

Solist-AI

Aiming for effective/efficient use of Solist-AI™

Solist-AI™ use cases

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ROHM Co., Ltd.

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Click on each item name to jump to the corresponding explanation slide.

- 1-1. [Industrial "Infrastructure motor"](#)
- 1-2. [Industrial "Infrastructure motor/Machine tool"](#)
- 1-3. [Industrial "Infrastructure motor/Manufacturing Machinery/Robot"](#)
- 1-4. [Industrial "FA Sensors, Product Inspection"](#)
- 1-5. [Industrial "Server equipment, Odor sensor, Printer"](#)

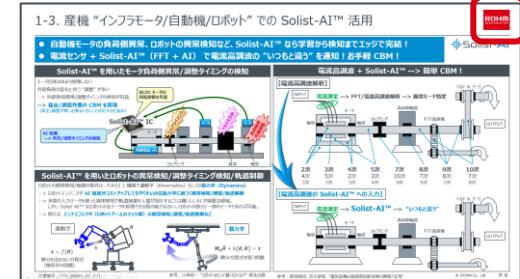
- 2-1. [Tools/Construction machinery/Agricultural machinery](#)

- 3-1. [Kitchen appliances/equipment](#)
- 3-2. [Air conditioning appliances/equipment](#)
- 3-3. [Bathroom appliances/equipment](#)

- 3-4. [Desk appliances, cleaning appliances/equipment](#)

- 4-1. [For pre-processing only or as hardware for implementing other algorithms](#)

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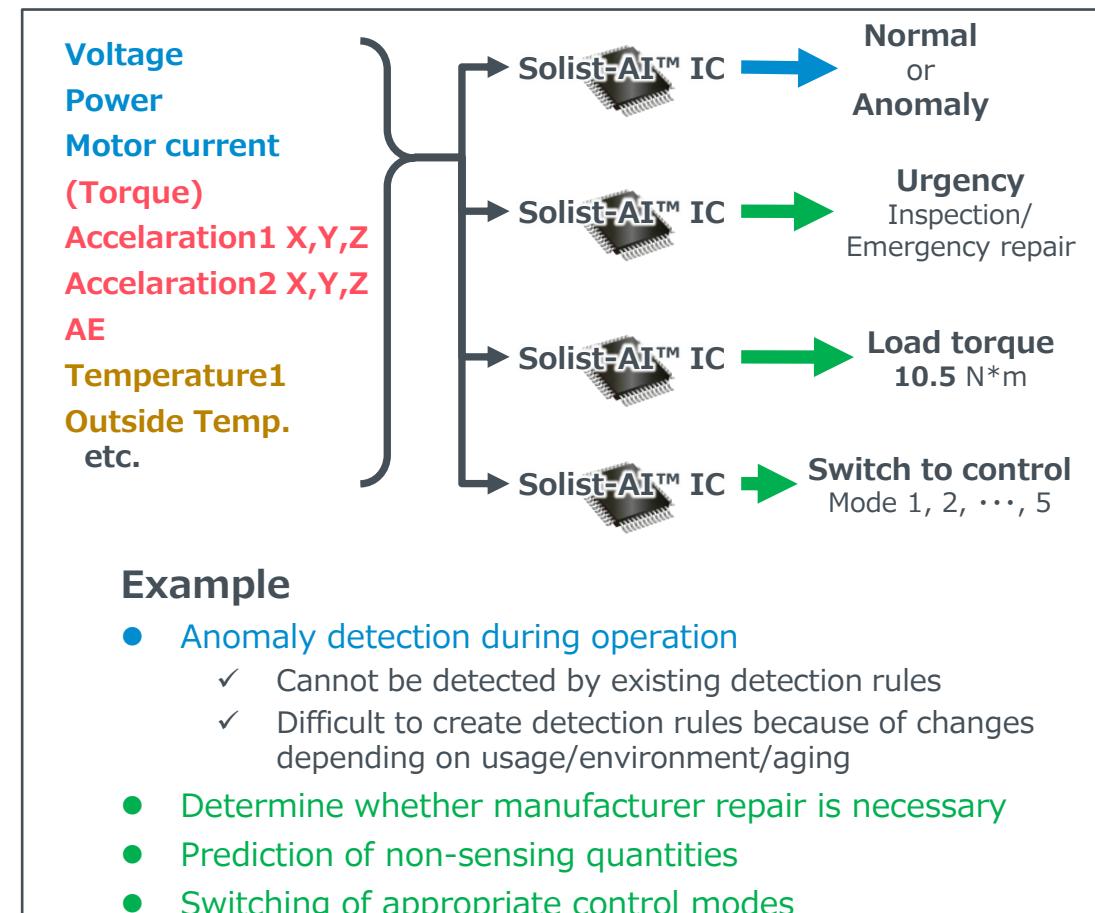
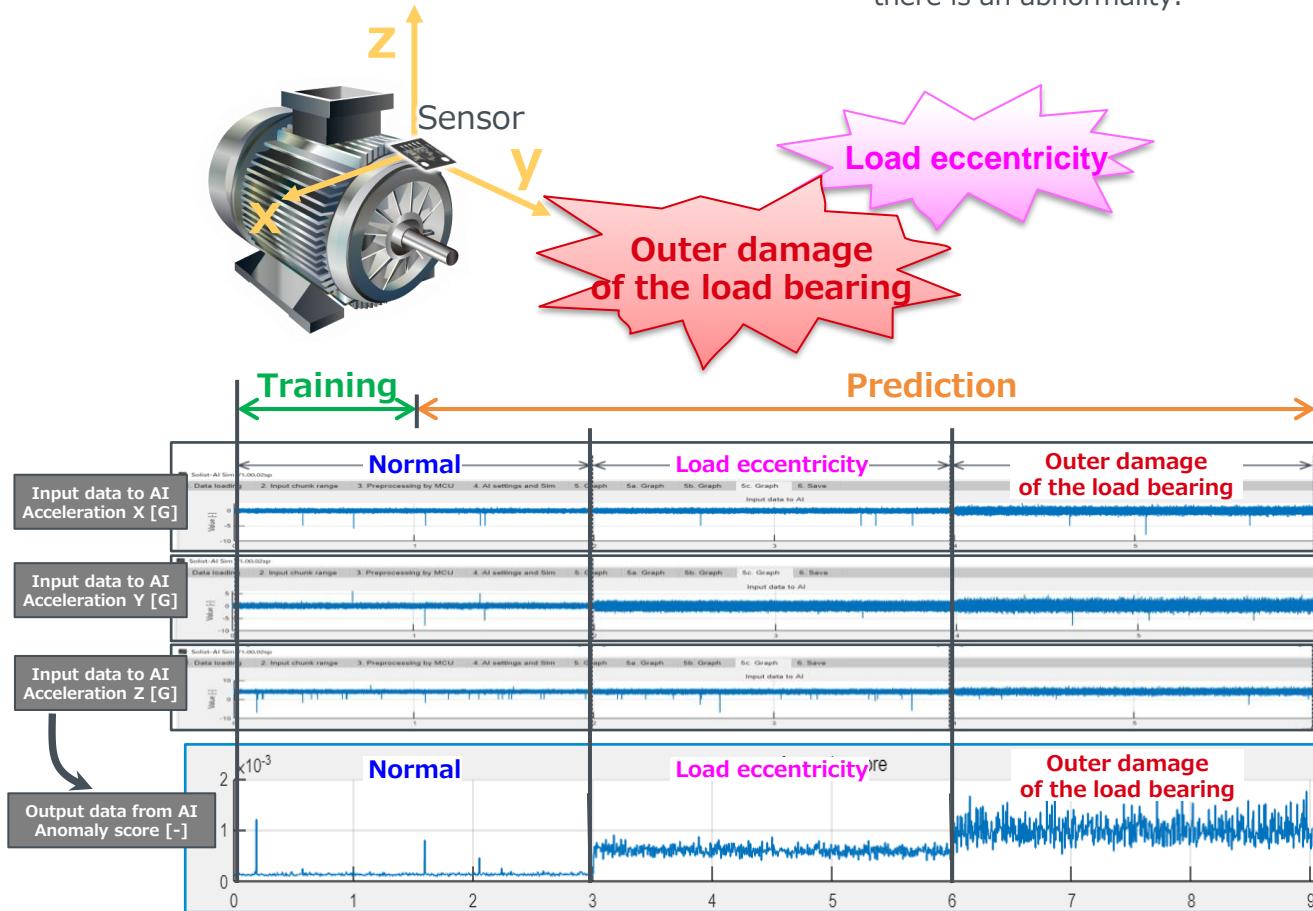
Use cases

