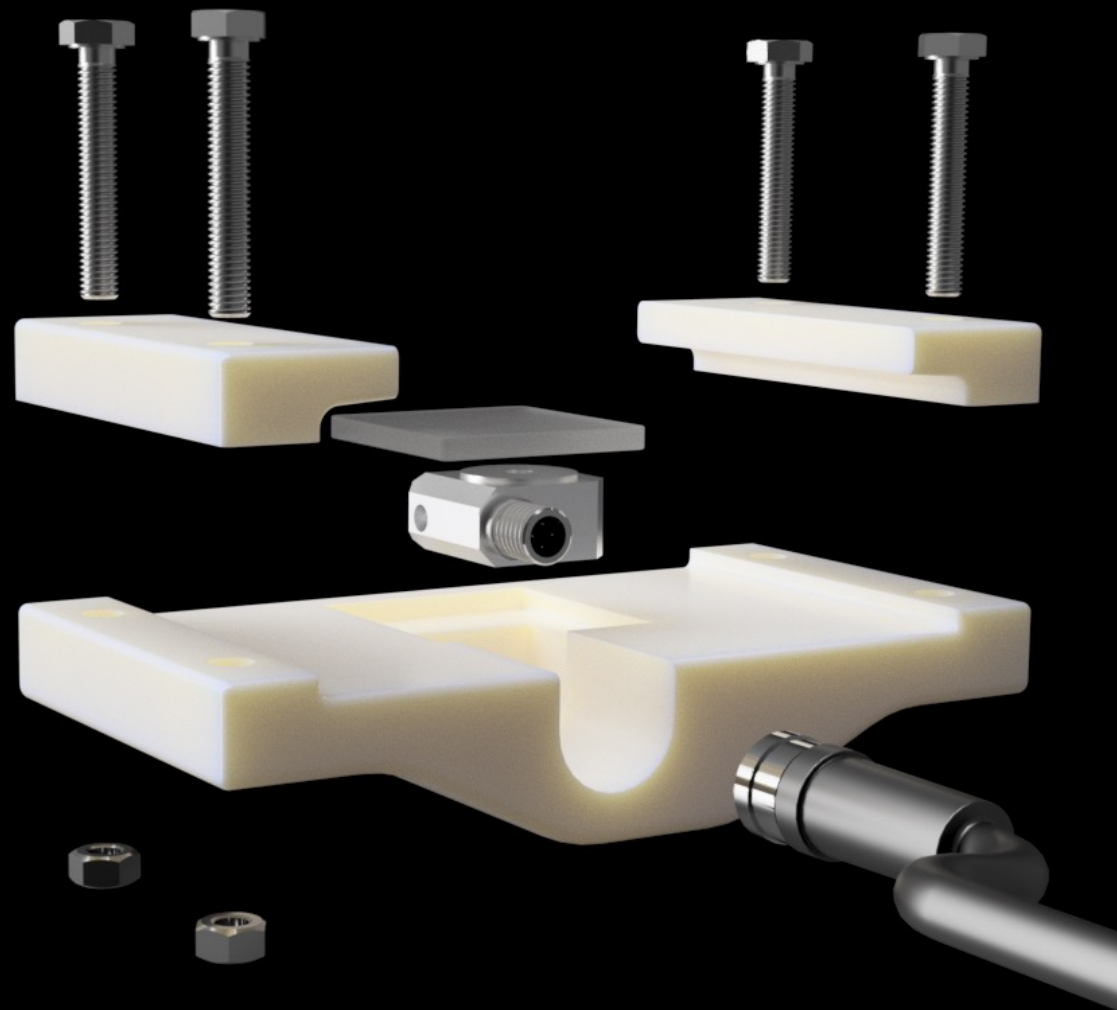
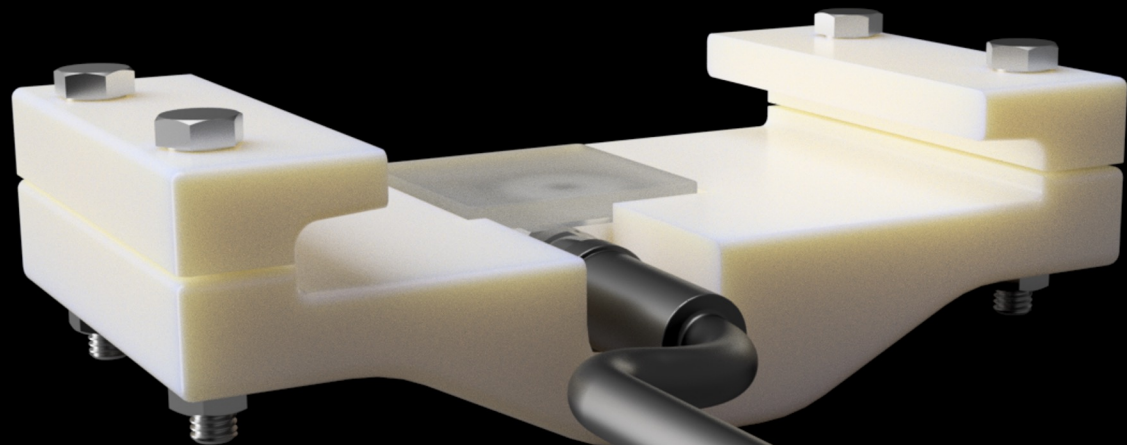


