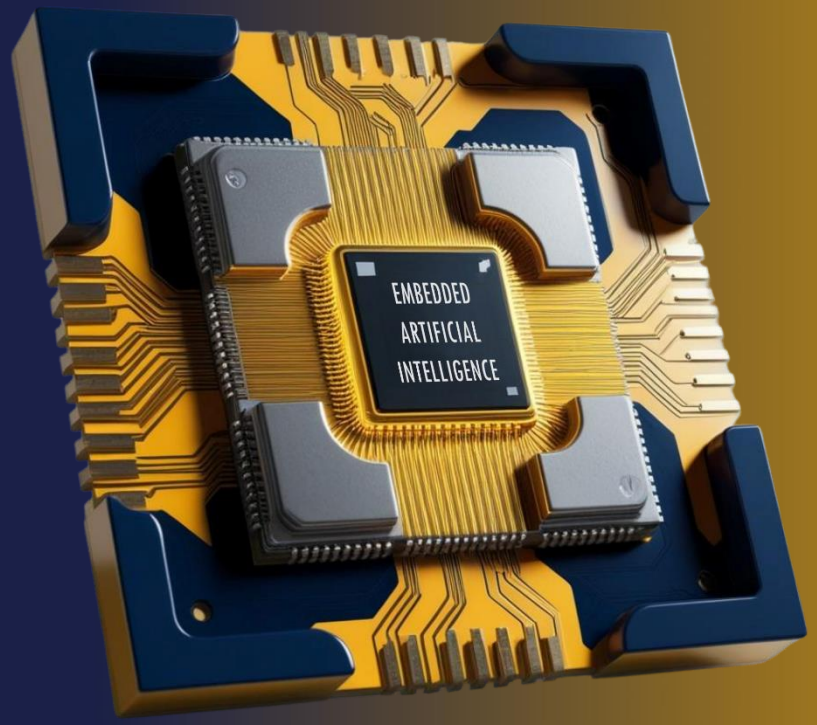
SHIRATECH KNOWTION

Embedded AI
for Smart Products



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CTO & Managing Director Knowtion GmbH

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About Us | Next-Gen Software Solutions

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We are your **one-stop technology partner** for developing cutting-edge software solutions tailored to meet your specific needs.

2011 founded in Karlsruhe out of **KIT**

200+ scientific publications in **innovative research**

100+ successful customer **projects**

SME to Corp customer **range**

Since 2021 a subsidiary of **Shiratech Solutions Ltd.**

PhD & Master degrees build our development **team**

ICG ISO 9001 zertifiziert
Knowtion GmbH, Karlsruhe
certified since 2012

Allianz für Cyber-Sicherheit
Teilnehmer

Mitglied im AMA Verband für Sensorik - Messtechnik
Innovatoren verbinden

OPEN INDUSTRY 4.0 ALLIANCE

Our Expertise

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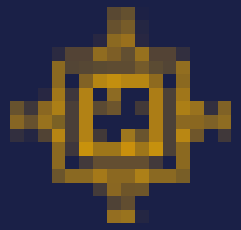
Industrial Applications

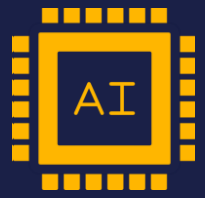
Aviation Software

Power Technologies

Public Projects



Sensor Technologies



Smart Products

Defence & Aerospace

Medical Technologies

We develop...

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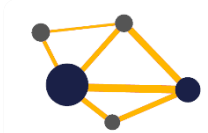
...tailor-made algorithms and software for complex, mathematical problems with sensor fusion and automatic data analysis / machine learning.

Sensor Fusion

Combination of different
sensor data and information sources



Algorithm Development

Development of mathematical
algorithms, Prototyping,
Simulation and evaluation

Automatic Data Analysis

Real-time surveillance of sensor data
and detection of anomalies

Software Development

Development according to standards
Software safety and quality

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What is Embedded AI?

What is Embedded AI?

