UDMTEK OPTRA platform for Enhancing

Quality, Productivity, and Equipment Efficiency

UDMTEK has developed MLP (machine language processing) technology for the first time by interpreting static control language when the control program is present and understanding the dynamic data flow when the control programs is executing.

1. Company Introduction

Company Introduction

Leading Innovator in AI-Driven Smart Manufacturing

Unified Digital Manufacturing Technology

UDMTEK

KOSDAQ
코스닥상장법인

Establishment	May 28, 2007
Employee	52
Business	Industrial AI , Edge analytics, and Digital twin
Office	Ace Gwanggyo Tower 2, #1401 Changryong-daero 256th gil, Suwon-si, ROK
Homepage	www.udmtek.com
Telephone	82-1661-1888

2019

- Raised KRW 4 billion in funding from KB and DAOL

2020

- Expanded of UDMTEK Black-box™ & UXIM Analyzer (MOBIS, LGES)

2021

- Registered as one of APAC CIO Outlook Manufacturing Top10
- Raised KRW 3 billion through DS Asset investment

2022

- Supplied UDMTEK Black-Box™ to Hyundai-Kia Motors
- Growing industry presence,
  Electronics / PCB: SEMC, SIFLEX, DAEDUCK
  Batteries: Innometry, LG Energy Solution, SK On
  Others: LS Electronics, Hyundai MOBIS, Jinsun TEC, SK Gas

2023

- Selected as TOP 10 Most Influential Companies on the year 2023
- Raised KRW 10 billion from Eugene Investment & Securities

2024

- **Listed on the Korean IPO market (Nov. 20th)**

2025

- Growing partnerships with major industry leaders such as SK Group, LG U+, POSCO, and KOEN

Clients & Reward

Successive AI Projects for Various Industries

Battery

LG에너지솔루션
HYUNDAI MOBIS
JASTECH (주)제이스텍
innometry
DAEJOO

Automotive

HYUNDAI
GM
KIA
PHC Valeo
PHC PHA
SL
서연이화
KORENS 주식회사 코렌스
東洋피스톤株式會社

Electrical & Electronics

LG전자
ATEC 에이텍
SIFLEX
LG디스플레이
LG이노텍
LS ELECTRIC

2017
Building a Smart Factory Ministerial commendation

2018
National R&D Outstanding Performance

2024
2023
2022
2021
4IR AWARDS AI 부문

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UDM Platform Overview

All-in-One Platform for Machine, Production, and Quality

Equipment

Description

- Real-time monitoring and root cause tracing through abnormal operation replay
- AI-driven anomaly detection and predictive maintenance to reduce unplanned downtime

Features

Category	Description
Monitoring	Real-time production monitoring
Alarm	Root cause Identification of alarms: distinguishing false alarms
Lifecycle	Show component usage status and remaining lifespan
Pattern	Pattern for detecting irregularities in process cycles automatically
Trend	Predictive alerts based on control operation time trends
Signal	Root cause identification of anomalies via Gantt and ladder logic chart analysis

Production

Description

- Real-time monitoring of production status, process tracking, and detailed OEE reporting to boost productivity

Features

Category	Description
Monitoring	Real-time production monitoring
Alarm	Root cause Identification of alarms: distinguishing false alarms
Production	Real-time display of production plan vs. actual, uptime, and OEE
Cycle	Display KPI per cycle time
Pattern	Pattern for detecting irregularities in process cycles automatically

Quality

Description

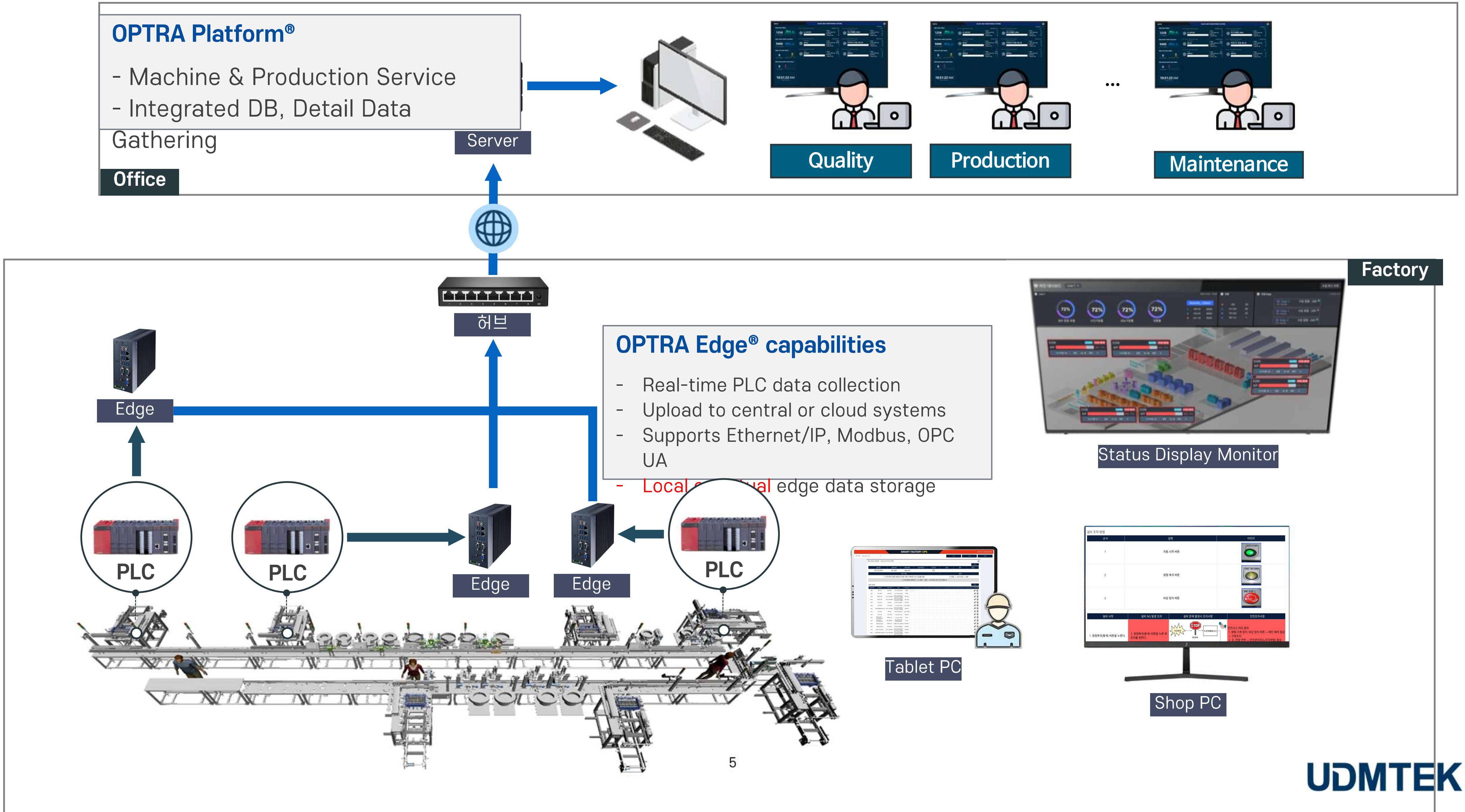
- Detect abnormalities to identify defects, predict quality with AI, and reduce defects through proactive analysis

Features

Category	Description
Monitoring	Real-time production monitoring
Alarm	Root cause Identification of alarms: distinguishing false alarms
Prediction	Defect prediction, root cause analysis, anomaly detection, and condition optimization