Detection

Visual inspection
Ultrasonic testing
Acoustic monitoring
Infrared Thermography
Track geometry measurement
Ground penetrating radar (GPR)

Vibrations

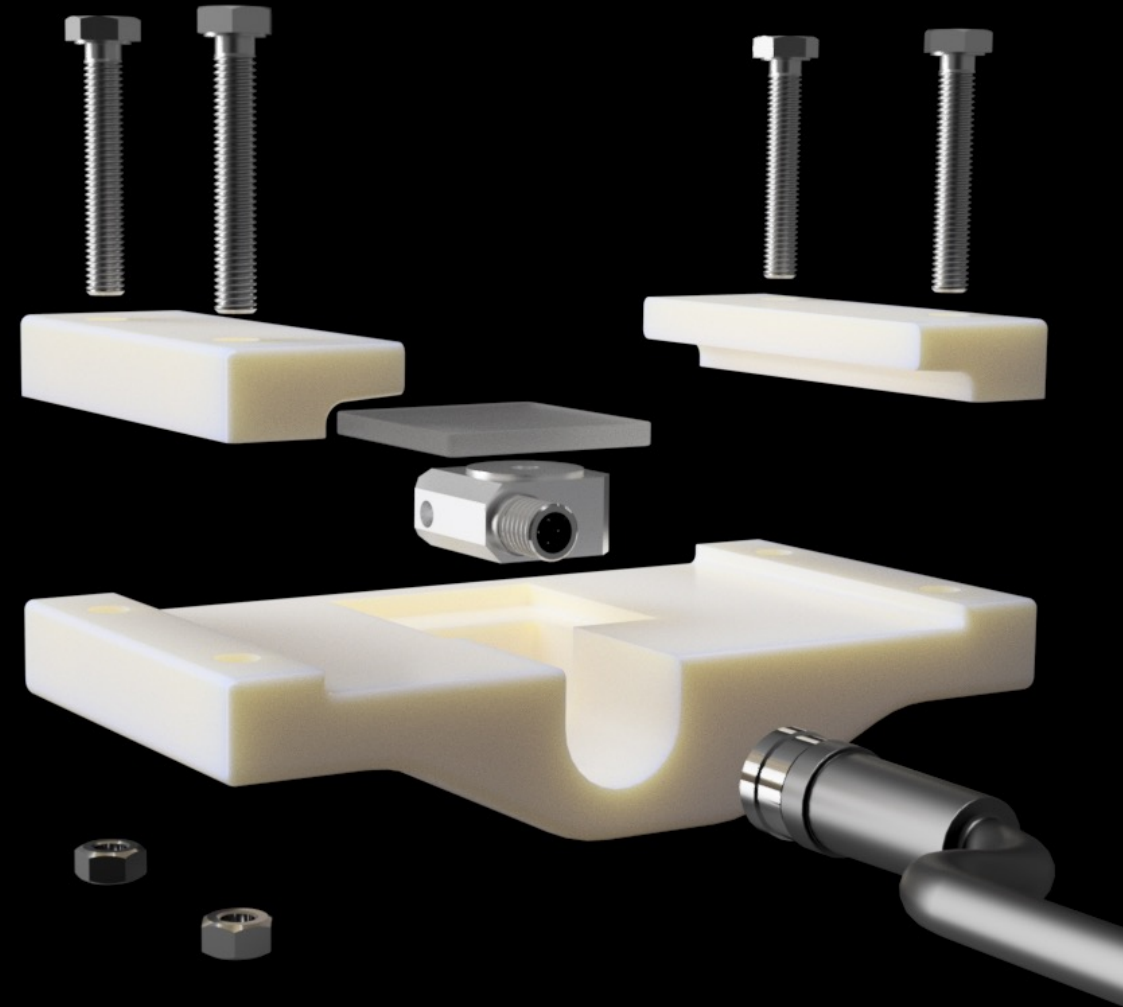


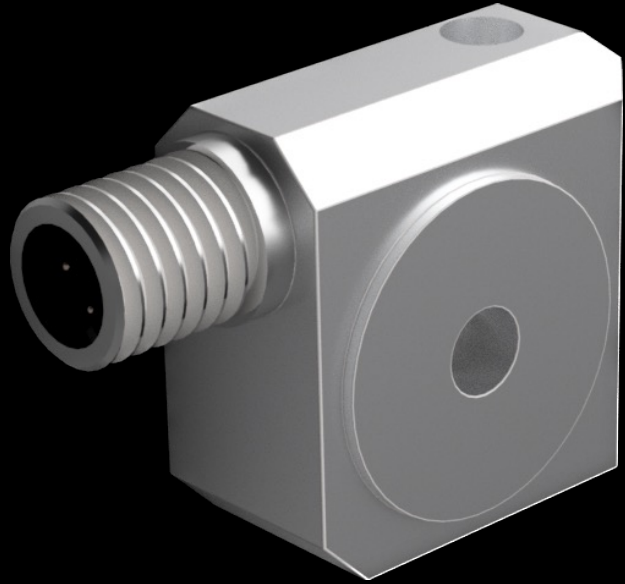


Electrical Insulator

Accelerometer

Polymer Housing





Triaxial

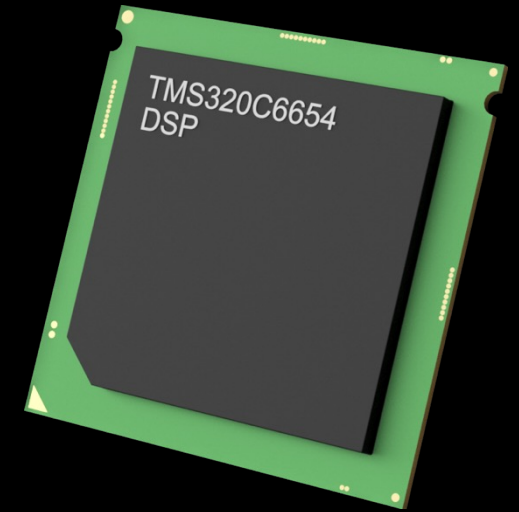
Piezoelectric

Durable housing