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- Embedded AI is the **deployment** and **processing** of AI models **directly on edge devices** such as **microcontrollers**, **sensors**, or **smartphones**

- Edge **devices** are typically **constrained** by **limited computing power**, **memory**, and **storage**

***Traditional AI**: Models are processed on powerful servers.*

***Embedded AI:** Data is processed locally on devices, closer to where the data is generated.*

Comparison

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AI in the Edge

- **Training**
  - Only a limited subset of data available at once, no memory of old data
  - Stream processing
- **Resources**
  - Limited memory & computing power
  - Limited model size

Classical AI

- **Training**
  - All data available
  - Batch processing
- **Resources**
  - Virtually infinite
  - Billions of model parameters

Embedded AI | Two Approaches

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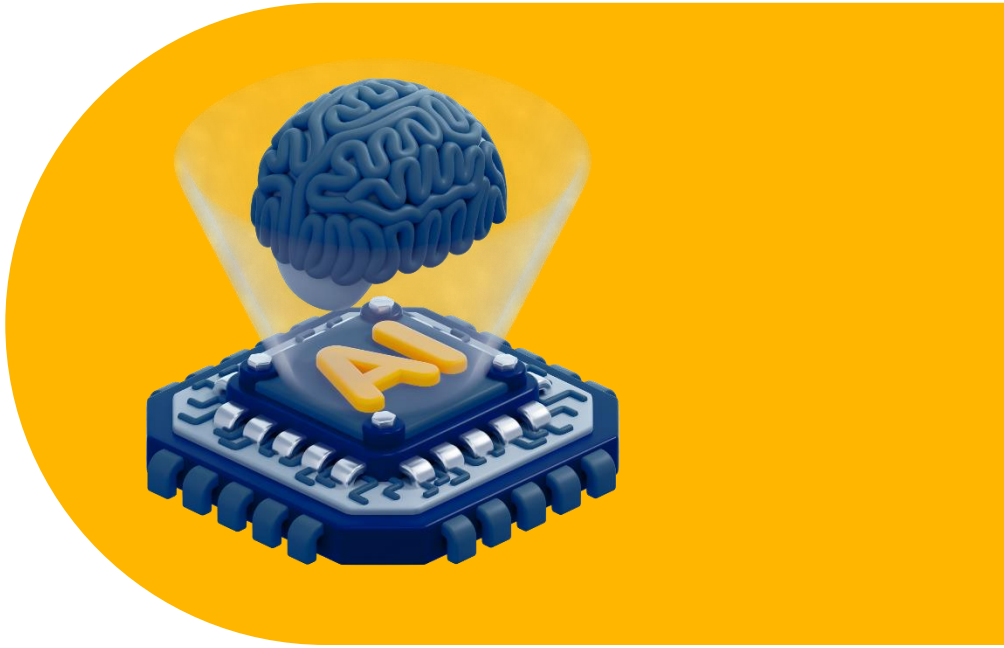
Off-line Training

- Training with classical approach on server
- Model reduction / approximation
- Deployment onto edge device
- Inference on edge device



On-line Training

- **Training and inference** directly on edge device
- Specialized algorithms that are able to cope with limited resources (memory!)
  - Streaming approach
  - Only use a limited subset of data → perform model update → discard data

Key benefits of Embedded AI

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Lower Latency & Fast Response Times

- ✓ AI processes data more quickly due to missing communication channels, (e.g., to cloud), enabling rapid decision-making

Sustainability

- ✓ Reduces energy consumption and data transfer needs

Maximized Data Security & GDPR Compliance

- ✓ Operates locally (offline) and ensures high levels of data security in line with data governance and privacy requirements