System Configuration

Integrated Platform and Edge Computing Structure



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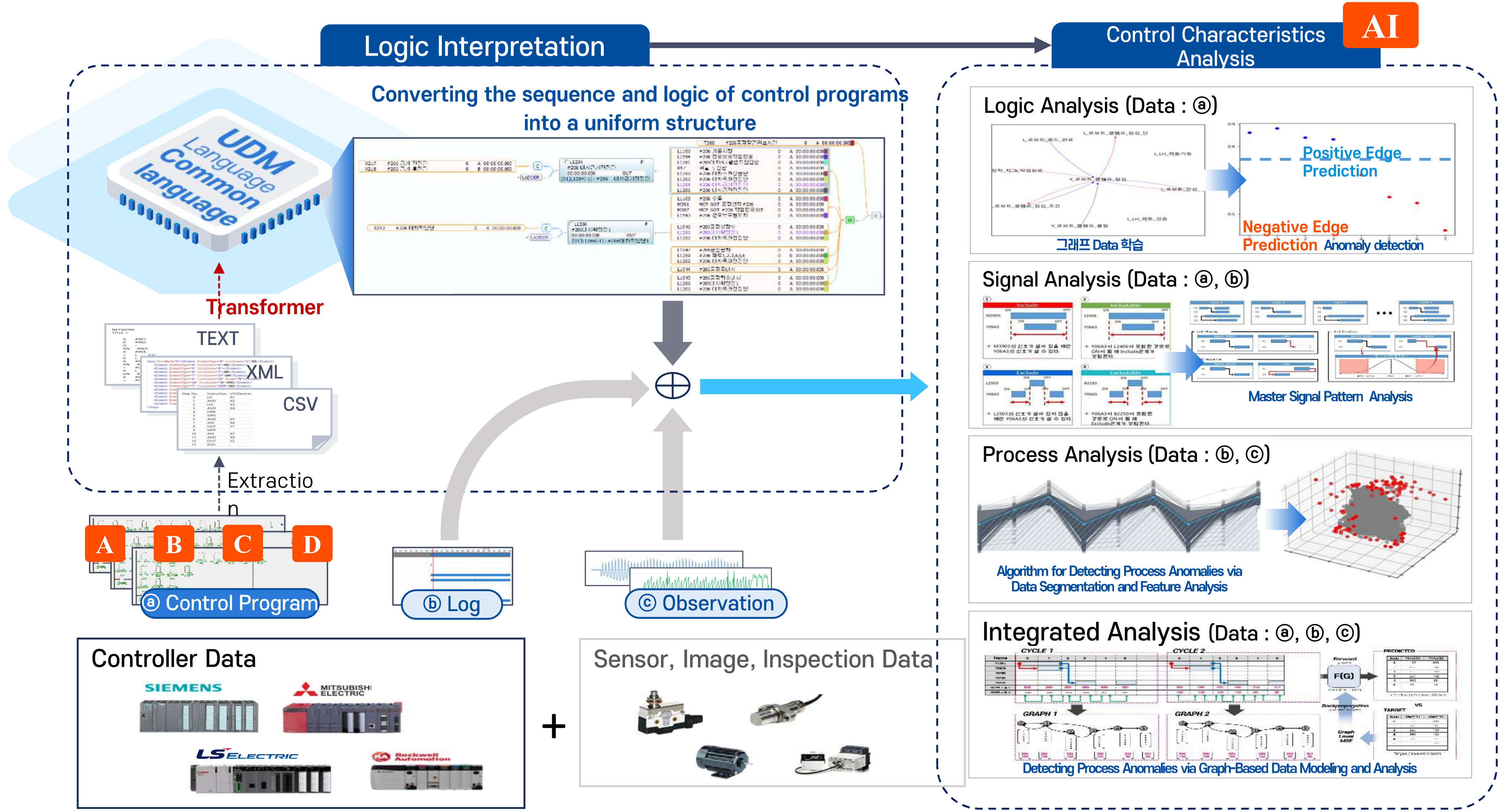
Key Technology

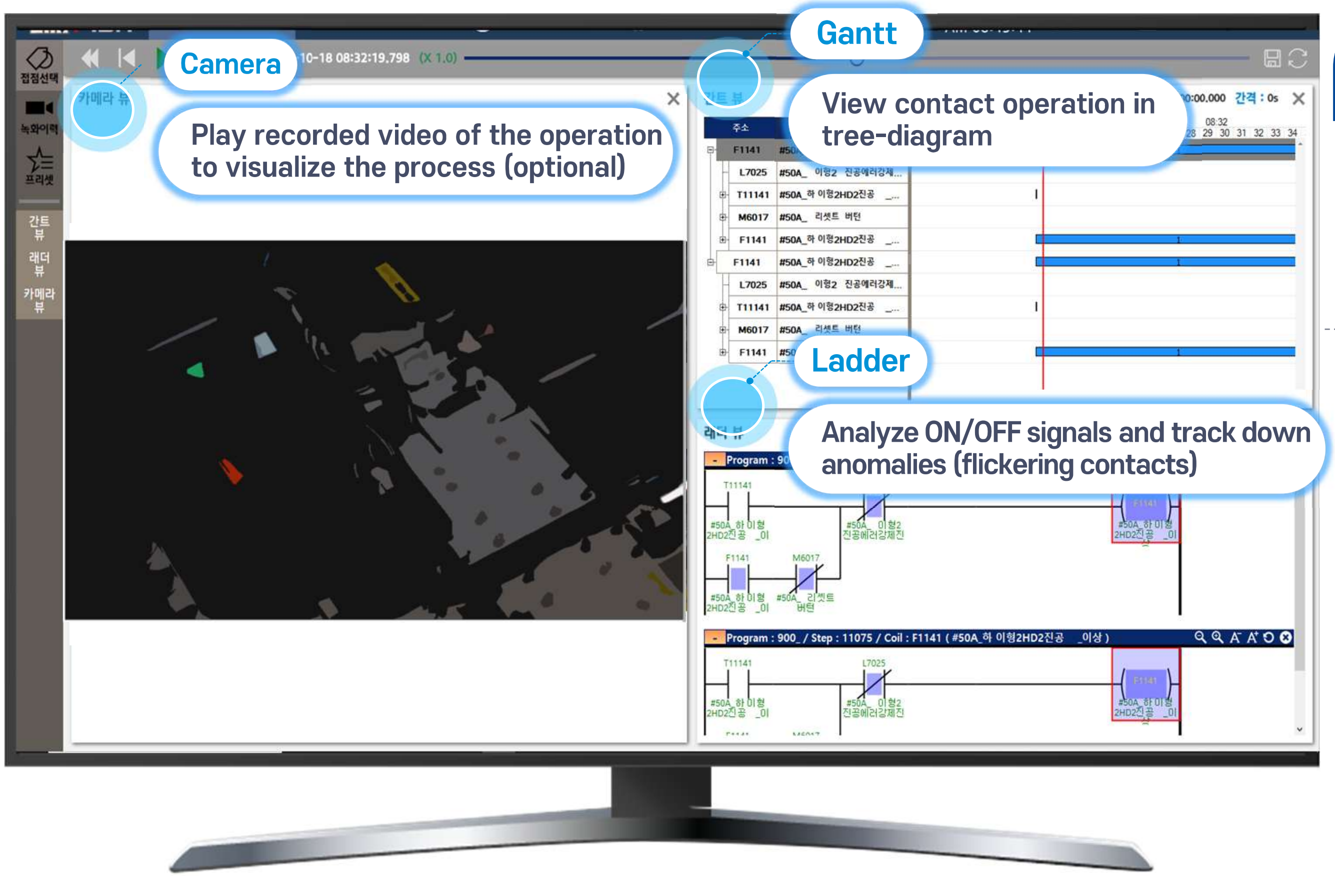
Exclusive Global Technology for Control Logics Interpretation



2. Key Functions

Function: Signal Analysis

Replay of Process Operations at the Time of Past Alarms and Anomalies



Operation Replay

- List operation history
- Three modes to view (Gantt, Ladder, Camera)
- Playback options available

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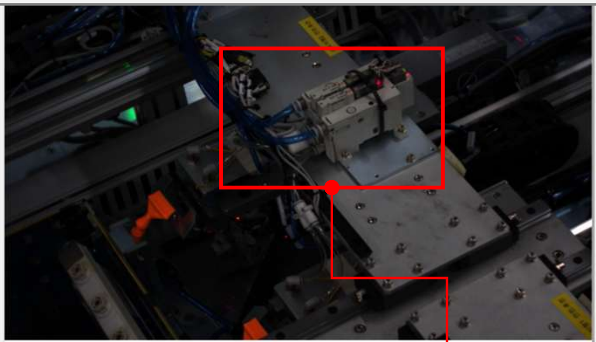
Function: Signal Analysis

Replay of Process Operations at the Time of Past Alarms and Anomalies

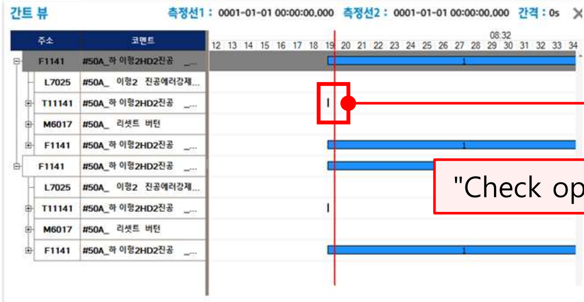
▶ Image replay aligned with ladder logic execution for visual inspection of control signal behavior

Control Logic & Machine Synchronization
Live Logic View + Image-Based Process Visualization



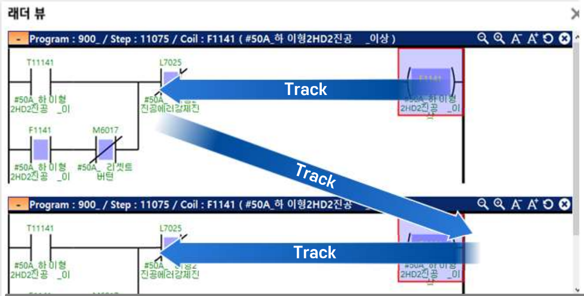
Track equipment position during specific control process events

▶ Track and analyze ladder logic execution over time using a Gantt chart view



"Check operation errors of specific contact points"

▶ Ladder View for Time-Specific Logic Inspection and PLC Operation Review via Ladder Visualization



Analyze past signal paths to determine failure causes and highlight the end control contact in the logic flow.