Noise filtering

Efficient calculations

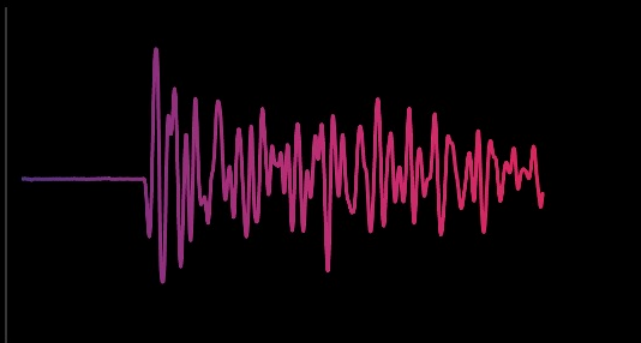
High-speed processing







Acceleration
m/s²



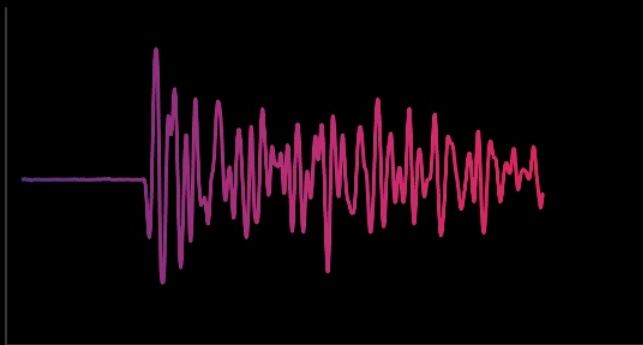
Time
ms

Acceleration
m/s²



Time
ms

Acceleration
m/s²



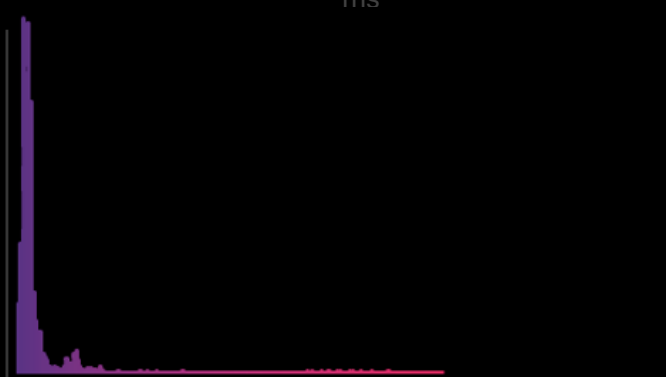
Time
ms

Acceleration
m/s²



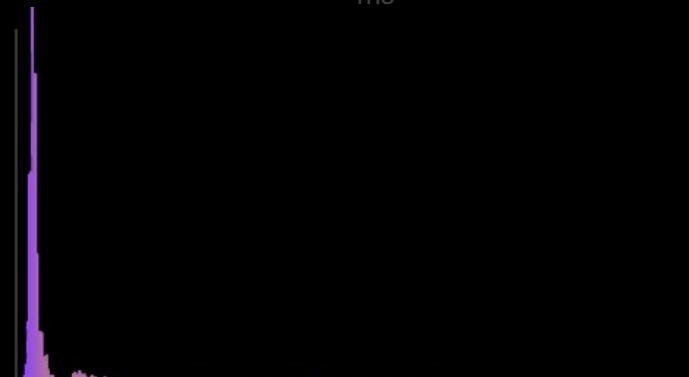
Time
ms

Amplitude
dB