Edge vs. Cloud

- ✓ Intelligent distribution of workloads between edge and cloud

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StorAIge

Embedded AI in Action

Tracking Logistics Pallets

Tracking Logistics Pallets

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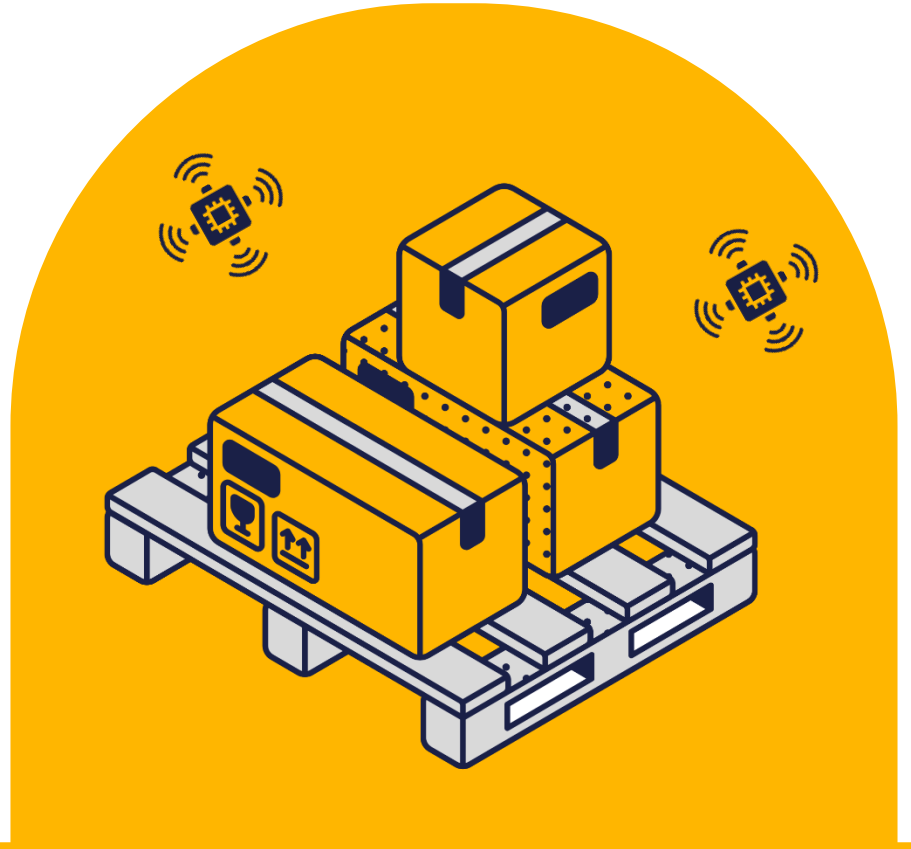
Goal → Monitoring of shipment (e.g. damage during transport)

- ✓ Detection (classification) of different movements of a pallet during transport
- ✓ Wireless microcontroller mounted on the pallet
  - RSL15 von Onsemi mit Arm Cortex-M33
    - RAM 64 kB
    - Flash 512 kB
  - Acceleration sensor (3 axes) → Sampling rate 400 Hz
- ✓ Data recorded & analyzed during transport
- ✓ Result can be read out via Bluetooth



Data-driven Detection of Movement

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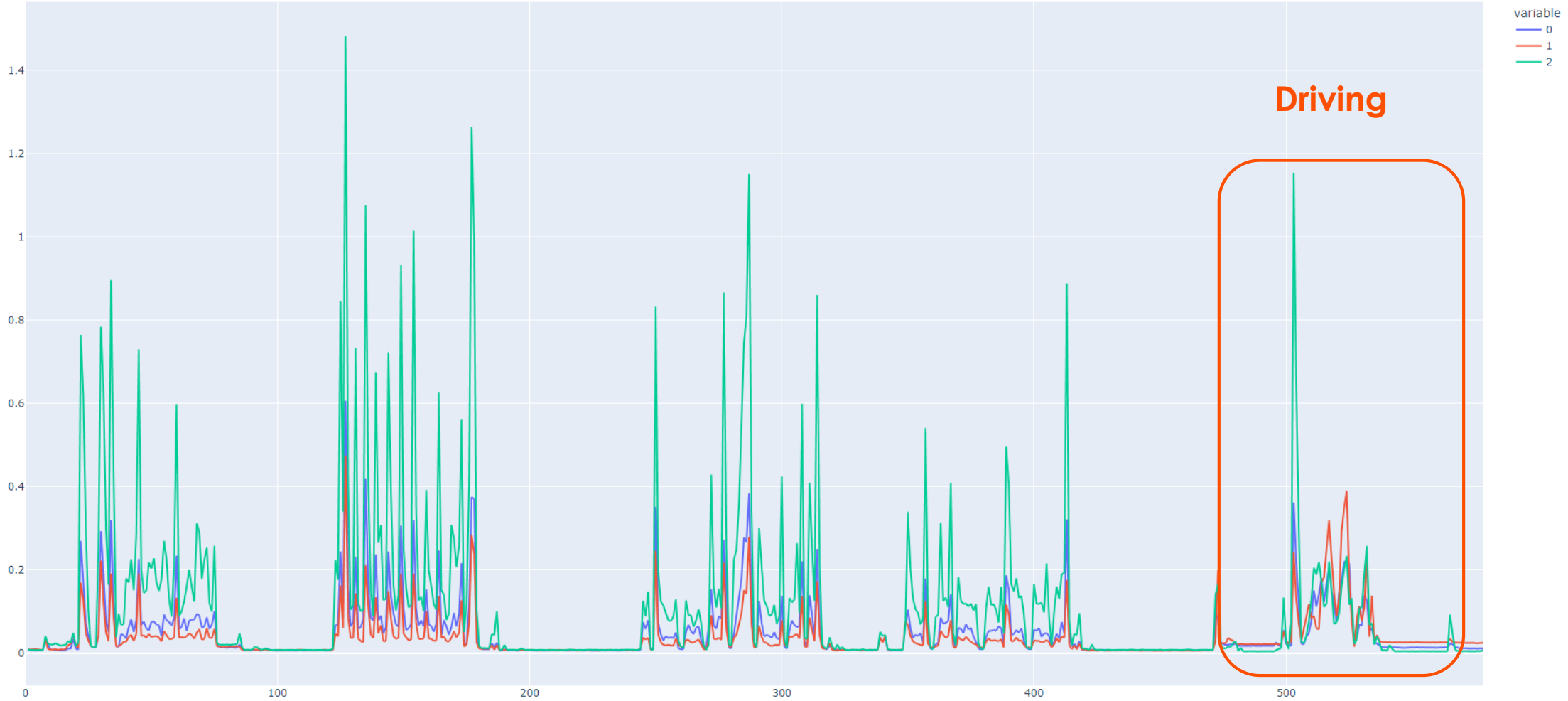

