



# HACARUS

**FOUNDED:** 2014 | **STAGE:** Series B (13M+ USD) | **TEAM:** 80+

## BIG INSIGHTS FROM SMALL DATA

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VP of Global Sales  
Adrian@hacarus.com

 CBINSIGHTS

TOP 100 AI  
2020



# COMPANY OVERVIEW



SPECIALIST EXPERTISE:  
**AI Powered Image &  
Time-Series Data Analysis**

REFERENCE CLIENTS:



## HACARUS

**LATEST ROUND:** Series B

(Lead: Osaka Gas (B), Kyoto University (A))

**FOUNDED:** 2014

**EMPLOYEES:** 80+

**LOCATIONS:** Kyoto (HQ), Tokyo, Kobe, Wakayama, Manila

**CUSTOMER SUPPORT IN:** Japanese, English, German,  
Chinese and Swedish

ACADEMIC PARTNERS:



Kentaro Ohki



TOHOKU  
UNIVERSITY



Masayuki Ohzeki



SHIGA UNIVERSITY



Kaoru Kawamoto

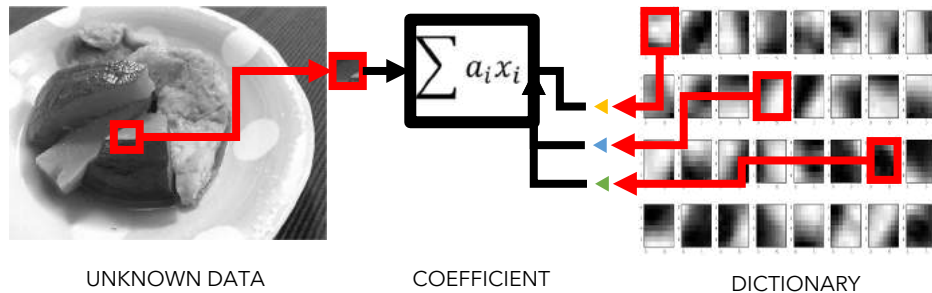
# PROPRIETARY AI ENGINE BUILT WITH SPARSE MODELING

HACARUS focuses on Sparse Modeling based, Deep Learning based and Hybrid methods

The basic assumption of this approach is that most of the features of data are insignificant, and that insights can be derived from a relatively small amount of essential information. Instead of relying on the input data, Sparse Modeling based AI focuses on the relationship between the inputs and outputs which allows for high accuracy even with small data sets.

## SPARSE MODELING

$$E(x) = \frac{1}{2} \|y - Ax\|_2^2 + \lambda \|x\|_1$$



Technical Reference Blog on Dictionary Learning:  
<https://hacar.us/SPM-DL>

Selected Whitepapers introducing Sparse Modeling (Download Links):



<https://hacar.us/black-hole>

<https://hacar.us/SPM-in-AI>

<https://hacar.us/challenges-solved>



Featured in **nature** <https://hacar.us/Nature>

# SPECTRO: BIG INSIGHTS, SMALL DATASETS

- Powered by HACARUS proprietary AI engine with proven market fit - in use across manufacturing plants in Japan across automotive and electronics and construction materials - saving clients on average 30% of costs associated with QE/QC.
- All operation local - no separate hardware (GPU), or cloud connectivity needed for predictions or training AI models.
- Ability to train an inspection model with a small dataset - highly accurate predictions with as little as 20 samples.
- Training with only good data samples means that all defects, no matter size or rarity is captured.