1-1. Industrial “Infrastructure motor”

- To implement CBM* by monitoring the condition of machines/equipment and “maintaining them if an anomaly is detected.” --> Time-consuming to design detection that suits each machine
--> Solve the problem with Solist-AI™!

Infrastructure motor

* Traditionally, maintenance was often carried out after a breakdown occurred, or after a certain period of time had passed, using TBM(Time Based Maintenance). However, recently the trend has been for more efficient maintenance to be achieved using CBM(Condition Based Maintenance), which allows equipment to continue operating as is unless there is an abnormality.



Example

- Anomaly detection during operation
 - ✓ Cannot be detected by existing detection rules
 - ✓ Difficult to create detection rules because of changes depending on usage/environment/aging
- Determine whether manufacturer repair is necessary
- Prediction of non-sensing quantities
- Switching of appropriate control modes

1-2. Industrial "Infrastructure motor/Machine tool"

- Acceleration sensor/AE sensor + Solist-AI™ monitors machine vibrations.
Detects "anomaly" vibrations and prevents long/short stops!



Points

- In the case that on-site data is unique and no other competitors or companies that handle similar data
 - Little point in using big data from cloud. Just noise.
 - Solist-AI™ can learn from on-site data.
- In the case that there is no cloud environment on-site
 - Solist-AI™ can train without cloud

Solist-AI™ IC board + Acceleration sensor

【Created by "EcoSystem Partner : DATATECNO"】



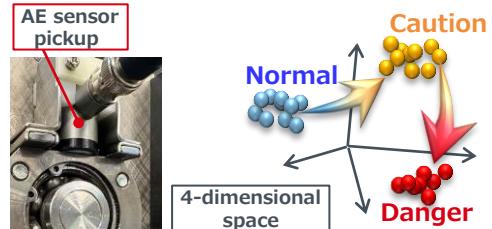
➢ Demonstration at the exhibition "EdgeTech+ 2024"

Board and module images: Provided by DATATECHNO

Solist-AI™ IC board + AE sensor

[Conventional AE sensor analysis]

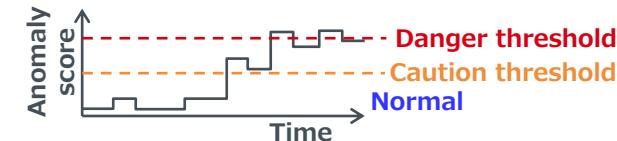
The indices output by the AE sensor (Maximum amplitude, Average, Energy, Count) are plotted in multi-dimensional space, and changes in the machine's condition can be read from their trends.



[New analysis using Solist-AI™]

AI input : 4 indices of AE sensor (Maximum amplitude, average, energy, count)
AI output : Anomaly score

- Summarized into one index, anomaly score.
- Easy to design the threshold and judge
- Possible to judge even if you do not understand the AE phenomenon.

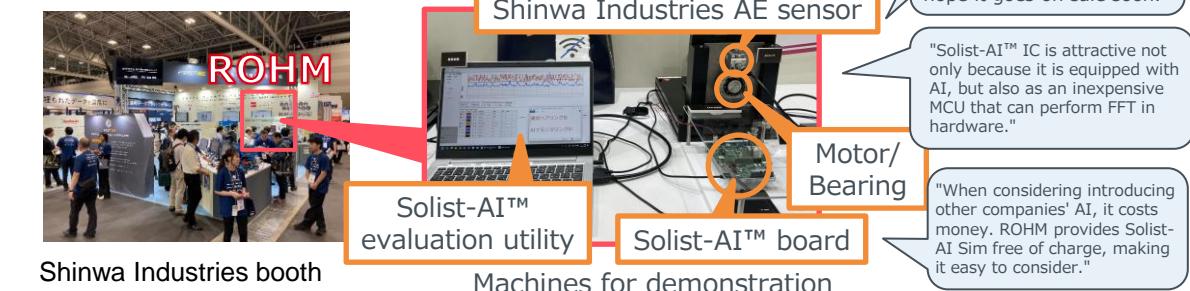


[AE sensor solution FIRST AE + Solist-AI™]

Exhibition "Factory Innovation Week Nagoya 2024, RoboDEX"

“Use AI to analyze and detect anomalies at early stage”

- Detecting bearing anomalies (rust, poor lubrication)



Visitors' comments

"AE sensor data is difficult to handle, but it's good that AI can handle that part. I hope it goes on sale soon."

"Solist-AI™ IC is attractive not only because it is equipped with AI, but also as an inexpensive MCU that can perform FFT in hardware."

"When considering introducing other companies' AI, it costs money. ROHM provides Solist-AI Sim free of charge, making it easy to consider."

1-3. Industrial “Infrastructure motor/Manufacturing Machinery/Robot”

- With Solist-AI™, you can detect anomalies in motor loads on manufacturing machines and robots, all at the edge!



Detecting motor load anomalies/adjustment timing

The motor itself does not break down very often

Many "adjustments" are made in response to changes in external load

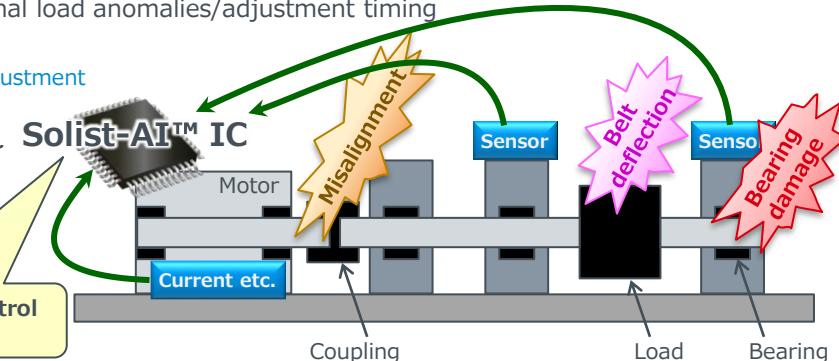
--> Beneficial to detect external load anomalies/adjustment timing

--> Achieving CBM!

(Respond when maintenance/adjustment is truly necessary.)