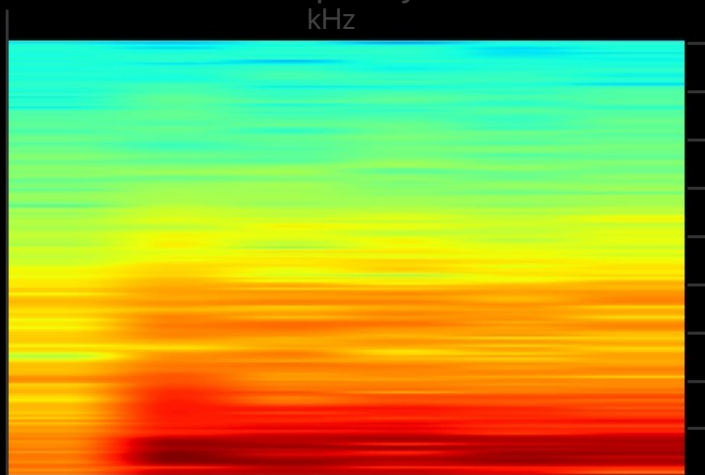
Frequency
kHz

Amplitude
dB



Frequency
kHz

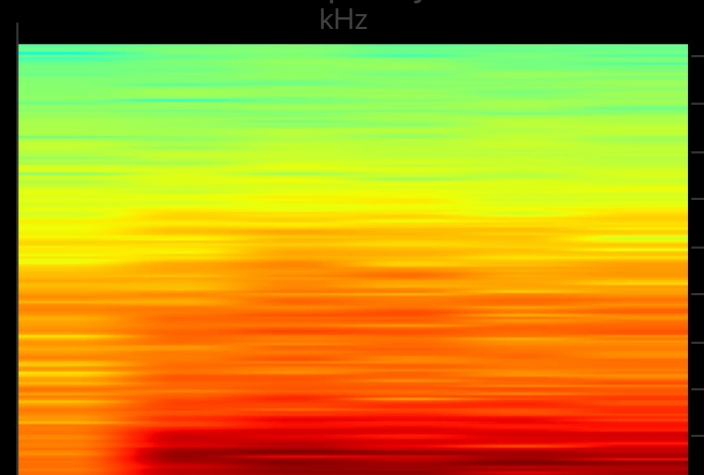
Frequency
kHz



Time
us

Amplitude
dB

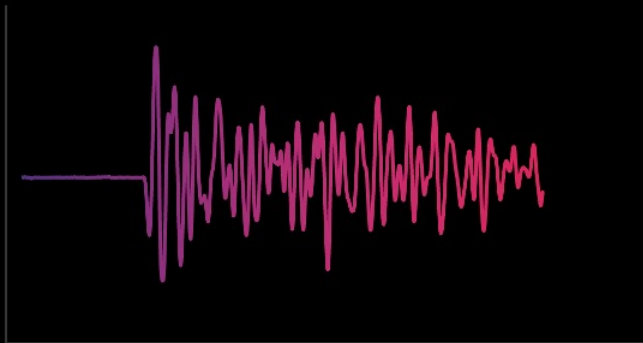
Frequency
kHz



Time
us

Amplitude
dB

Acceleration
m/s²



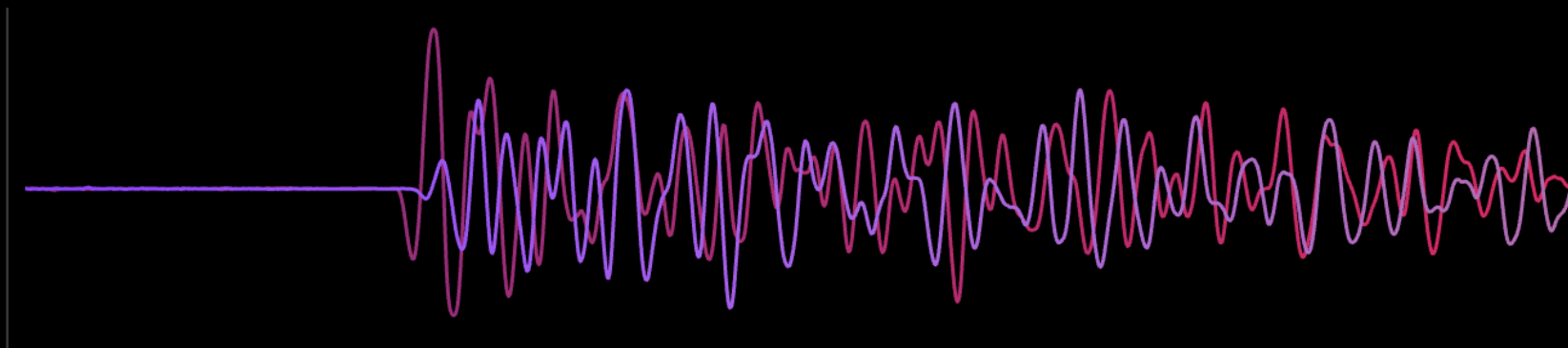
Time
ms

Acceleration
m/s²



Time
ms

Acceleration
m/s²



Time
ms

Data overload

Signal ambiguity