## REFERENCE CLIENTS:

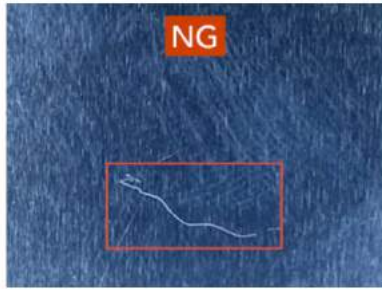


Hitachi Zosen Corporation

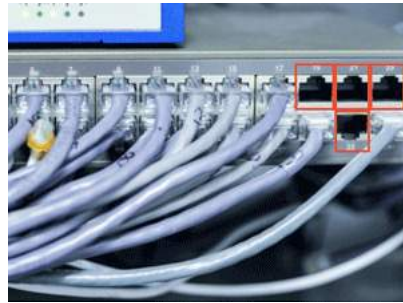


# SPECTRO: CAPABILITIES & FEATURES

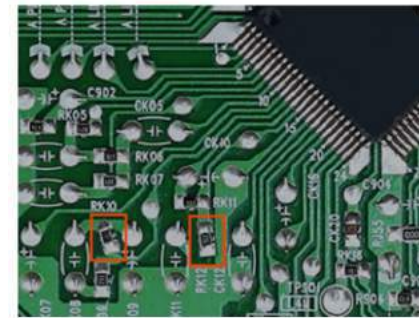
FEATURES



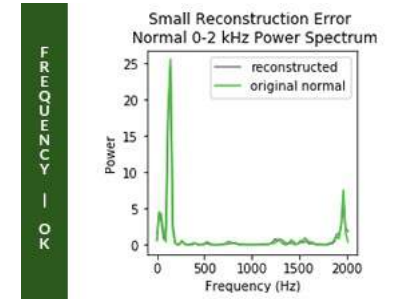
DEFECT DETECTION



MISSING PARTS & MISALIGNMENT DETECTION

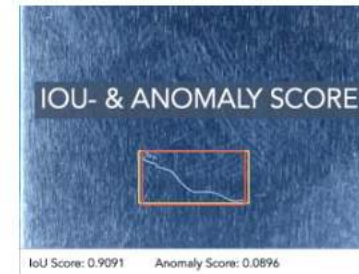
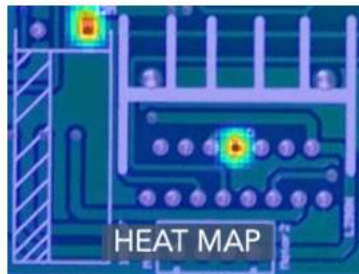


PATTERN MATCHING



PREDICTIVE MAINTENANCE

FUNCTIONALITY

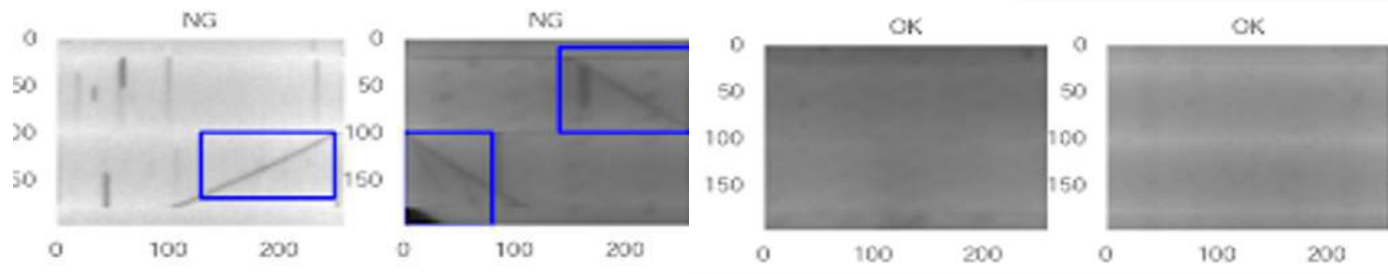


# PERFORMANCE COMPARISON:

## Best in Class Image Analysis

- An article published with Cornell University used conventional AI for defect / error detection on EL images  
(Reference: <https://arxiv.org/abs/1807.02894>)
- HACARUS applied SPECTRO to the same problem to assess performance through an experiment
- When comparing SPECTRO's performance with Classifier (SVM) and Deep Learning (CNN) techniques for defect detection on Solar Cells, SPECTRO far outperforms the competition: Not only is accuracy higher, but SPECTRO also creates AI models faster - even when using a far smaller dataset.