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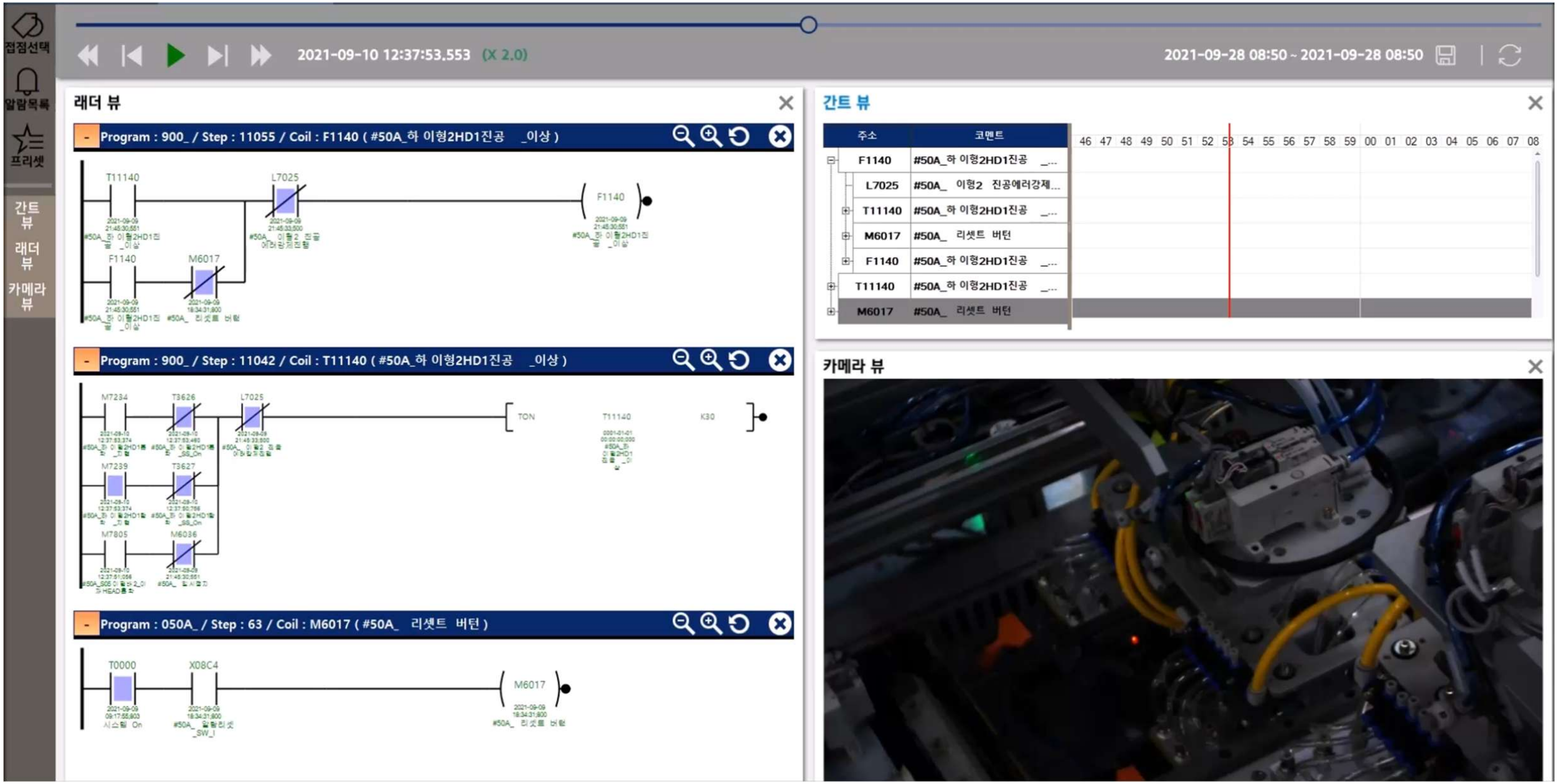
Function: Signal Analysis (Demo)

Replay of Process Operations at the Time of Past Alarms and Anomalies



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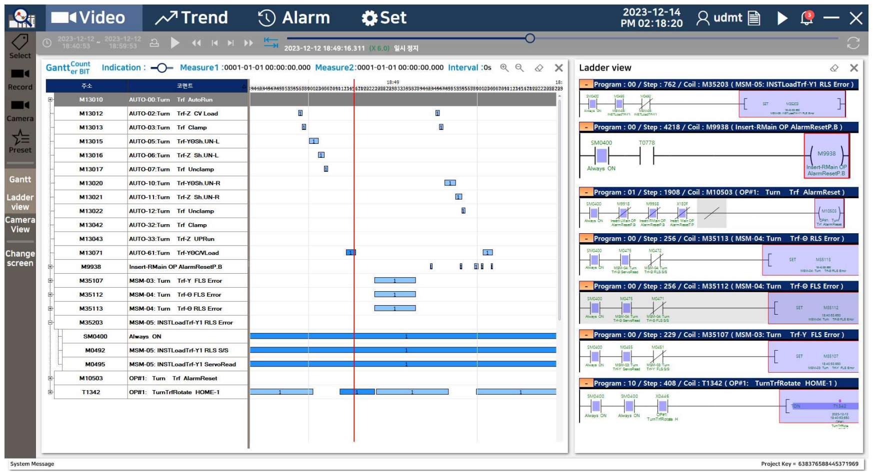
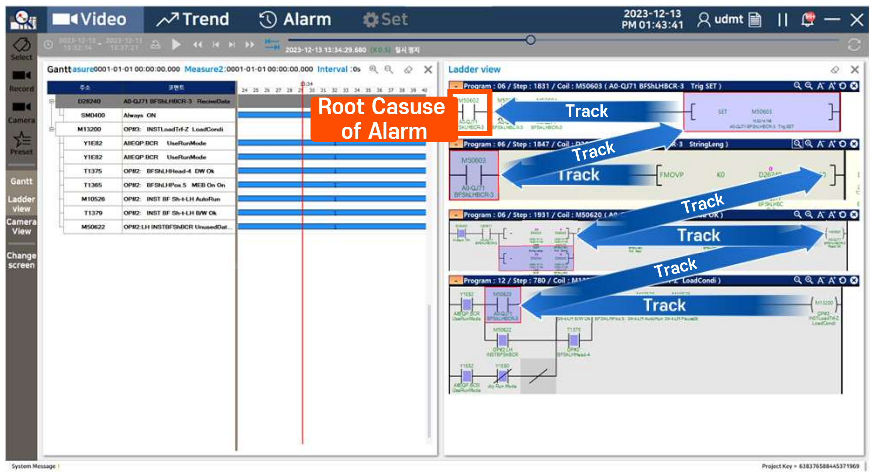
Reference: Signal Analysis

LG Energy Solution – Poland Plant

Replay of Process Operations– PLC Gantt/Ladder View Tracking





Content	Gantt chart and ladder view analysis
Problem	Silent stoppages in the TURN TRANSFER loader
Occurrence Times	6 times per Day
Rott Cause	Silent stoppage caused by sensor failure, triggered by voltage drop
Resolution	**Preventing malfunction by adjusting sensor relay wiring**

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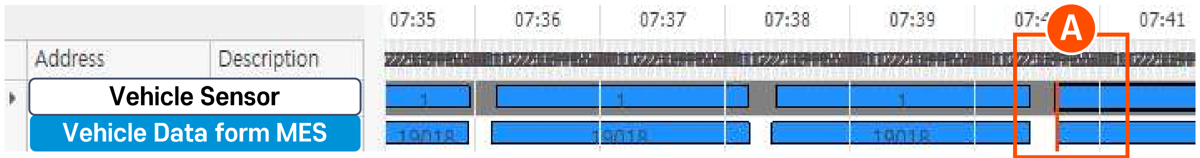
Reference: Signal Analysis

Gantt View

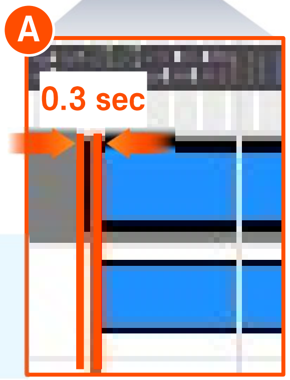


Problem

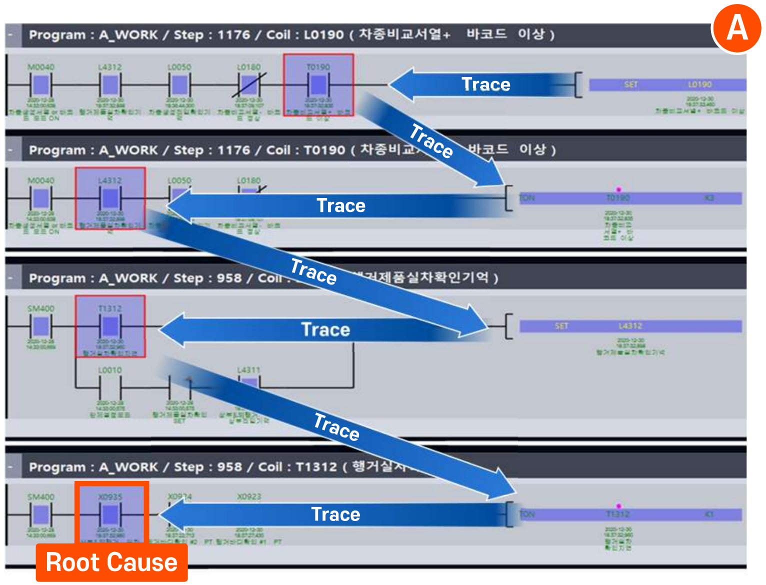
- Sensor activates before vehicle model data is processed, complicating root cause analysis.

Result

- Sensor activated 0.3 seconds before vehicle data; resolved by adjusting PLC logic.