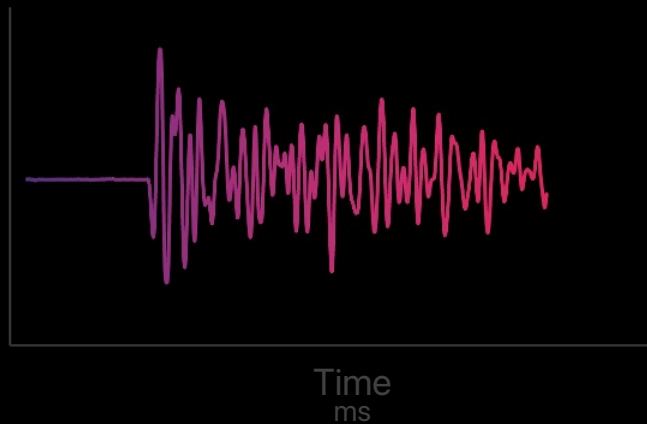
Pattern complexity

Data analytics and Neural Network

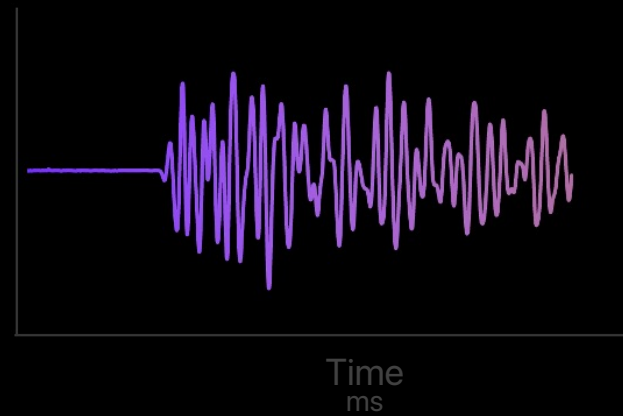
Data
Learning
Computation
Prediction



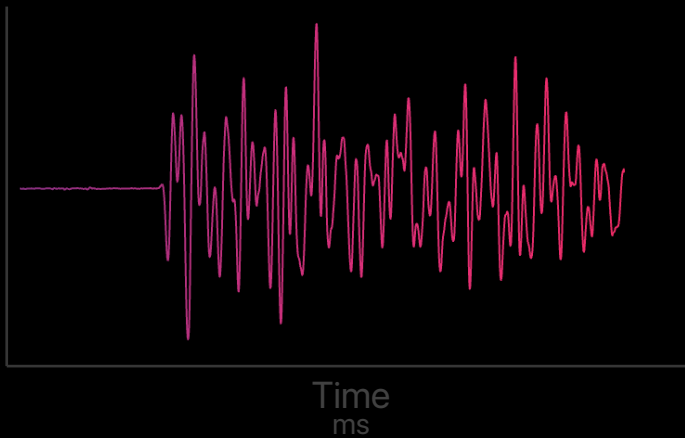
Acceleration
m/s²



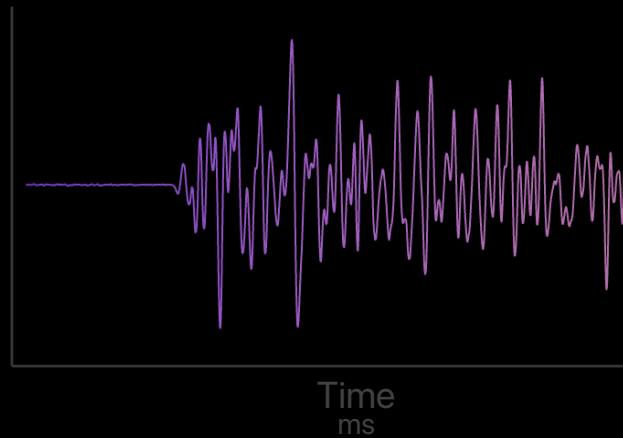
Acceleration
m/s²

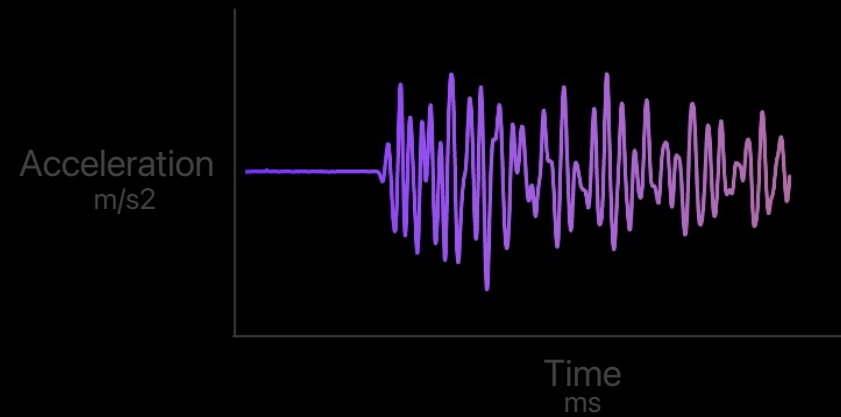
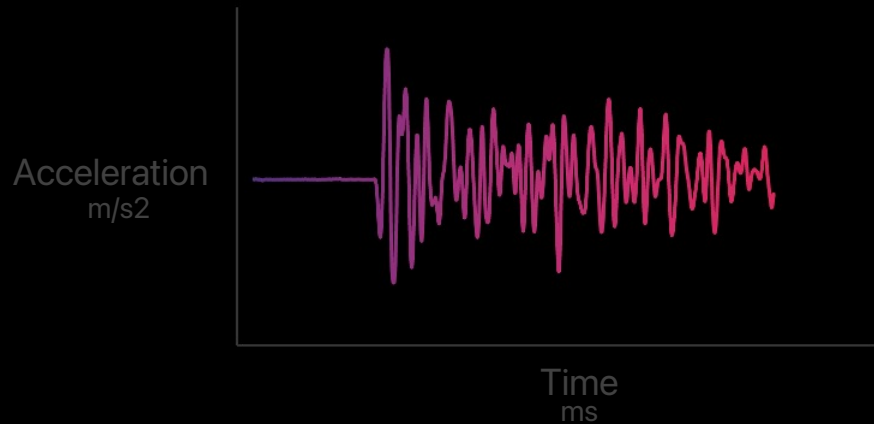