	SVM	CNN	SPECTRO
TRAINING DATA	800 images	800 images	60 images
TRAINING TIME	30 min	5 hours	19 sec
PREDICTION TIME	8 min	20 sec	10 sec
PRECISION	85%	86%	90%



# PERFORMANCE COMPARISON:

## Best in Class Time-Series Analysis

- Time Series Analysis of Vibration Data
- SPECTRO's versatile algorithms can detect anomalies in time-series data, both in the frequency and time-domains
- In the case study highlighted on the right, using data from industrial fans, the solution can detect anomalies over 200 times faster compared with a common k-Nearest Neighbors (KNN) approach, with 100% accuracy.



	KNN	SPECTRO
PREDICTION TIME	212,876 $\mu$ s	973 $\mu$ s
TRAINING TIME	33 sec	14.36 sec
ACCURACY	100%	100%
PRECISION	100%	100%
RECALL	100%	100%

# POC READY EVALUATION KIT:

# Spectro GO

**SPECTRO GO** is a complete visual inspection AI starter kit, designed for new users that are looking for an out-of-the-box ready bundle to get started with early-stage deployments and evaluations.

Working with leading industry partners HACARUS has assembled a kit that includes camera, lens, industrial PC, evaluation software license (developer's license / 6-months), lighting, stand and measurement setup - all pre-configured to work seamlessly together and ready to tackle inspections tasks.

Priced at **EUR9,500**



Industrial  
BOX PC



Precision  
Stand



Basler Ace U



Measurement  
Mat



LED  
Lighting



\*Display not included in bundle



# FROM PILOT TO ROLL-OUT:

## 3 Phases: Test, Build & Deploy

Phase 1: Feasibility Study	Phase 2: Build The AI Model for Inspection	Phase 3: Use The AI Model for Inspection
<p><b>“Assess Use Case for AI Automation”</b></p> <ul style="list-style-type: none"> <li><b>Overview:</b> HACARUS DS Team works with customer data to make initial assessment of fit for automation by SPECTRO</li> </ul>	<p><b>Developers License - “You develop the AI models”</b></p> <ul style="list-style-type: none"> <li><b>Overview:</b> Provides you with all the tools to make unlimited custom AI Models, including a wide range of purpose-built algorithms, allowing for both training and prediction with your own data</li> </ul> <hr/> <p><b>HACARUS DS Consulting Service - “We build the AI models”</b></p> <ul style="list-style-type: none"> <li><b>Overview:</b> HACARUS DS Team builds AI model for your use case, with your data. Custom software development - developed AI model is your IP</li> </ul>	<p><b>Runtime License - “Using the AI model for inspections”</b></p> <ul style="list-style-type: none"> <li><b>Overview:</b> Required licensing when taking AI models from Phase 2 to Phase 3. Node lock license, for hardware failure, renewal of the license up to 3 times.</li> </ul>

# TEAM & TRACTION



## ACADEMIC PARTNERS



## CORE TECHNOLOGY

SPARSE MODELING

$$E(x) = ||y - Ax||^2 + \lambda \sum_i |x_i|$$

## SUPPLIER TO FIRMS SUCH AS



Hitachi Zosen Corporation 



## TECHNOLOGY PARTNERS:



# REFERENCE MATERIALS: Customer Success Stories

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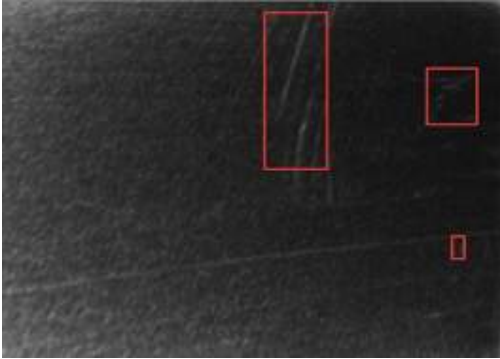
# REAL WORLD RESULTS:

## Metal Surface Inspection for Automotive Tier1

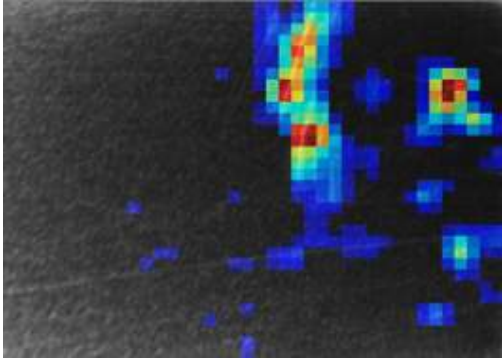
Test data



Anomaly BBox



Anomaly Heatmap



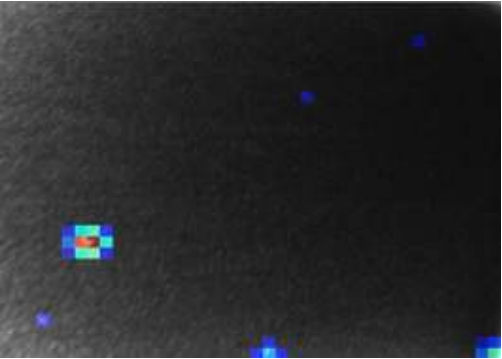
Test data



Anomaly BBox



Anomaly Heatmap



# CUSTOMER SUCCESS STORY:

## Precision Parts (Gears) Inspections

### Customer

- Large Japanese machine manufacturer
- Use case: Secondary inspection of gear parts
- Customer goal: Reduction in manual inspection due to poor performance
- Result: 30% reduction in manual re-inspection

### Data Set:

- Image size: 250x4800px (line scan), split into ~50 sub-images
- Training images: 20
- Evaluation dataset (at PoC): 686 good and 569 defect

### Compute Environment:

- HW: 2.7 GHz Intel Core i7

### Technical Details:

- Training time: ~25s
- Prediction time: ~20-30ms per sub-image
- PoC Result: AUC\*: 0.978



# CUSTOMER SUCCESS STORY:

## Quality Assessment for Circuit Boards (Automotive Use)

### Customer

- Large Japanese electrical manufacturer
- Use case: Automatic inspection of circuit boards
- Customer goal: Reduction in manual inspection by automation
- Result: Accuracy above human inspectors

### Data Set:

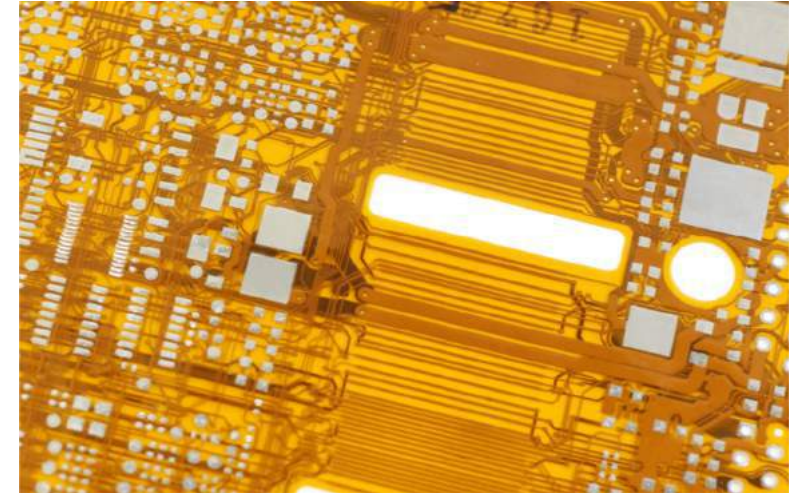
- Image size: 2500x2000px
- Training images: 7500 images
- Evaluation dataset (at PoC): 5000

### Compute Environment:

- HW: 2.7 GHz Intel Core i7

### Technical Details:

- Training time: ~20min
- Prediction time: per image: ~30msec per image
- Accuracy: 95%



# CUSTOMER SUCCESS STORY:

## Gypsum Ceiling Tiles Inspections

### Customer

- Japanese producer of construction material
- Use case: Secondary inspection of surface detection of ceiling tiles.
- Customer goal: Find defects missed by existing inspection system.
- Result: Commercially deployed as inspection system nationwide

### Data Set:

- Image size: 1600x1200px
- Training images: 200 (good samples)

### Compute Environment:

- HW: conga-QA5 (Intel® Atom™ Quad Core on Qseven)

### Technical Details:

- Training time: ~2min
- Prediction time: ~300ms per image
- Accuracy: 99%