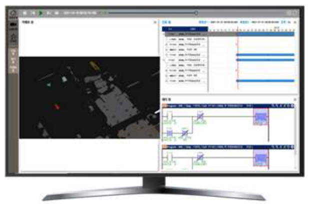


Ladder View (tracking)



Classification	H Company
Problem	Vehicle data input error
Frequency	3 per day
Solution	Changing PLC (controller logic)
Cost Reduction	**Saving yearly cost of $20 million for breakdown**

Remark



Unable to detect the root cause of anomaly before UDMTEK Solution

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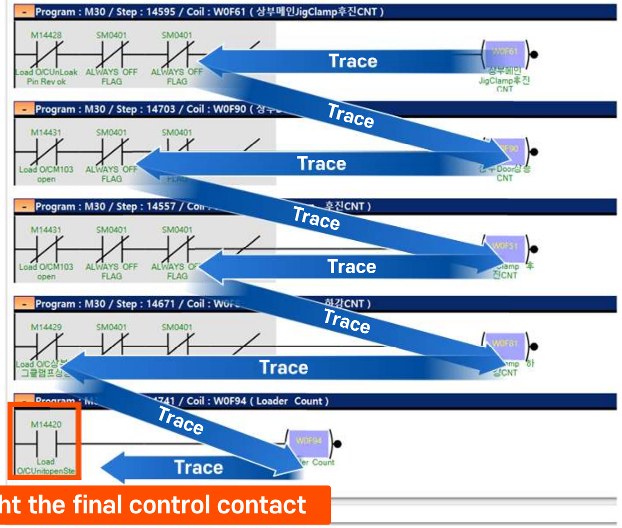
Reference: Signal Analysis

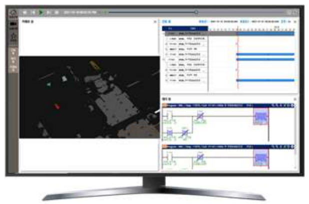
False alarm – Trace the logic paths to identify false alarm causes and highlight the final control contact in the sequence.

Operation Replay - tracking the logic paths



Classification	H Company
Problem	False Alarm
Frequency	3 per day
Solution	Changing LAN card
Cost Reduction	Saving yearly cost of **$5 million** for breakdown

Remark



Unable to detect the root cause of anomaly
before UDMTEK Solution

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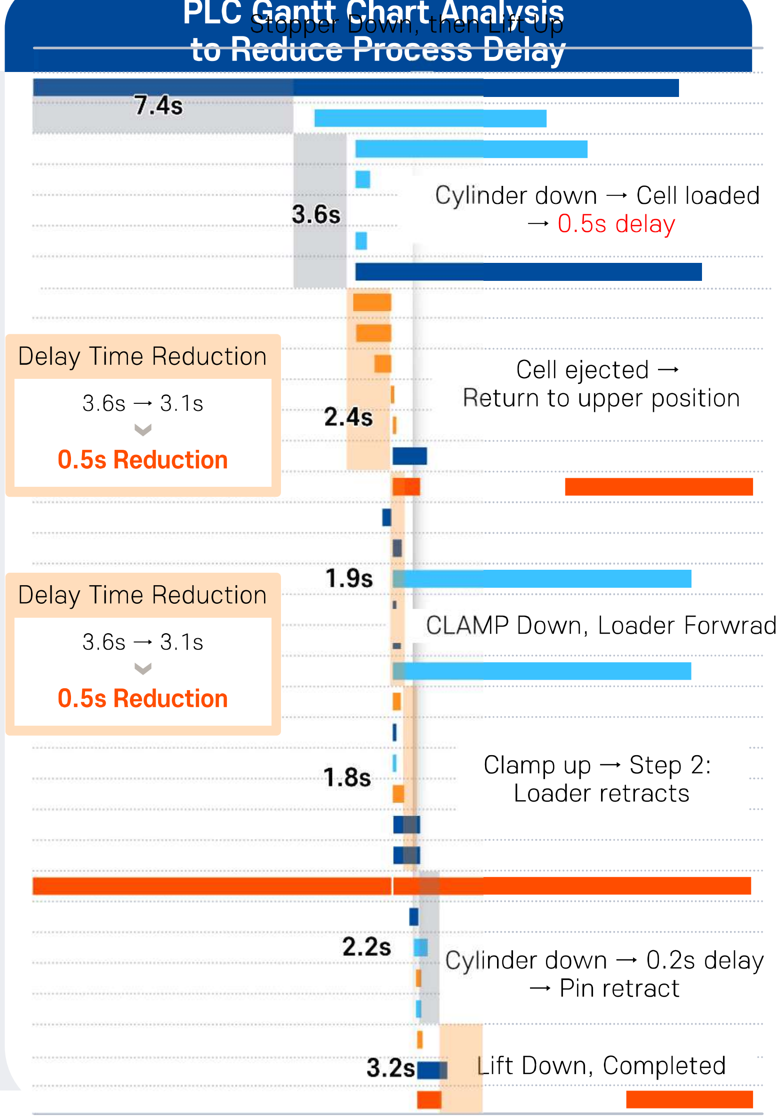
Reference: Signal Analysis

LG Display (Display Area)

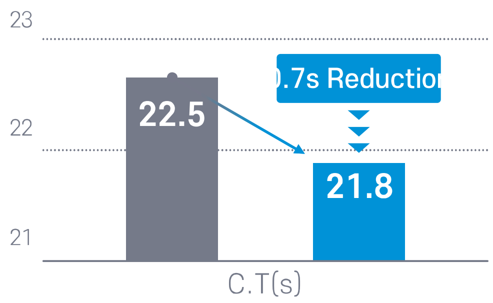
PLC Gantt Chart Analysis to Reduce Process Delay



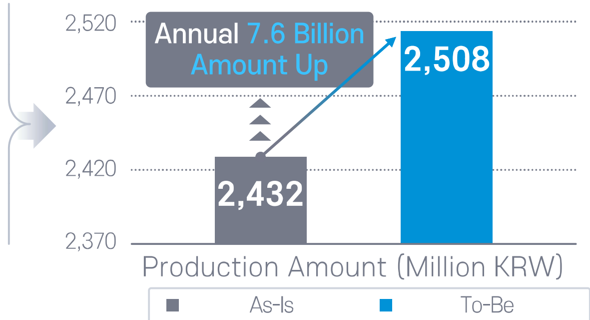
Cost-Benefit Analysis of Line 2 Design Implementation at Company L (Per Line Basis)

Classification		Operation Time(h)	C.T(s)	UPH (Hourly throughput)	Production Capa. (EA)	Production Cost(KRW	Production Amount (KRW)
Line 1	2019 Result(s)	3,766	22.5	160	602,560	38,000	22,897,280,000
Line 2	AS-IS	4000(Target)	22.5	160	640,560		24,320,000,000
	To-Be	4000(Target)	21.8	165	660,560		25,080,000,000
Benefit							760,000,000

Cycle Time Due to Process Optimization



Production Gains by Improvements



Full-line improvements boost equipment utilization and maximize production output.

	1 Year	2 Year	3 Year	5 Year	10 Year
Applied lines	10	15	20	25	50
Benefit (Billion)	76	114	152	190	380

※ Annual production gain projected by applying improvements to 5 lines

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Reference: Signal Analysis

GM Automotive Plant in Korea

1) Problem Occurrence

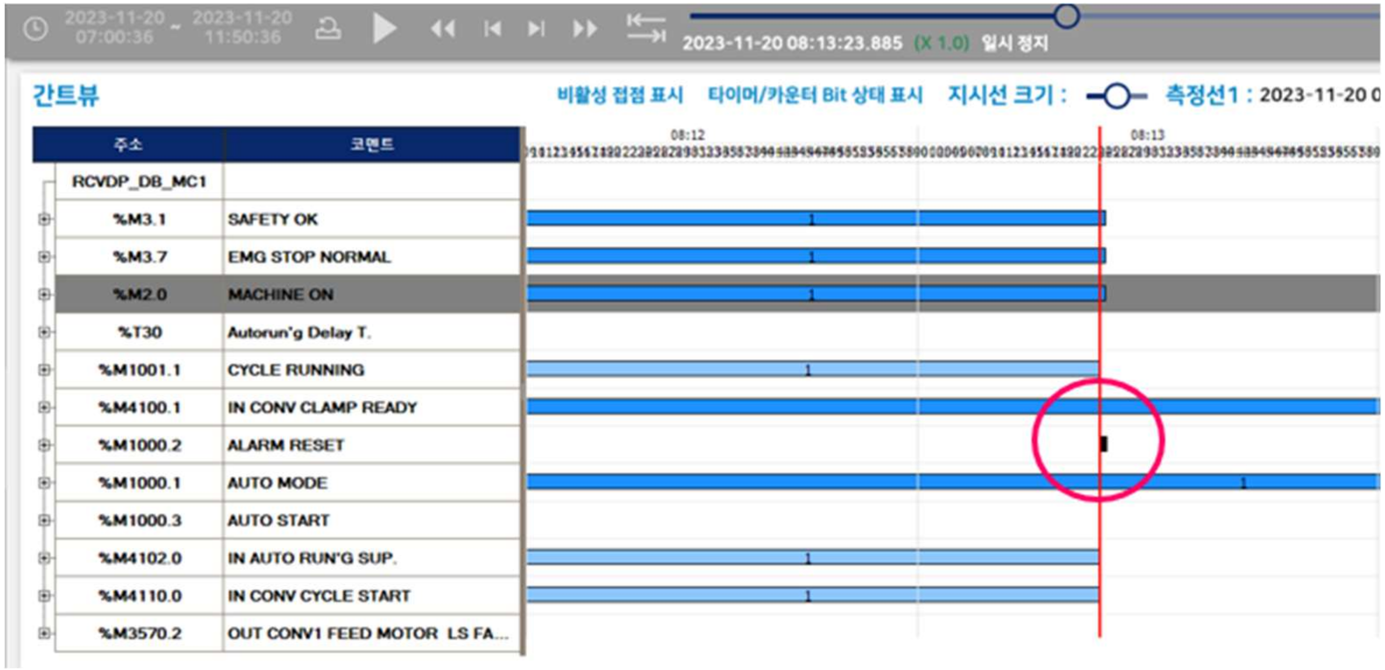
The robot intermittently stopped during automatic startup without generating any error messages or alarms.