Acceleration
m/s²

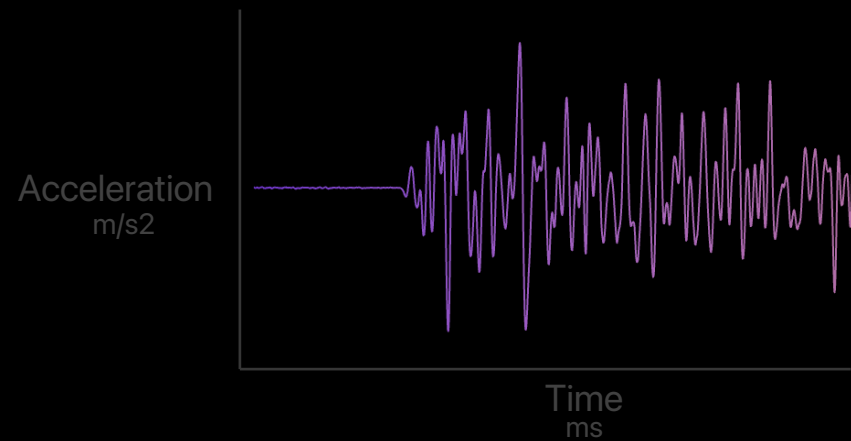
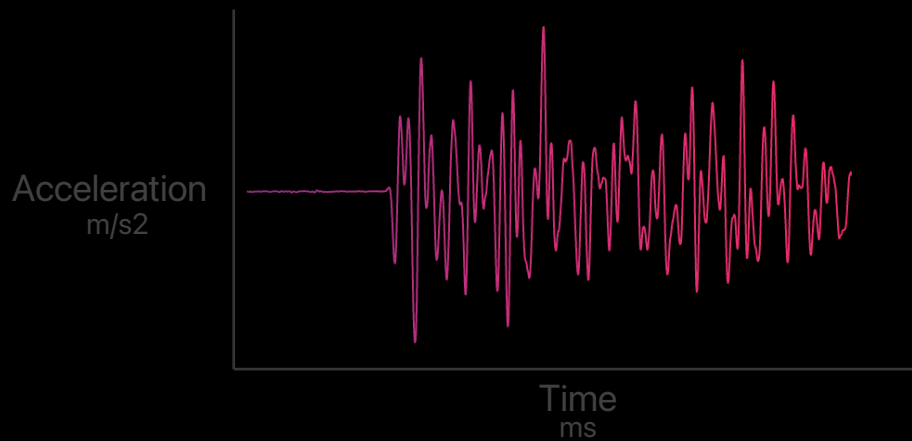


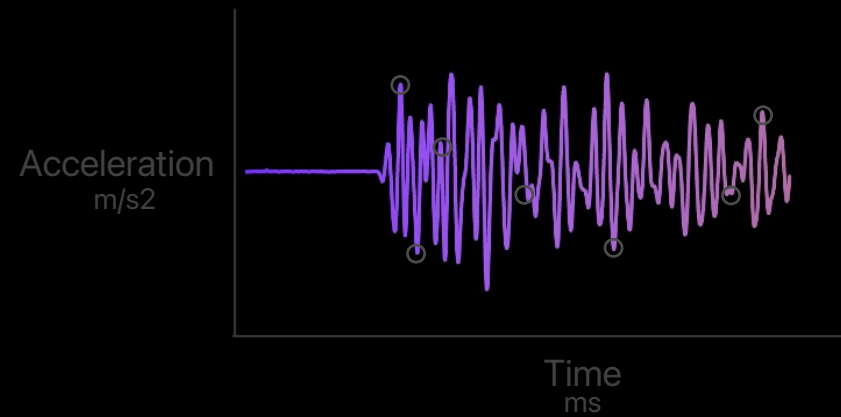
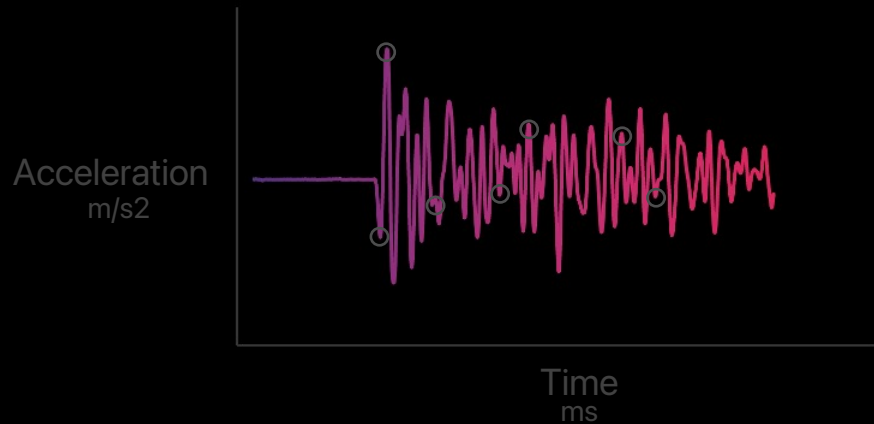
Acceleration
m/s²