AI processing
--> Detection of anomalies/adjustment timing

Solist-AI™ IC can also control the drive of BLDC motors.



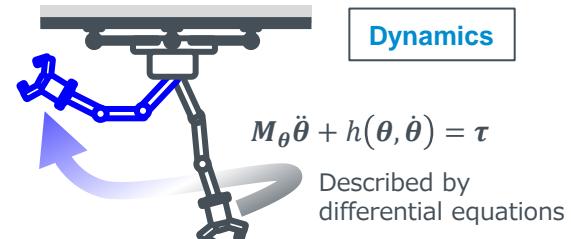
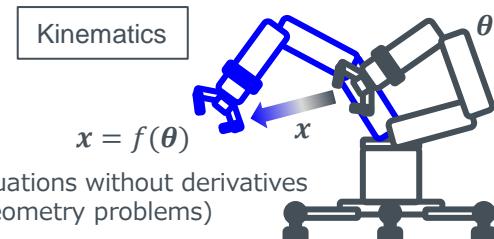
Robot anomaly detection/adjustment timing detection/trajectory control

Robot anomaly detection/control is a kinematics or **dynamics** problem.

--> Robot engineers' targets are **dynamic** anomaly detection, adjustment, and trajectory control

--> AI excels at anomaly detection and trajectory control using a large amount of input data.
Because Solist-AI™ is small-scale, it can process partial data from the robot.

--> For example, issues regarding the **end effector (the edge of the robot arm)**



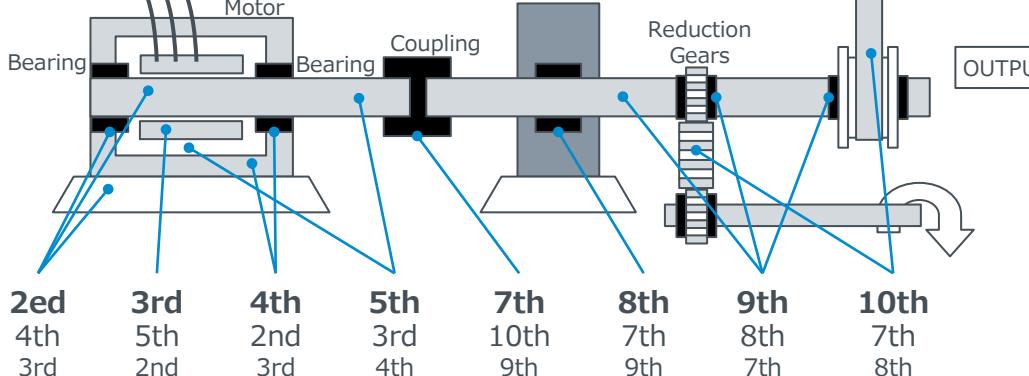
Equations without derivatives
(geometry problems)

Current Harmonics + Solist-AI™ --> Easy CBM!

[Current Harmonic Analysis]

INPUT

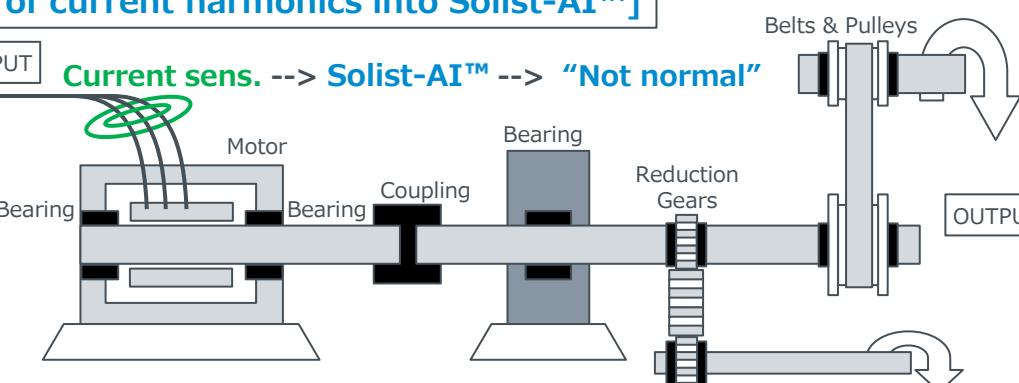
Current sens. --> FFT/analysis --> Anomaly mode identification



[Input of current harmonics into Solist-AI™]

INPUT

Current sens. --> Solist-AI™ --> "Not normal"



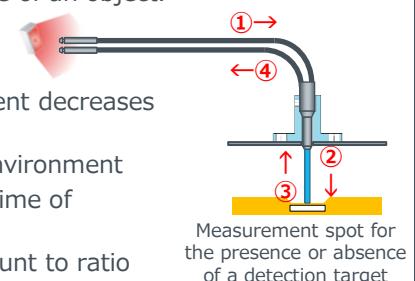
1-4. Industrial “FA Sensors, Product inspection”

- Previously, anomaly detection/condition identification required analysis by engineers. The collected data could not be fully utilized. --> Sensors + Solist-AI™ eliminates the analysis and resolves the issue by converting sensor data into usable "numerical values"!

Detecting deterioration of photoelectric sensors

Actual cases from the past:

- After being shipped, the amount of reflected light from photoelectric sensors gradually decreases over time, making it impossible to detect the presence or absence of an object.
- According to analysis of deteriorated products
 1. The LED light emission amount decreases
 2. The filter transmittance in front of the light receiving element decreases
 3. The degree of deterioration is strongly dependent on individual sensor differences/mounting variations/usage environment
 4. A large variation in the amount of received light from the time of manufacturing the set product with the sensor attached

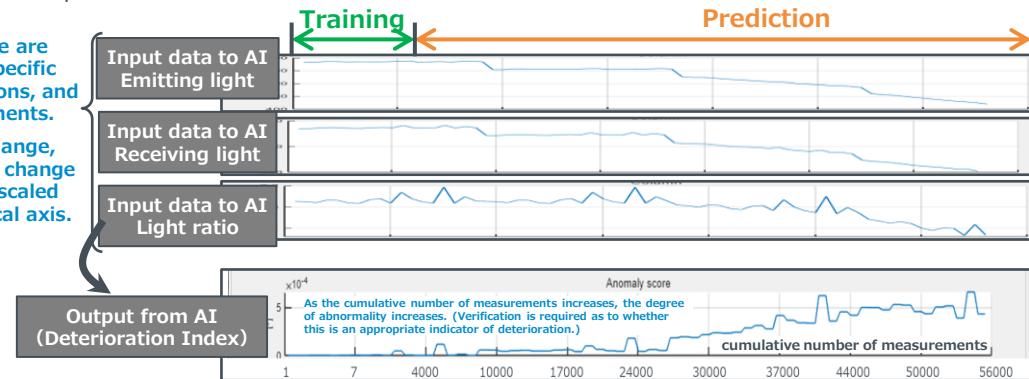


Past provisional solution: Changed threshold from absolute amount to ratio

Remaining Issues:

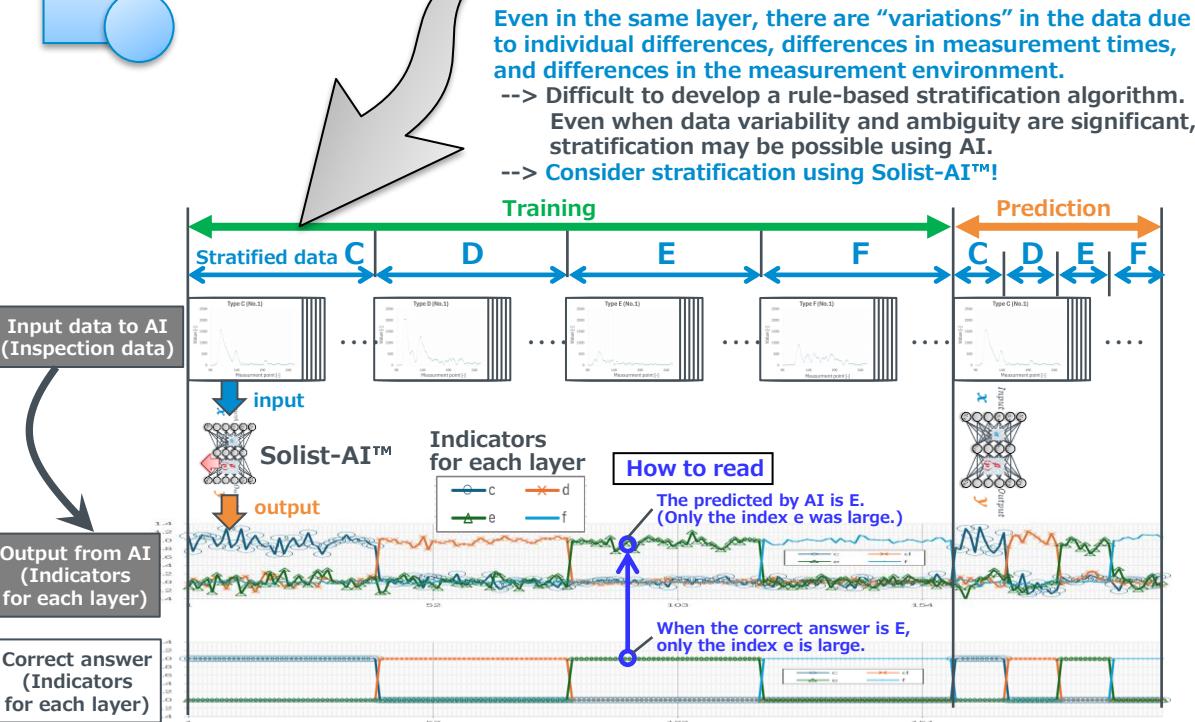
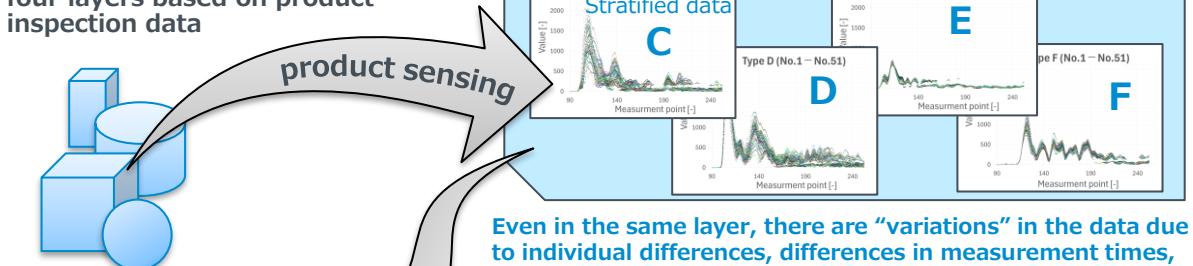
- The decrease in the amount of emitted light over time. --> **The data into Solist-AI™!**
- The amount of received light decreases over time. --> **The data into Solist-AI™!**
- Difficult to design a common threshold value --> **Solist-AI™ sets appropriate threshold values for each device!**
- A detection is required to check whether the function itself is normal. --> **Detect with Solist-AI™ !**

The graphs here are examples for specific units, installations, and usage environments. If conditions change, each graph will change as it is shifted/scaled along the vertical axis.



Stratification of product test data (Supervised)

The task of classifying products into four layers based on product inspection data



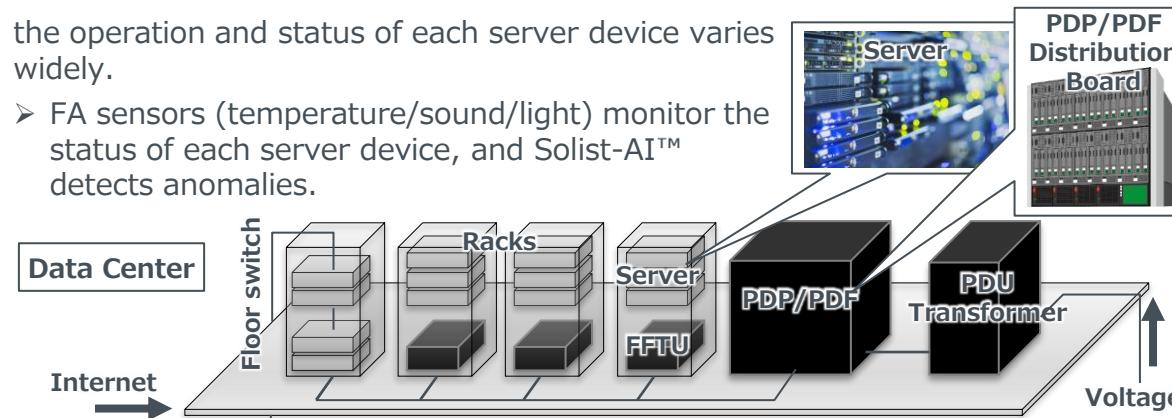
1-5. Industrial “Server equipment, Odor sensor, Printer”

- FA Sensors + Solist-AI™ --> Add new value to your sensors!
- Solist-AI™ can detect when the condition of the printer, the print quality, is anomaly.

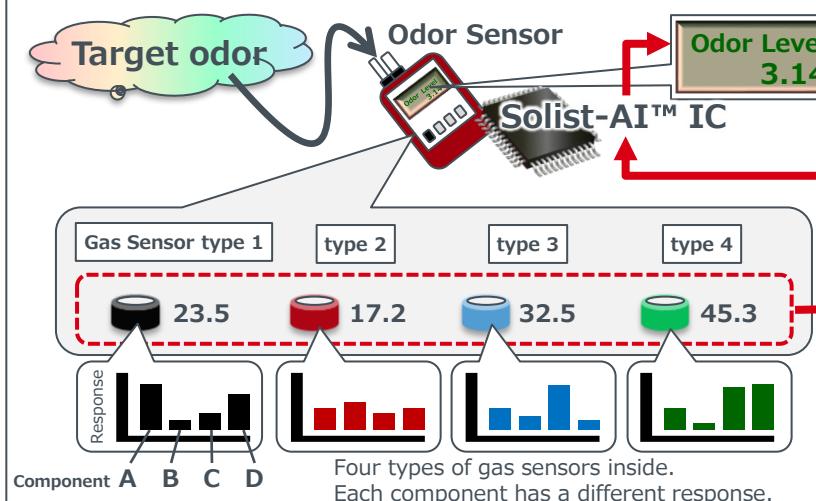
Server equipment anomaly detection (unsupervised), state identification (supervised)

the operation and status of each server device varies widely.

- FA sensors (temperature/sound/light) monitor the status of each server device, and Solist-AI™ detects anomalies.