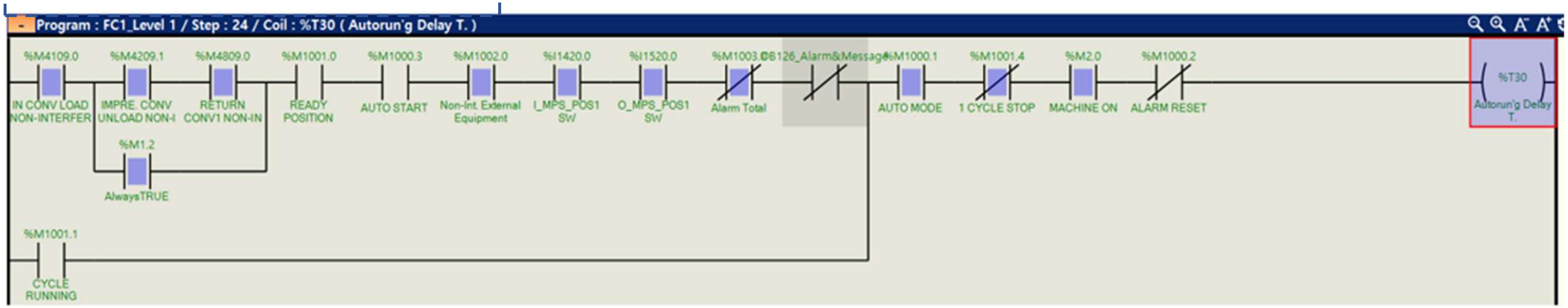
2) Root Cause Identification

Robot stoppage reoccurred due to a control logic error—pressing the Alarm Reset button, despite no alarms being active, triggered an unrelated sequence, causing a 110-minute halt.

3) Resolution

The problem was fixed by updating the control logic.





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Function Trend Analysis

Operational Time Trend Analysis for Predictive Maintenance

Trend Analysis

Time — Unit time extraction **Start~End Signal**

Training — AI Time Series Model Training

Analysis — Signal Trend Analysis

- Anomaly prediction based on automatic detection of trend changes
- Enables preemptive action against equipment downtime caused by wear, jamming, or breakage of mechanical components
- Playback of recorded history at the point of trend change is available

Preventive Maintenance Application

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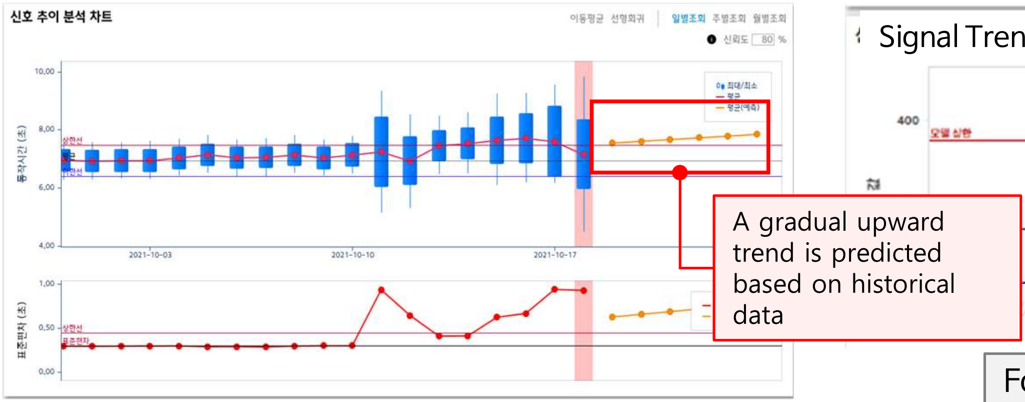
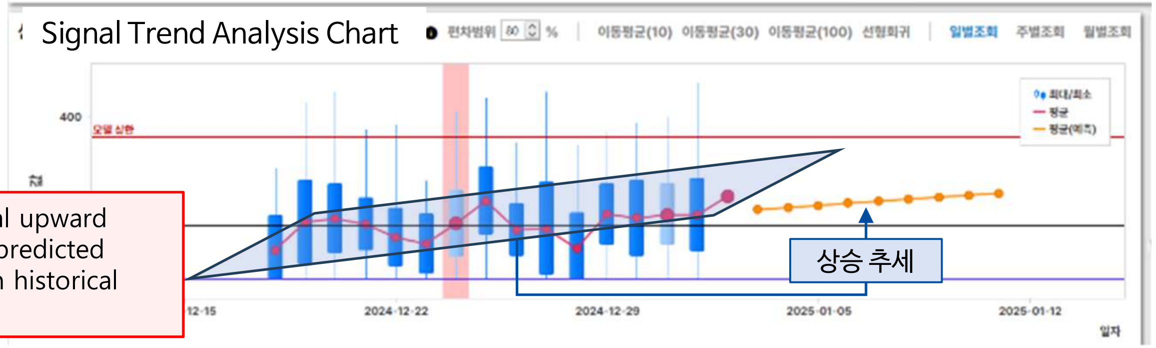
Function Trend Analysis

Operational Time Trend Analysis for Predictive Maintenance

▶ Anomaly Detection via Operation Time Trend Charts

: Utilizes time-series analysis on historical operational data





Forecasting Future Trends by Applying Time-Series Algorithms to Historical Data

〈Time-Series Algorithms〉

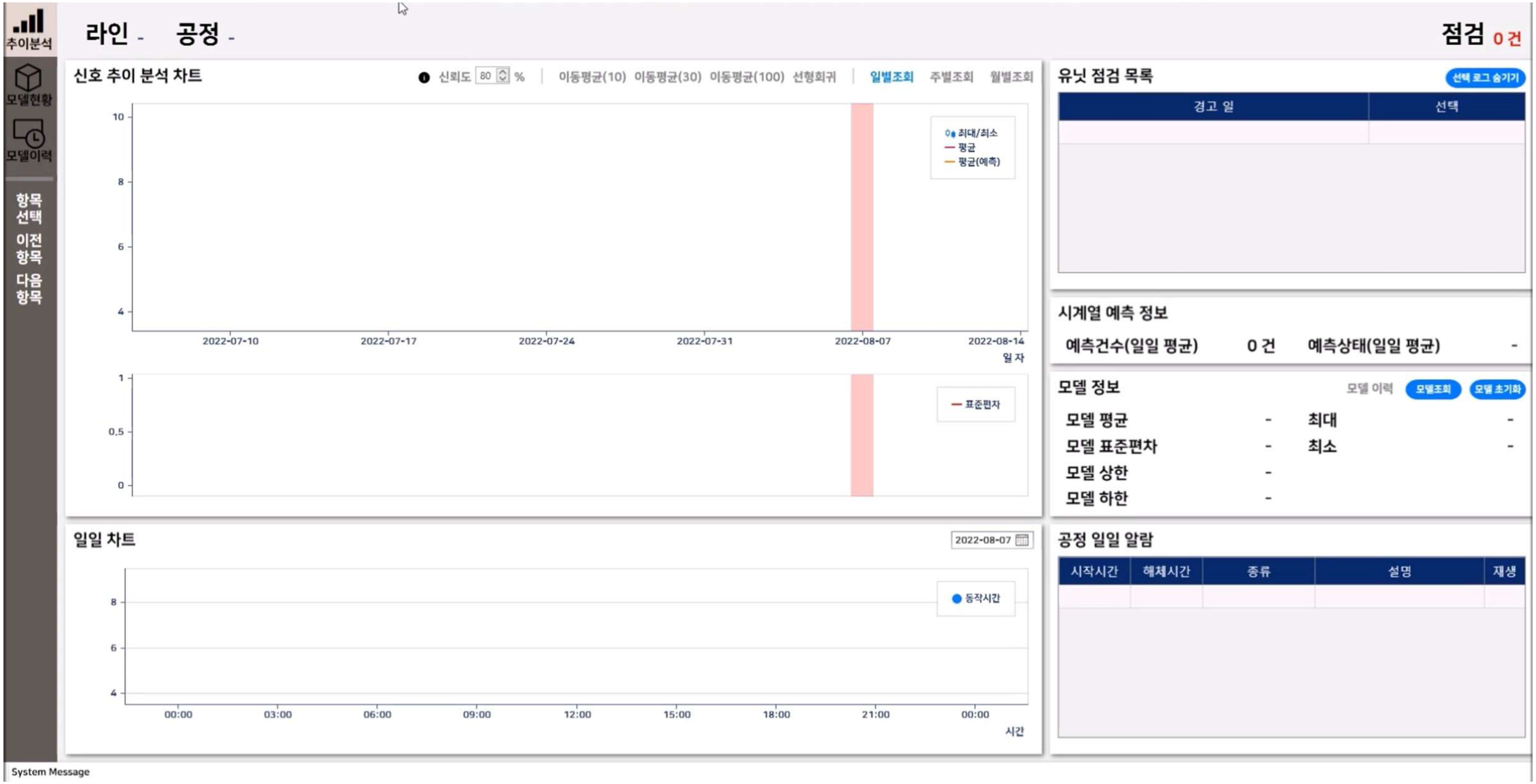
- **Moving Average**: Smooths out short-term fluctuations to better reveal the overall data trend
- Double Exponential Smoothing: A forecasting method that considers both level and trend components of time-series data
- ARIMA (AutoRegressive Integrated Moving Average): Predicts future values based on the autocorrelation of past data
- LSTM (Long Short-Term Memory): A type of recurrent neural network that learns complex time-series patterns for nonlinear future prediction