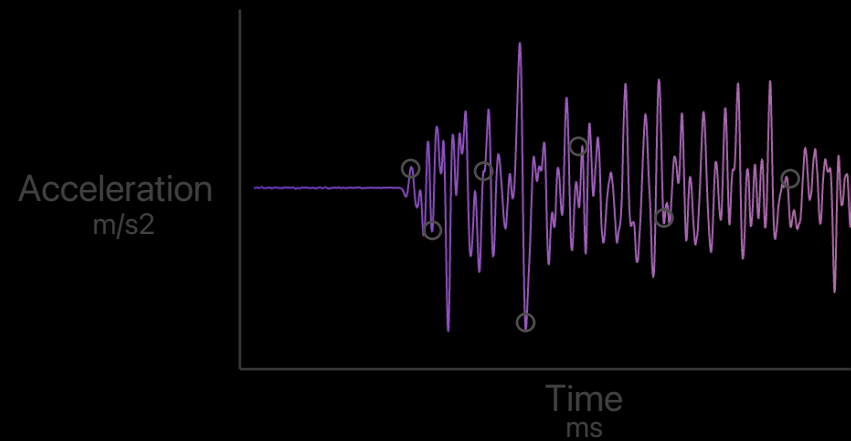
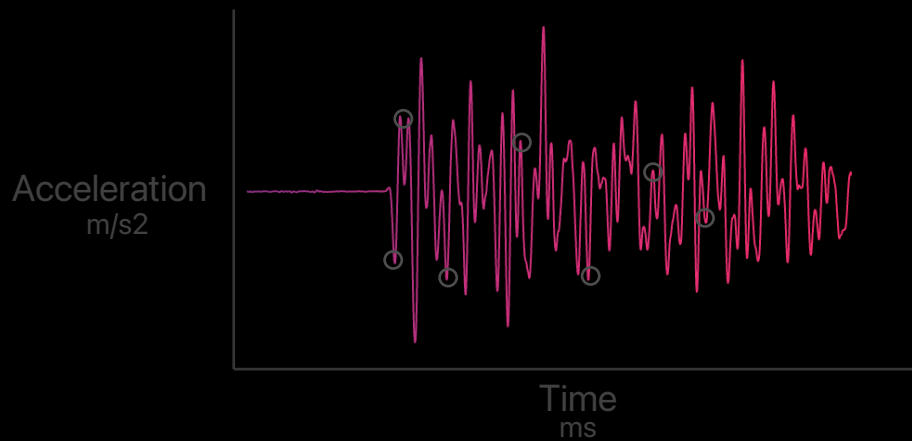


Neural network





Neural network



tracktec
Proteus System

File Serial Port ML Extensions Server Help

Ports: Start Stop Port: COM4

Parameters: Detection: Only threshold Threshold value: 0.6 Signal state: Raw Threshold factor: 1 Phase filter: Common Filter recursiveness: 10 Sensors distance: 100 Samples per 1m: 145 Mark threshold Save data Compute Output: Distance

Calculated Results: 70 Distance [cm]

Matrix:

0	0	0	0,4742138...
1	0	1	0
2	0,6322851...	2	0
3	0,6322851...	3	0
4	0,6322851...	4	-0,1580712...

Aquired data

Chart Samples Amount:4000 ns Amount:4000

tracktec
Proteus System

File Serial Port ML Extensions Server Help

Ports: Start Stop Port: COM4

Parameters: Detection: Only threshold Threshold value: 0.6 Signal state: Averaged Threshold factor: 1 Phase filter: Common Filter recursiveness: 10 Sensors distance: 100 Samples per 1m: 145 Mark threshold Save data Compute Output: Distance

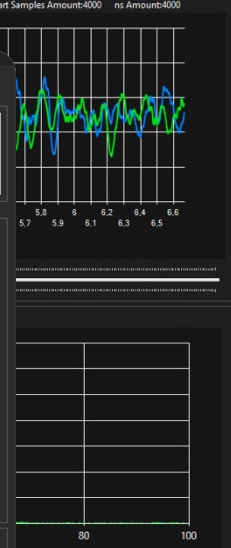
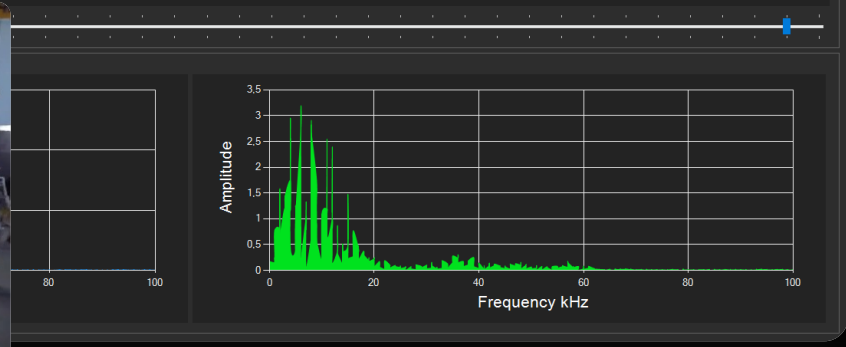
Calculated Results: 70 Distance [cm]

Matrix:

0	0	0	0,4742138...
1	0	1	0
2	0,6322851...	2	0
3	0,6322851...	3	0
4	0,6322851...	4	-0,1580712...