Realization of “Portable Odor Sensor” (Supervised)



- Odors (bad breath, unpleasant odors, aromas) are composed of a balance of various gas components.

- An odor sensor is made up of multiple types of gas sensors.

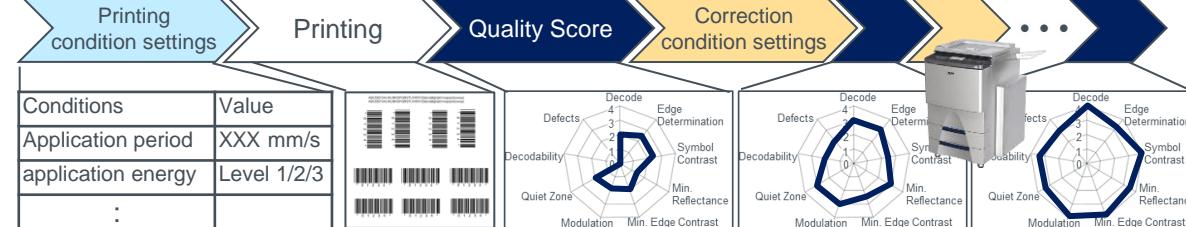
- Measuring "odor" requires analysis that takes into account the responses of multiple types of sensors, which is difficult with portable devices.

- Solist-AI™ can outputs odor levels based on multiple sensor responses!

Printer print quality adjustment (supervised), anomaly detection (unsupervised)

[Easily adjust]

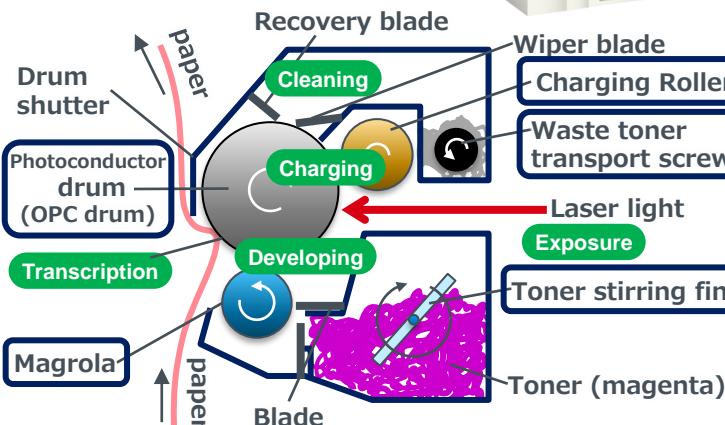
- Adjust quality indicators from printer model standards to individual printer standards!



- A series of **adjustments** --> **quality** indicators --> **adjustments** --> **quality** indicators --> ... are considered as inputs and outputs, and **trained by Solist-AI™**.

- Solist-AI™ automatically adjusts.

[Laser printer principles]



[Anomaly detection at the edge]

- The toner stirring fins and waste toner transport screw are driven by a stepping motor.

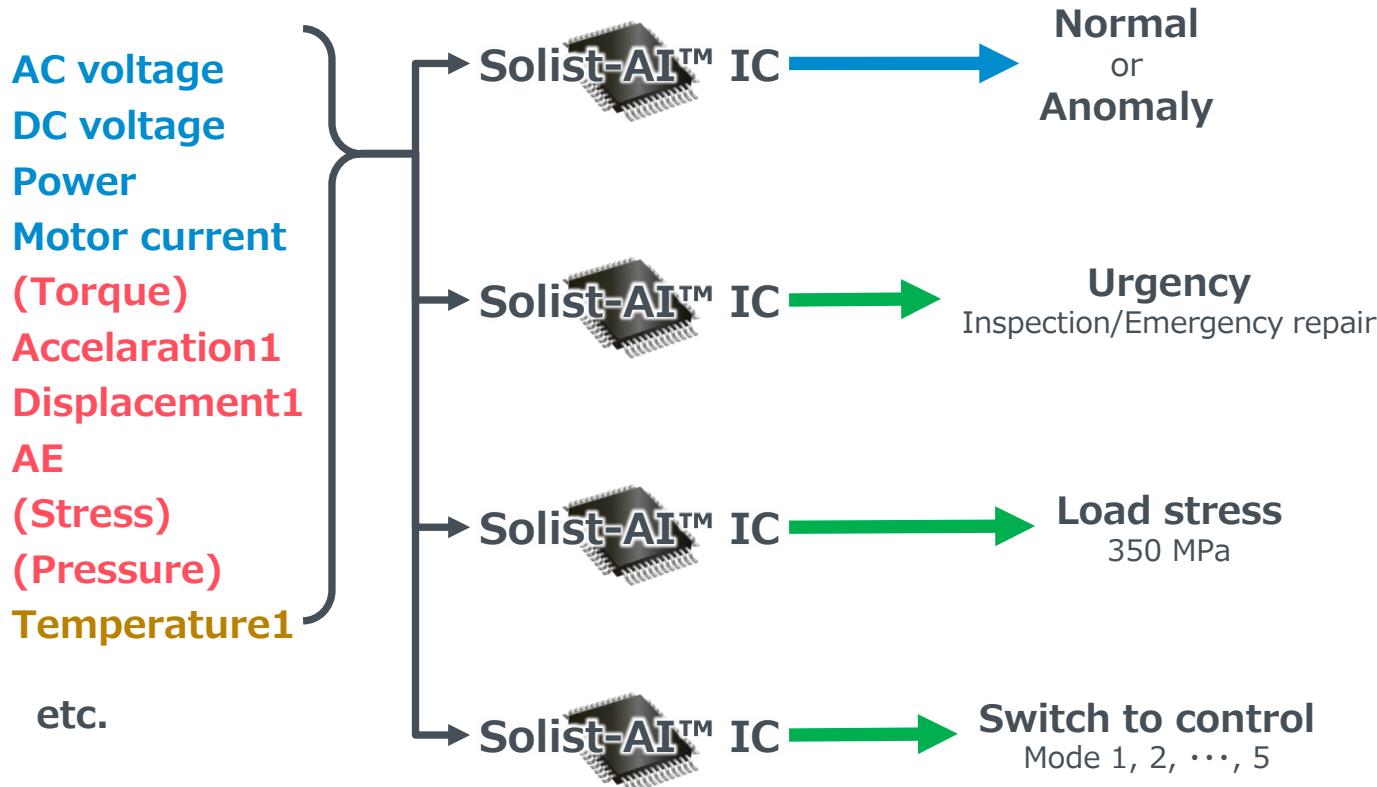
[The motor steps out due to an anomaly load]

- Gears jammed
- Paper dust adhesion to sliding parts
- external impact
- Waste toner jam
- Detect step-out with Solist-AI™

2-1. Tools/Construction machinery/Agricultural machinery

- A variety of businesses use agricultural and construction machinery. There are various types of cloud environments and on-site environments/usage methods..
--> Cloudless is essential for anomaly detection. On-site learning is appropriate. --> Let's start Solist-AI™!