▶ Trend Change Detection with Daily Runtime Charts

: Visualizes point-in-time data through scatter plotting.

Function Trend Analysis (Demo)

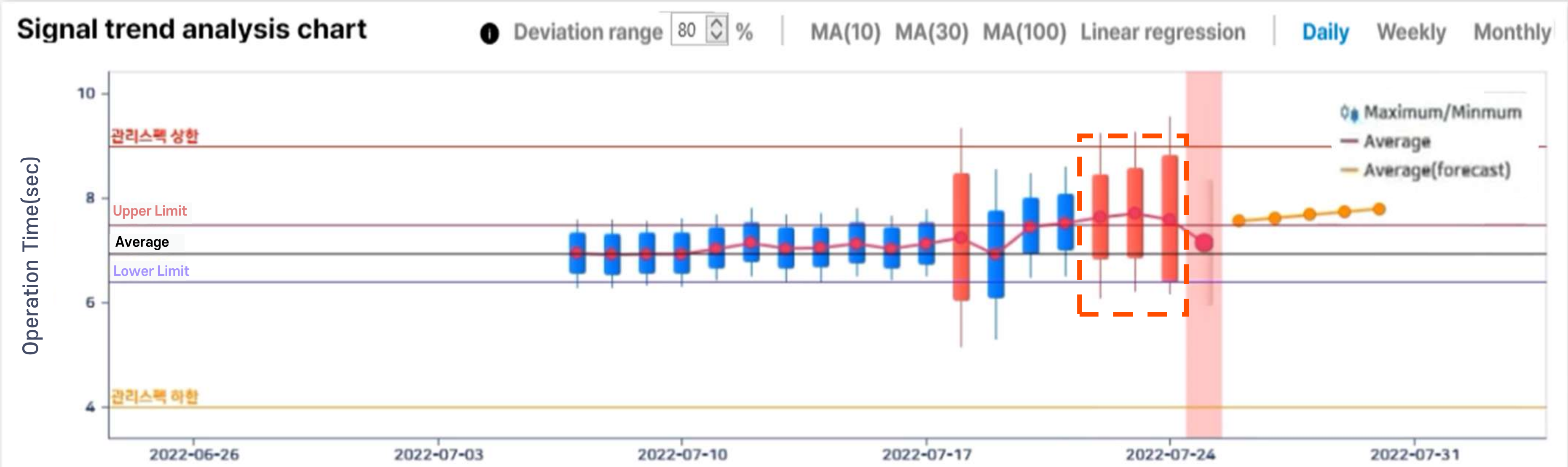
Operational Time Trend Analysis for Predictive Maintenance

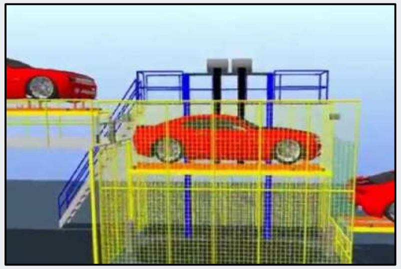


Reference: Trend Analysis

Kia Plant: Trend Analysis to Support Preventive Maintenance

Drop Lift Operation Time Delay



Classification	H Company	Image
Problem	Drop lift operation time delay	
Solution	**Changed drop lift belt for future downtime**	
Cost Reduction	Saved yearly cost of **$15 million** for downtime	

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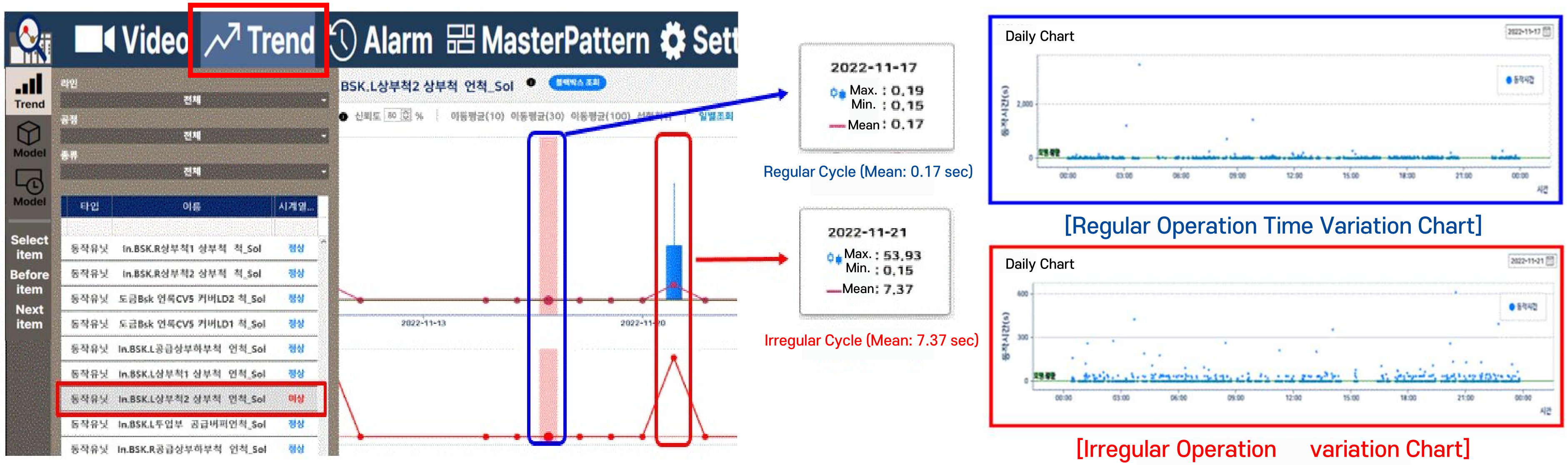
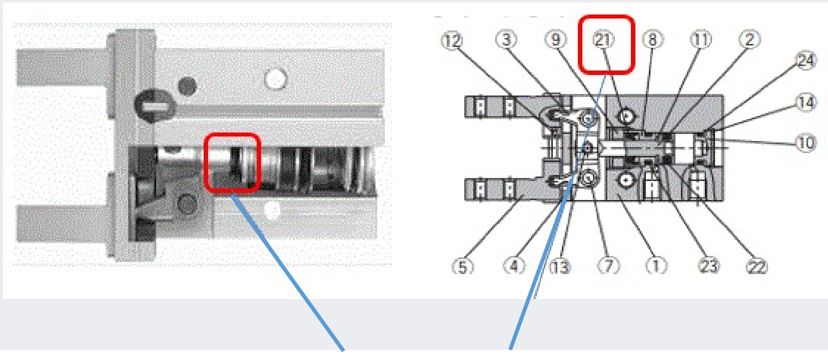
Reference: Trend Analysis (S. Electronic Company)

Trend Analysis – Cylinder Operation Time Variation



Classification	S Company
Problem	Significant variation in cylinder operation time
Root cause	The wear of cylinder rod packing
Resolution	**Replacing clamp cylinder**