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StorAIge

Embedded AI in Action

Wind Turbine Gearbox Monitoring

Monitoring Wind Turbines

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A gearbox manufacturer wants to detect damage in plain bearings.

Goal Development of a Predictive Maintenance Solution for Gearbox Monitoring

Approach

- ✓ Development of algorithms for anomaly detection
- ✓ Deployment of embedded AI models onto the sensor
- ✓ Mounting of the embedded device onto the gearbox
- ✓ Continuous monitoring & data collection

The Challenge

Unlike ball bearings, plain bearings function by gliding on an oil film

- If the oil disappears, metal parts rub against each other, causing permanent damage within seconds

→ **Critical component for monitoring**

Missing real-world operational data for training

- Option 1: Use of historical data to train the models
- Option 2: Wait for a real-life failure to occur while monitoring

Results & Benefits

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Real-time anomaly detection & prevention with on-site AI training

- AI learns quickly & directly on-site/on the sensor device
- Emerging faults are detected & warnings are sent in real-time to the control centre
- Permanent, costly damage can be prevented

Benefits

✓ Detects emerging gearbox issues, preventing costly turbine shutdowns

✓ Ensures continuous energy production and grid stability

✓ Reduces energy losses caused by mechanical inefficiencies

✓ Eliminates frequent and costly replacement of parts

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The Algorithm Explained

Example: M5Stick Mini Toy

The Algorithm Explained

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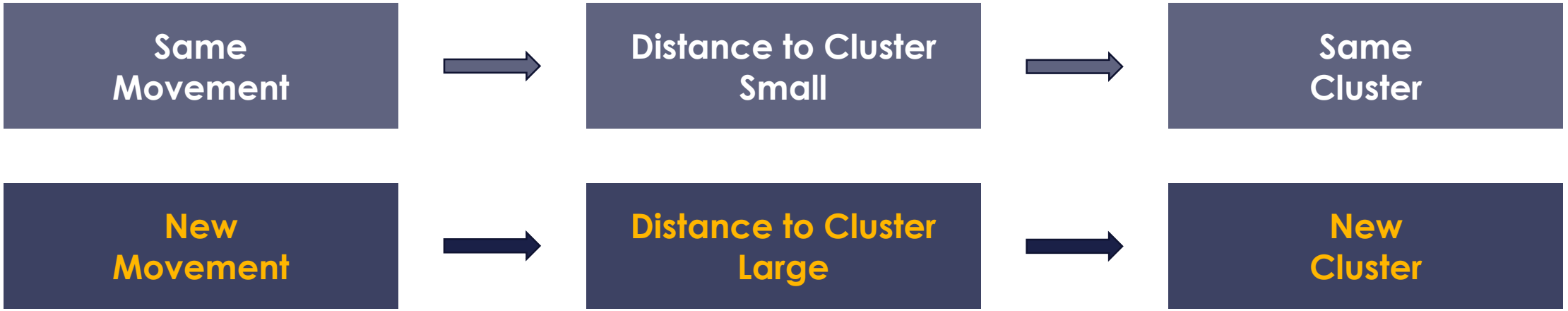
Detection & "LEARNING" of movements & positions