Tools/Construction/Agricultural



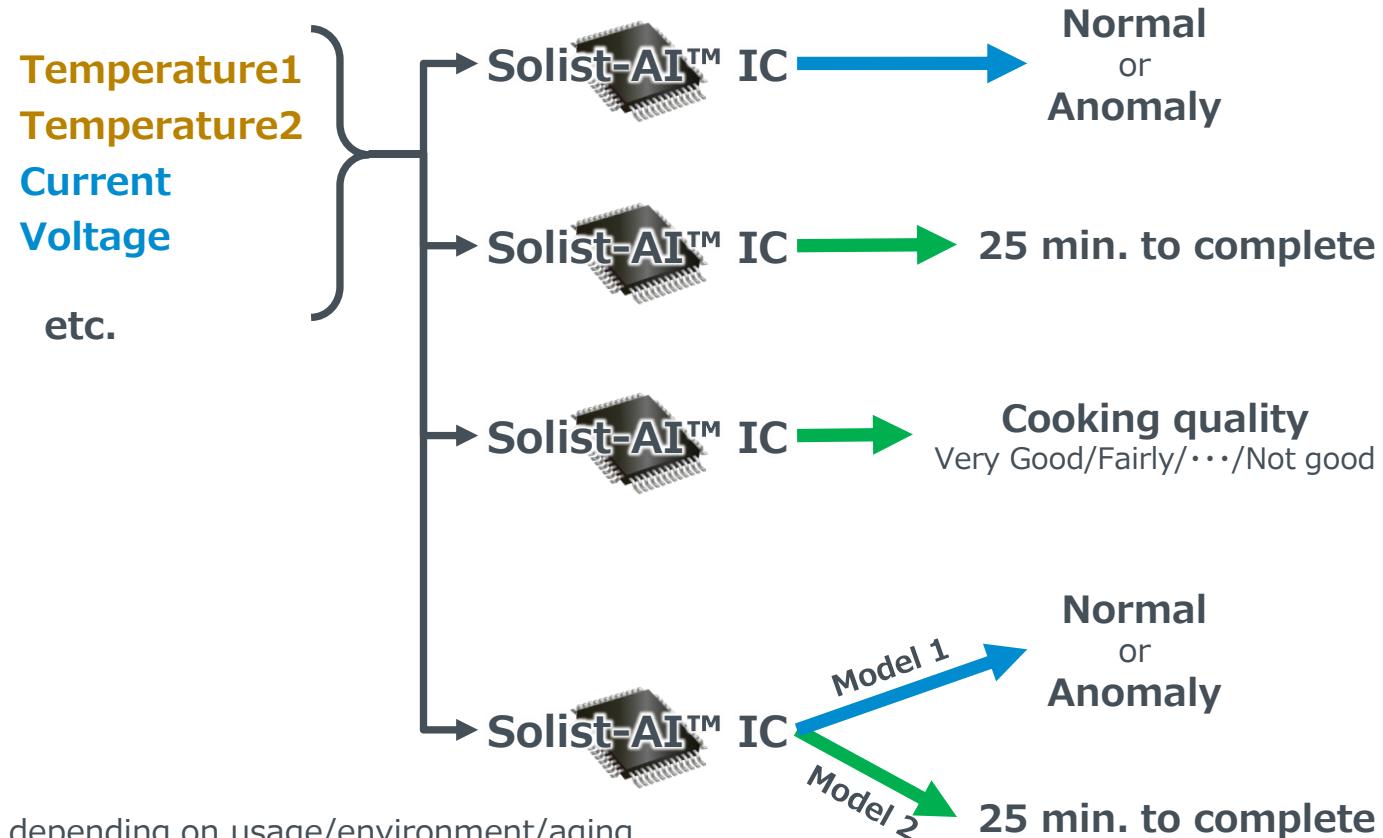
Example

- Anomaly detection during operation
 - ✓ Cannot be detected by existing detection rules
 - ✓ Difficult to create detection rules because of changes depending on usage/environment/aging
- Determine whether manufacturer repair is necessary, prediction of non-sensing quantities and Switching of appropriate control modes

3-1. Kitchen appliances/equipment

- Anomalies that could not be detected by rule-based methods during the operation of home appliances, and processing time predictions that tended to have large errors under certain conditions.
--> By effectively utilizing the nonlinearity of AI models, Solist-AI™ can detect and predict!

Kitchen



Example

- Anomaly detection during operation
 - ✓ Cannot be detected by existing detection rules
 - ✓ Difficult to create detection rules because of changes depending on usage/environment/aging
- Prediction of processing time for "cooking", "ventilation", etc.
 - ✓ Improve prediction accuracy for conditions where the accuracy of existing prediction rules is poor.
(effects of specific usage conditions/environment/aging)

3-2. Air conditioning appliances/equipment

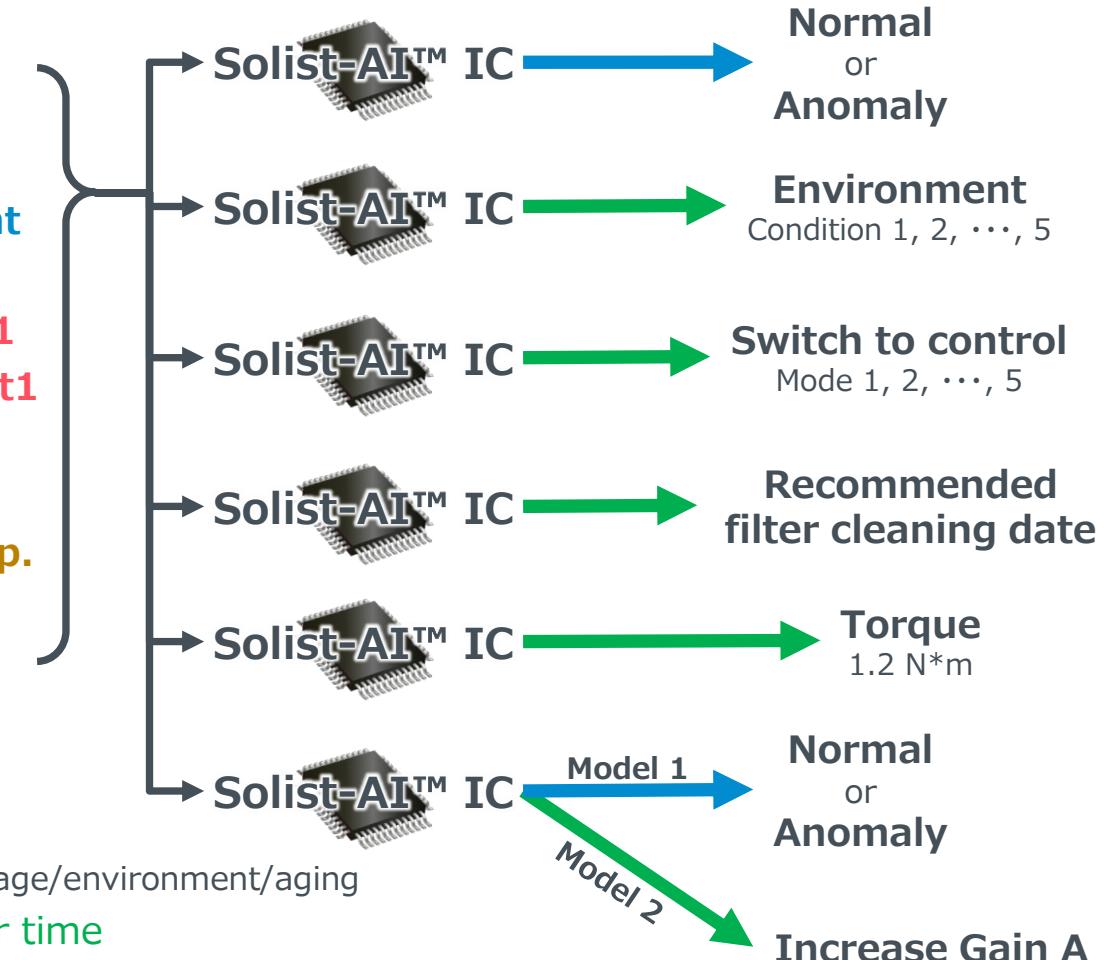
- Anomalies that could not be detected by rule-based methods during the operation of home appliances, and processing time predictions that tended to have large errors under certain conditions.
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Air conditioning



AC voltage
DC voltage
Motor current
(Torque)
Acceleration1
Displacement1
AE
Room Temp.
Outside Temp.
Humidity
etc.