* Cylinder rod packing

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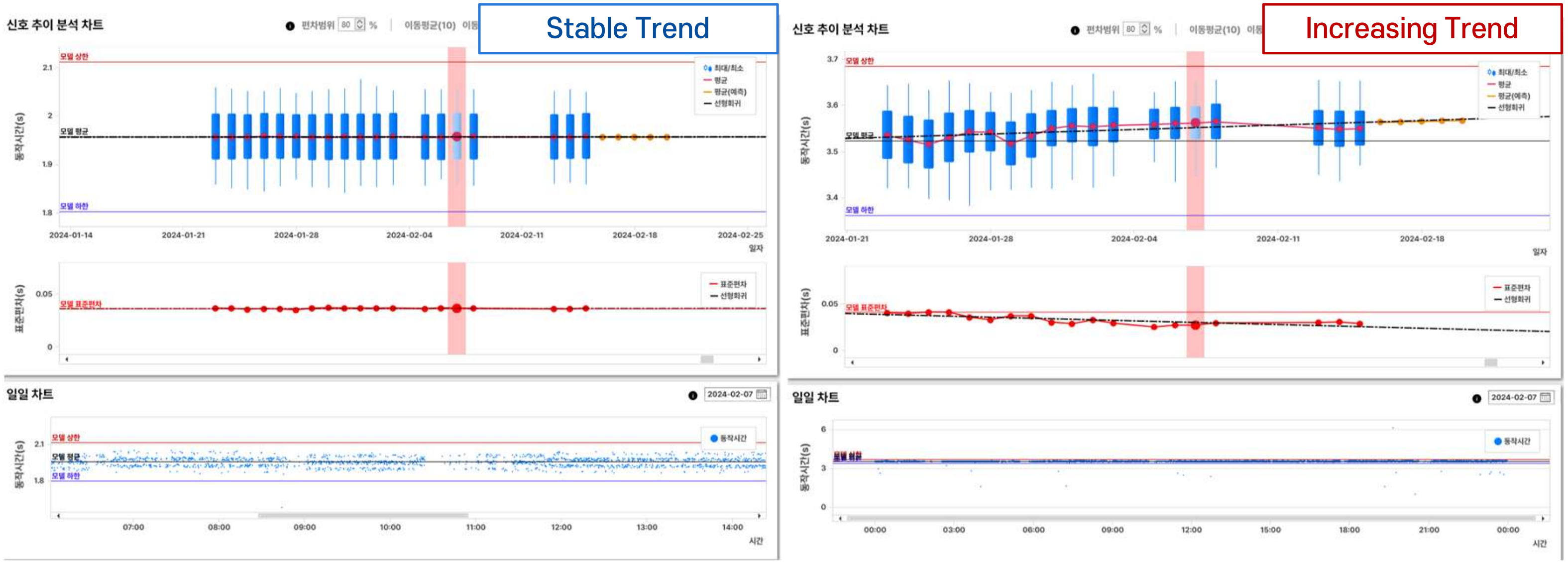
Reference: Trend Analysis

Trend Analysis of Measured Servo Motor RPM Values



Content	L Company
Anomaly Detection	The regression line of the measured values shows an increasing trend
Root Cause	Degradation of electrical contact performance due to brush wear inside the servo motor
Resolution	**No urgent replacement needed, but scheduled for preventive maintenance.**

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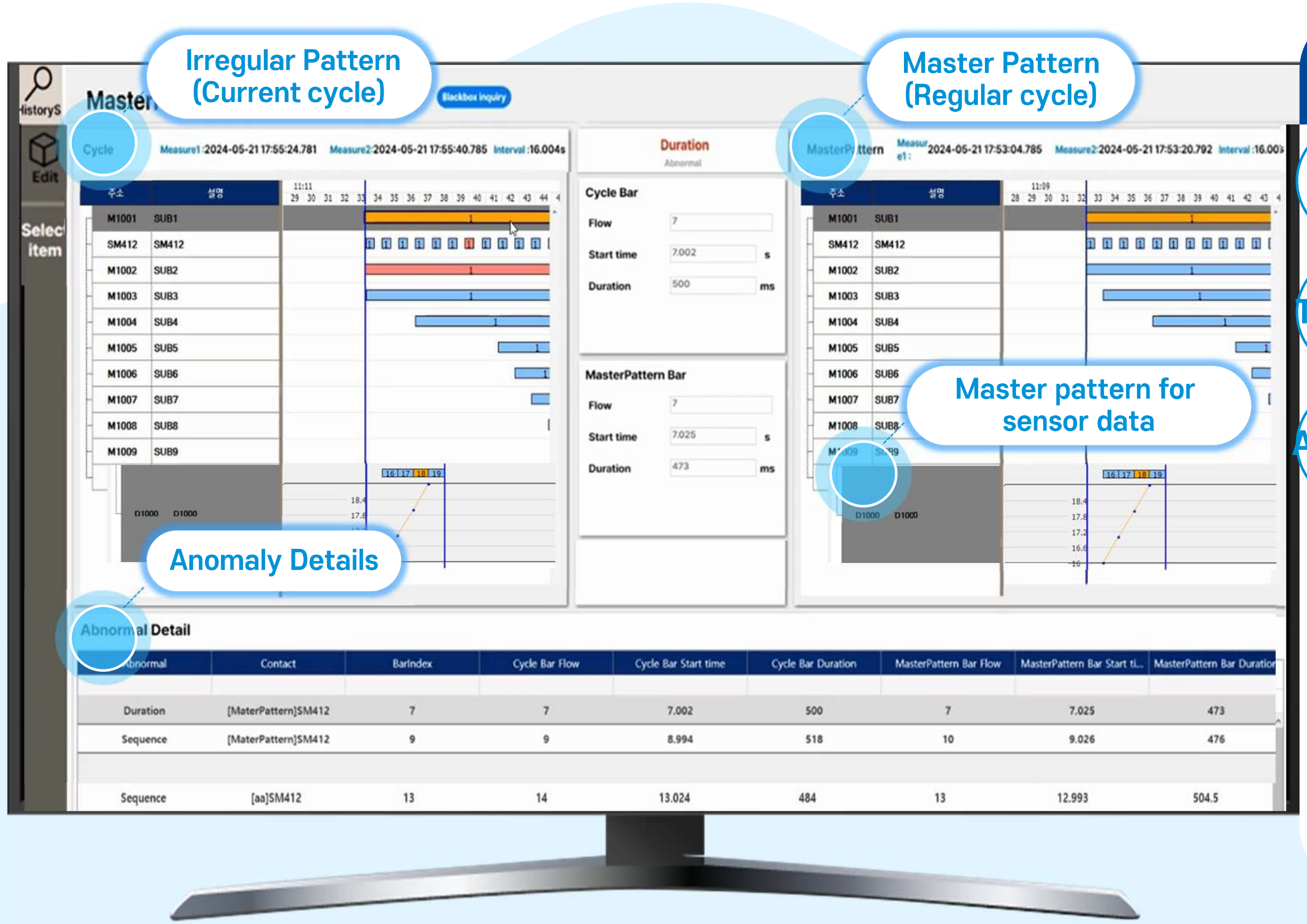
Function Pattern Analysis

Master Pattern for Detecting Irregularities in Process Cycles Automatically



Pattern Analysis

Data Control Extraction — PLC & Sensor Data

Training Auto-generation of Master Pattern

Analysis AI Automated Analysis of Irregular Cycle

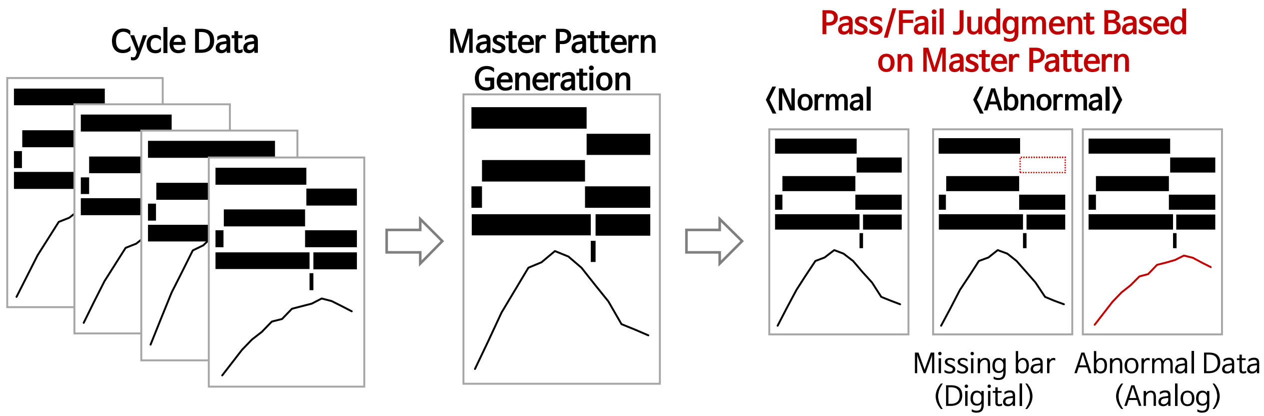
- Detection of Irregular Cycles through Automated Master Pattern Analysis
- Capable of detecting variations in operation time and sequence within each cycle
- Performs correlated analysis of analog data segmented by control logic
- Enables comparative analysis between the master pattern and individual control contacts

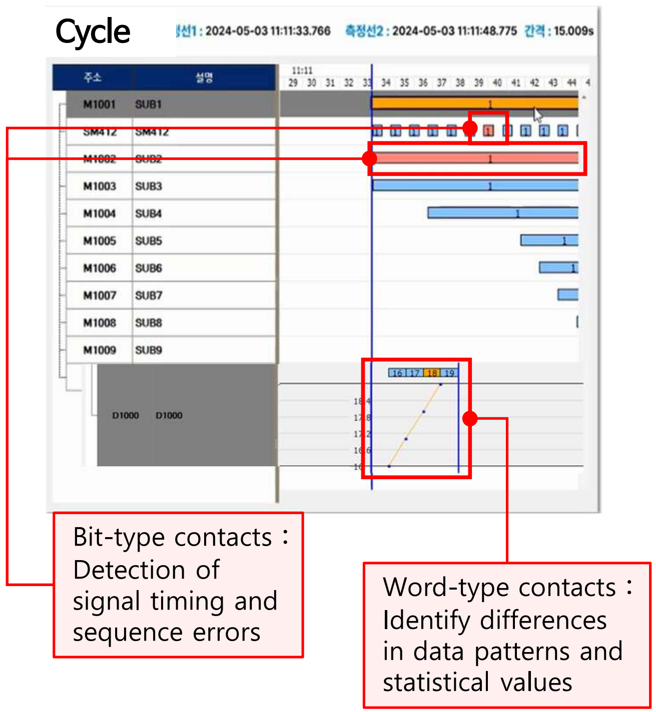
Utilized from a maintenance perspective

Function Pattern Analysis

Master Pattern for Detecting Irregularities in Process Cycles Automatically

- Master pattern represents the typical behavior of a repeated operation
- By analyzing the shape of each process cycle, the system automatically identifies abnormal patterns that differ from the master pattern





Apply time-series algorithms to historical data to forecast future trends

〈Deep Learning-Based Classification Model〉

- CNN Autoencoder: Trains on normal cycle data to learn pattern characteristics and detect deviations.