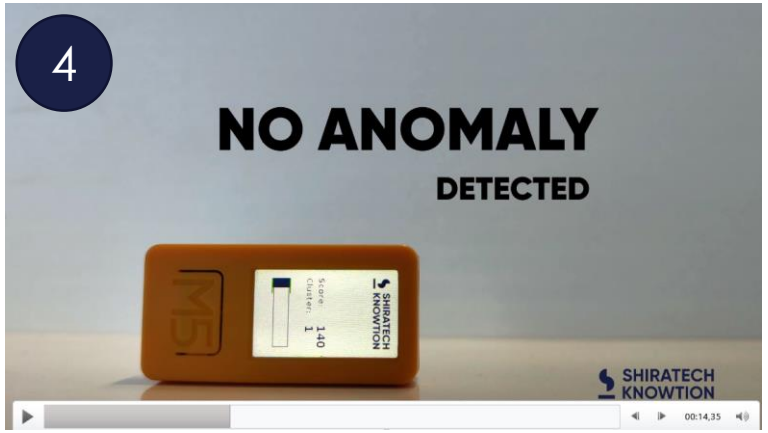
- Cluster algorithm
- Calculation of features from acceleration data




1
SHIRATECH KNOWTION
Score: 21
Cluster: 0
M5
SHIRATECH KNOWTION
00:00,11

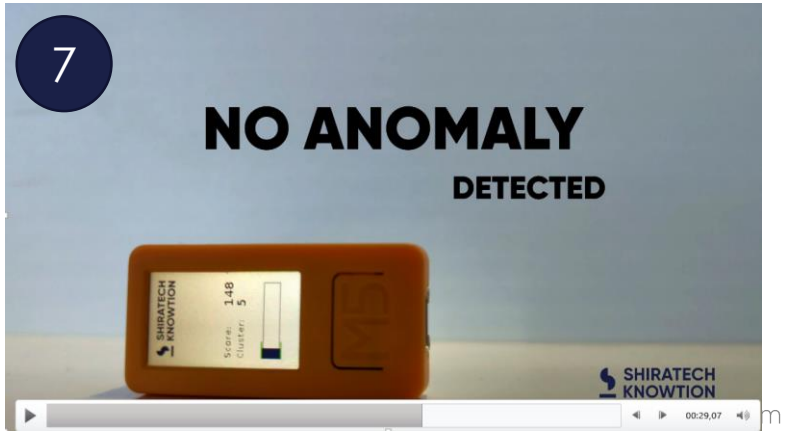

2
ANOMALY
DETECTED
M5
SHIRATECH KNOWTION
Anomaly: 7
Score: 351
Cluster: 1
SHIRATECH KNOWTION
00:05,93


3
SHIRATECH KNOWTION
Score: 26
Cluster: 0
M5
SHIRATECH KNOWTION
00:11,39


4
NO ANOMALY
DETECTED
M5
SHIRATECH KNOWTION
Score: 140
Cluster: 1
SHIRATECH KNOWTION
00:14,35


5
NEW ANOMALY
DETECTED
M5
SHIRATECH KNOWTION
Anomaly: 1.5
Score: 281
Cluster: 4
SHIRATECH KNOWTION
00:20,07


6
SHIRATECH KNOWTION
Score: 6
Cluster: 5
M5
SHIRATECH KNOWTION
00:26,74


7
NO ANOMALY
DETECTED
M5
SHIRATECH KNOWTION
Score: 148
Cluster: 5
SHIRATECH KNOWTION
00:29,07


8
STILL NO ANOMALY
DETECTED
M5
SHIRATECH KNOWTION
Score: 69
Cluster: 9
SHIRATECH KNOWTION
00:38,66


9
SHIRATECH KNOWTION
Score: 7
Cluster: 9
M5
SHIRATECH KNOWTION
00:44,32

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Visit us around the corner at

Booth B6.520

StorAIge

KDT JU
KEY DIGITAL TECHNOLOGIES JOINT UNDERTAKING

GEFÖRDERT VOM
Bundesministerium für Bildung und Forschung

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