Example

- Anomaly detection during operation
 - ✓ Cannot be detected by existing detection rules
 - ✓ Difficult to create detection rules because of changes depending on usage/environment/aging
- Identifying the surrounding environment/usage/deterioration over time
- Switching of appropriate control modes, Predicting suitable parameter changes and Prediction of non-sensing quantities

3-3. Bathroom appliances/equipment

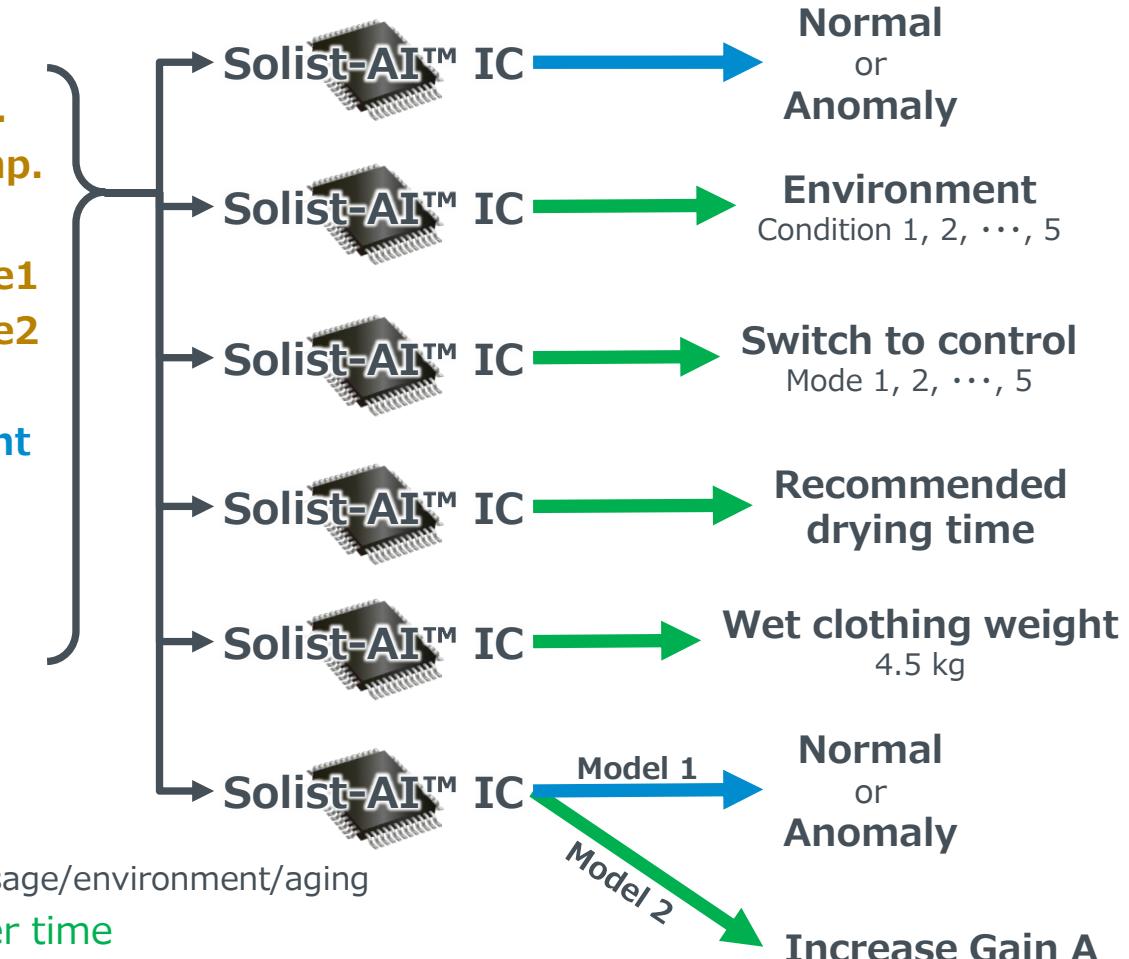
- Anomalies that could not be detected by rule-based methods during the operation of home appliances, and processing time predictions that tended to have large errors under certain conditions.
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Bathroom



Room Temp.
Outside Temp.
Humidity
Temperature1
Temperature2
Voltage
Motor current
(Torque)
(Weight)
Illuminance
etc.



Example

- Anomaly detection during operation
 - ✓ Cannot be detected by existing detection rules
 - ✓ Difficult to create detection rules because of changes depending on usage/environment/aging
- Identifying the surrounding environment/usage/deterioration over time
- Switching of appropriate control modes, Predicting suitable parameter changes and Prediction of non-sensing quantities

3-4. Desk appliances, cleaning appliances/equipment

- Anomalies that could not be detected by rule-based methods during the operation of home appliances, and processing time predictions that tended to have large errors under certain conditions.
--> By effectively utilizing the nonlinearity of AI models, Solist-AI™ can detect and predict!