Aquired data

Chart Samples Amount:4000 ns Amount:4000





Tracktec Diagnostics Systems

Status

Status połączenia z serwerem ftp

Utworzenie pliku

Data odczytów: 19.12.2021

Wyświetl

Wszystkie pliki na serwerze

Psary_symul_1_2021_09_28.csv
 Psary_symul_1_2021_01_23.csv
 Psary_symul_1_2021_10_16.csv
 Psary_symul_1_2021_05_21.csv
 Psary_symul_1_2021_02_20.csv
 Psary_symul_1_2021_10_20.csv
 Psary_symul_1_2021_12_15.csv
 Psary_symul_1_2021_12_18.csv

F--> [I]	Max_Is1 [A]	Max_Is2 [A]	Max_Is3 [A]	Max_I1 [A]	Max_I2 [A]	Max_I3 [A]	Usmax1 [V]	Usmax2 [V]	Usmax3 [V]	Ufmax1 [V]	Ufmax2 [V]	Ufmax3 [V]	U1_2 [A]	U2_2 [A]	U3_2 [A]	Us
1.8	1.7	1.8	1.8	1.7	1.8	1.8	1.8	1.7	1.8	1.8	1.7	1.8	1.8	1.7	1.8	1.8
1.8	1.7	1.8	1.8	1.7	1.8	1.8	1.8	1.7	1.8	1.8	1.7	1.8	1.8	1.7	1.8	1.8
-1.8	-1.9	-1.9	-1.9	-1.8	-1.9	-1.9	-1.8	-1.9	-1.9	-1.8	-1.9	-1.9	-1.8	-1.9	-1.9	-1.9
1.9	1.8	1.9	1.9	1.9	1.8	1.9	1.9	1.8	1.9	1.9	1.8	1.9	1.9	1.8	1.9	1.9
1.9	1.8	1.9	1.9	1.9	1.8	1.9	1.9	1.8	1.9	1.9	1.8	1.9	1.9	1.8	1.9	1.9
-1.8	-1.8	-1.9	-1.9	-1.8	-1.9	-1.9	-1.8	-1.9	-1.9	-1.8	-1.9	-1.9	-1.8	-1.9	-1.9	-1.9
1.8	1.7	1.8	1.8	1.7	1.8	1.8	1.8	1.7	1.8	1.8	1.7	1.8	1.8	1.7	1.8	1.8
1.8	1.7	1.8	1.8	1.7	1.8	1.8	1.8	1.7	1.8	1.8	1.7	1.8	1.8	1.7	1.8	1.8
1.8	1.7	1.8	1.8	1.7	1.8	1.8	1.8	1.7	1.8	1.8	1.7	1.8	1.8	1.7	1.8	1.8
-1.8	-1.9	-1.9	-1.9	-1.8	-1.9	-1.9	-1.8	-1.9	-1.9	-1.8	-1.9	-1.9	-1.8	-1.9	-1.9	-1.9
1.9	1.8	1.9	1.9	1.9	1.8	1.9	1.9	1.8	1.9	1.9	1.8	1.9	1.9	1.8	1.9	1.9
1.9	1.8	1.9	1.9	1.9	1.8	1.9	1.9	1.8	1.9	1.9	1.8	1.9	1.9	1.8	1.9	1.9
-1.8	-1.9	-1.9	-1.9	-1.8	-1.9	-1.9	-1.8	-1.9	-1.9	-1.8	-1.9	-1.9	-1.8	-1.9	-1.9	-1.9
1.8	1.7	1.8	1.8	1.7	1.8	1.8	1.8	1.7	1.8	1.8	1.7	1.8	1.8	1.7	1.8	1.8
1.8	1.7	1.8	1.8	1.7	1.8	1.8	1.8	1.7	1.8	1.8	1.7	1.8	1.8	1.7	1.8	1.8
-1.8	-1.9	-1.9	-1.9	-1.8	-1.9	-1.9	-1.8	-1.9	-1.9	-1.8	-1.9	-1.9	-1.8	-1.9	-1.9	-1.9
1.8	1.8	1.9	1.9	1.8	1.9	1.9	1.8	1.9	1.9	1.8	1.9	1.9	1.8	1.9	1.9	1.9
1.8	1.8	1.9	1.9	1.8	1.9	1.9	1.8	1.9	1.9	1.8	1.9	1.9	1.8	1.9	1.9	1.9

Os Y: Sun S, Os X: Time

Wykresy

1.0.30.424

Track Tec Smart Turnout Turnout 1

Sunday 19-12-2021 12:32:23

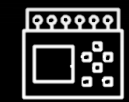
Switch Cycles=402

Switch Panel: L1 0.1V, L2 0.1V, L3 0.1V, L1 0.1A, L2 0.1A, L3 0.1A

Frog: L1 0.1V, L2 0.1V, L3 0.1V, L1 0.1A, L2 0.1A, L3 0.1A

Return

1.0.30.424





3rd Railway Talk UEEIV

Research and Development Department, Katowice

2023

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