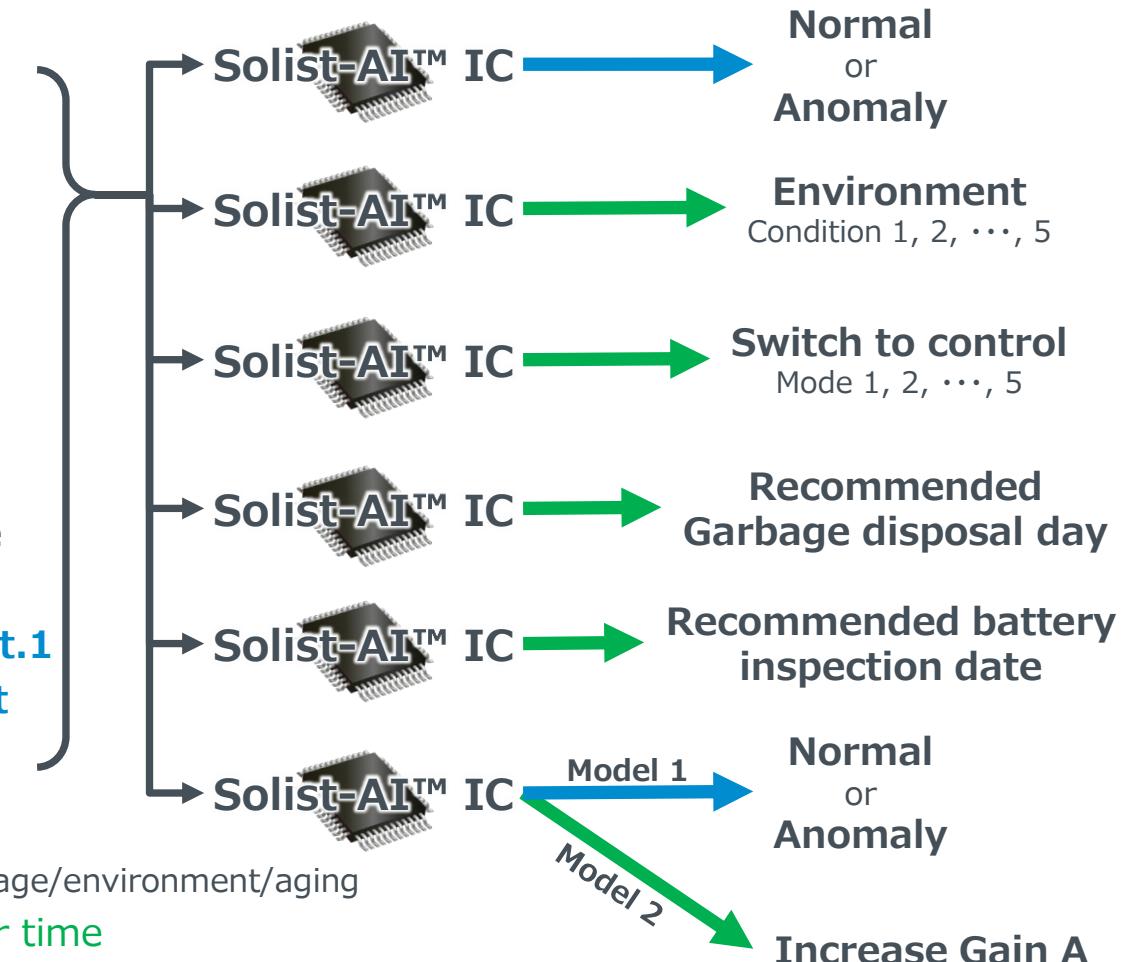
Desk and Cleaning



Example

- Anomaly detection during operation
 - Cannot be detected by existing detection rules
 - Difficult to create detection rules because of changes depending on usage/environment/aging
- Identifying the surrounding environment/usage/deterioration over time
- Switching of appropriate control modes, Predicting suitable parameter changes and Prediction of non-sensing quantities

Voltage
Motor current
(Torque)
Room Temp.
Temperature1
Temperature2
Photoelectric
Sensor1
Operating time
VOCs
Battery cell volt.1
Battery current
etc.



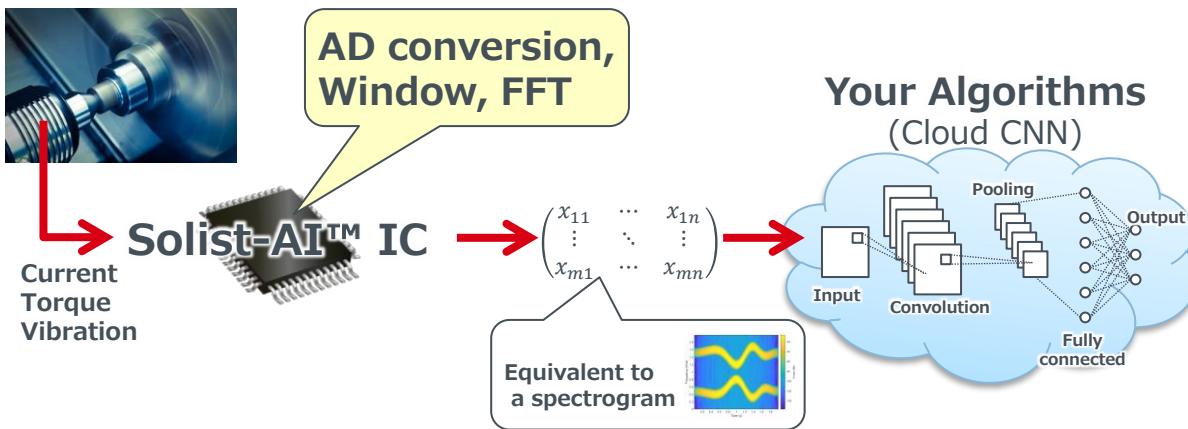
4-1. For pre-processing only or as hardware for implementing other algorithms

- The window and FFT of the Solist-AI™ IC are calculated at high-speed using HW circuits. Real-time pre-processing!
- Small algorithms based on neural networks or linear matrix operations may be implemented on Solist-AI™ IC.



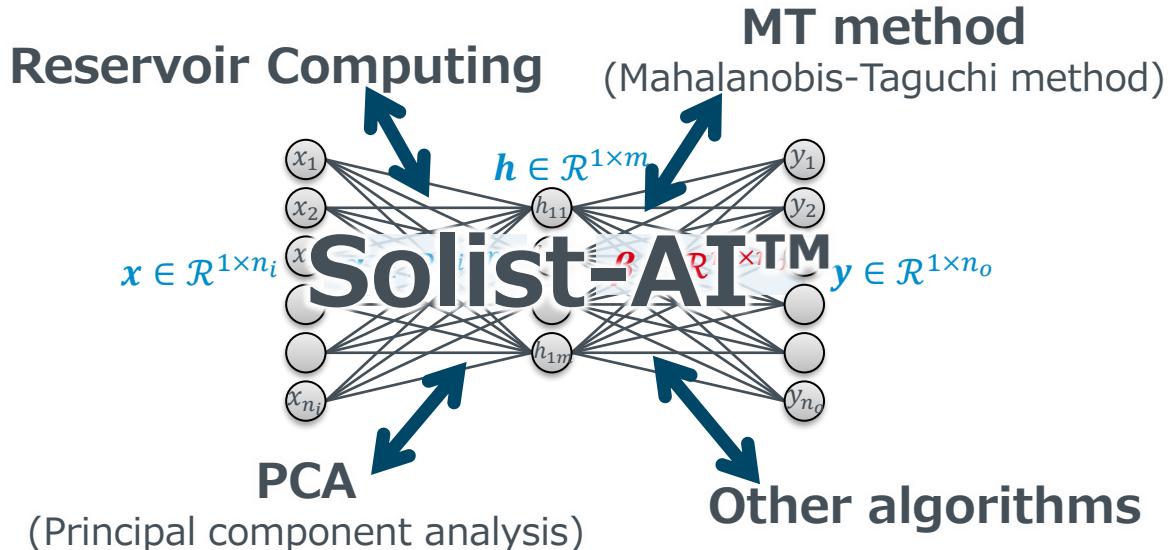
Real-time pre-processing with FFT on Solist-AI™ IC

- In the Solist-AI™ IC, not only AI processing is performed, but also window functions and FFT are calculated at high-speed using hardware circuits.
- You can also use the Solist-AI™ IC's window function and FFT to pre-process data in real time and pass it to your AI algorithm.
 - However, at present there are no plans to develop an IC that only performs pre-processing and does not include the AI function.



Use Solist-AI™ as HW for implementing other algorithms

- Solist-AI™ is a three-layer FFNN (Feedforward Neural Network).
- Other algorithms may also be able to perform high-speed calculations using AxICORE-ODL in the Solist-AI™ IC if they are based on networks similar to FFNN or linear matrix operations.
 - However, due to various constraints, we cannot guarantee that your algorithm/network will be implemented in its original form.



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