〈Cycle Learning Overview〉

- A master pattern is generated by learning the characteristics of a sufficient number of identical process cycles.
- Bit-type contacts: Includes features such as the number of bars per cycle, the operation time of each bar, and their execution order.
- Word-type contacts: Analyzes changes in word values during the cycle (e.g., statistical summaries, variation trends).

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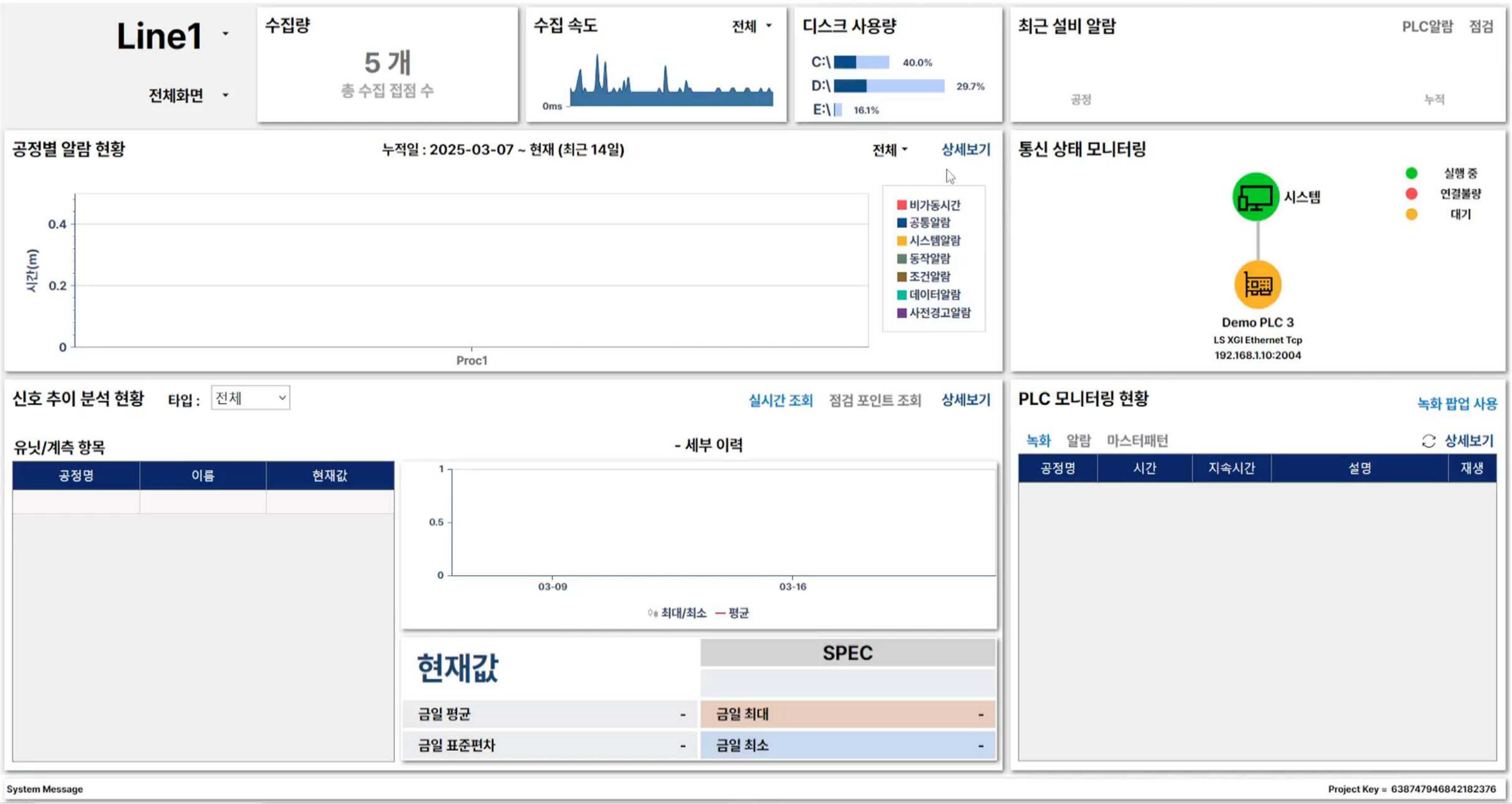
Function Pattern Analysis (Demo)

Master Pattern for Detecting Irregularities in Process Cycles Automatically



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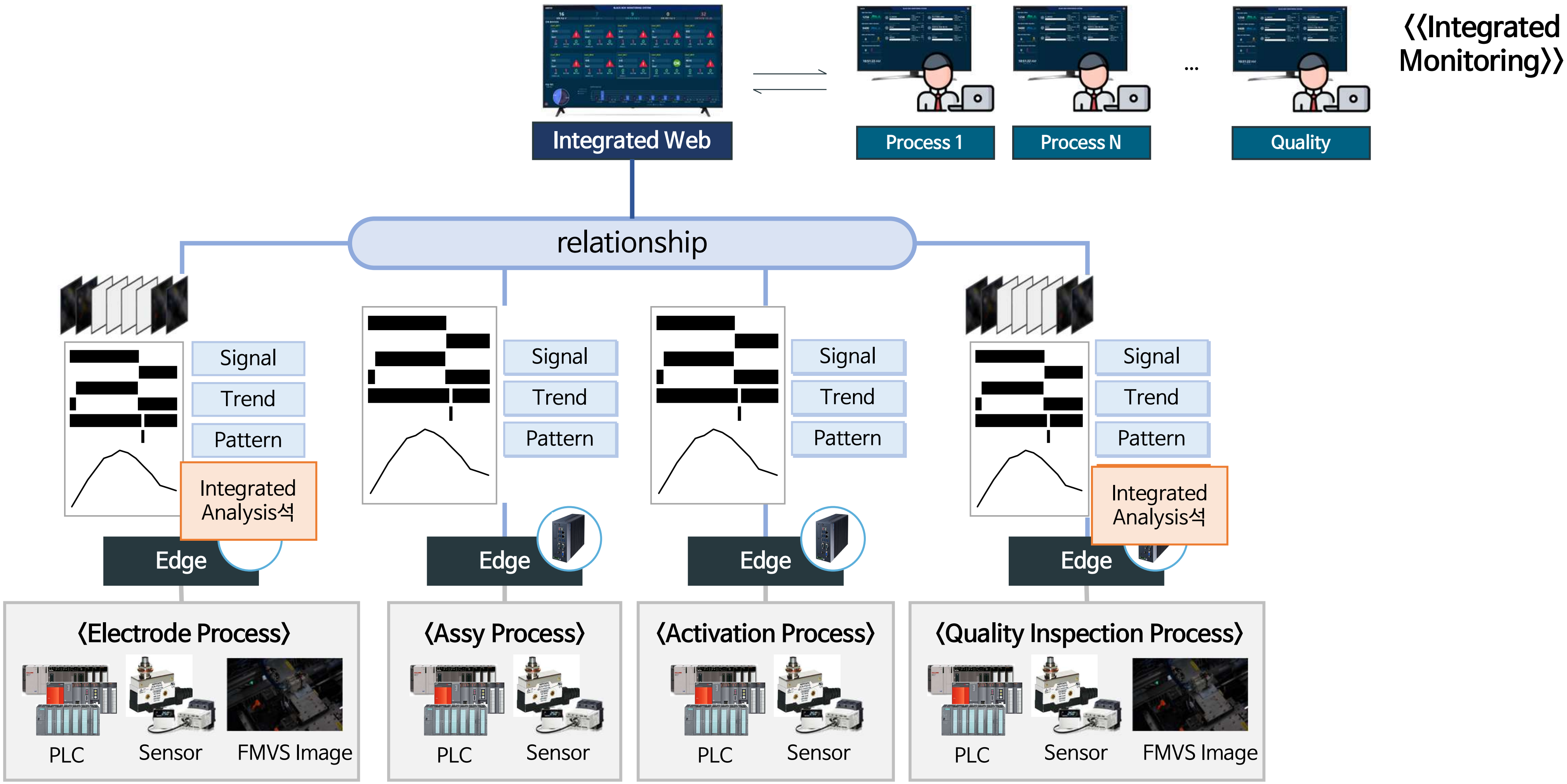
3. Integrated Analysis

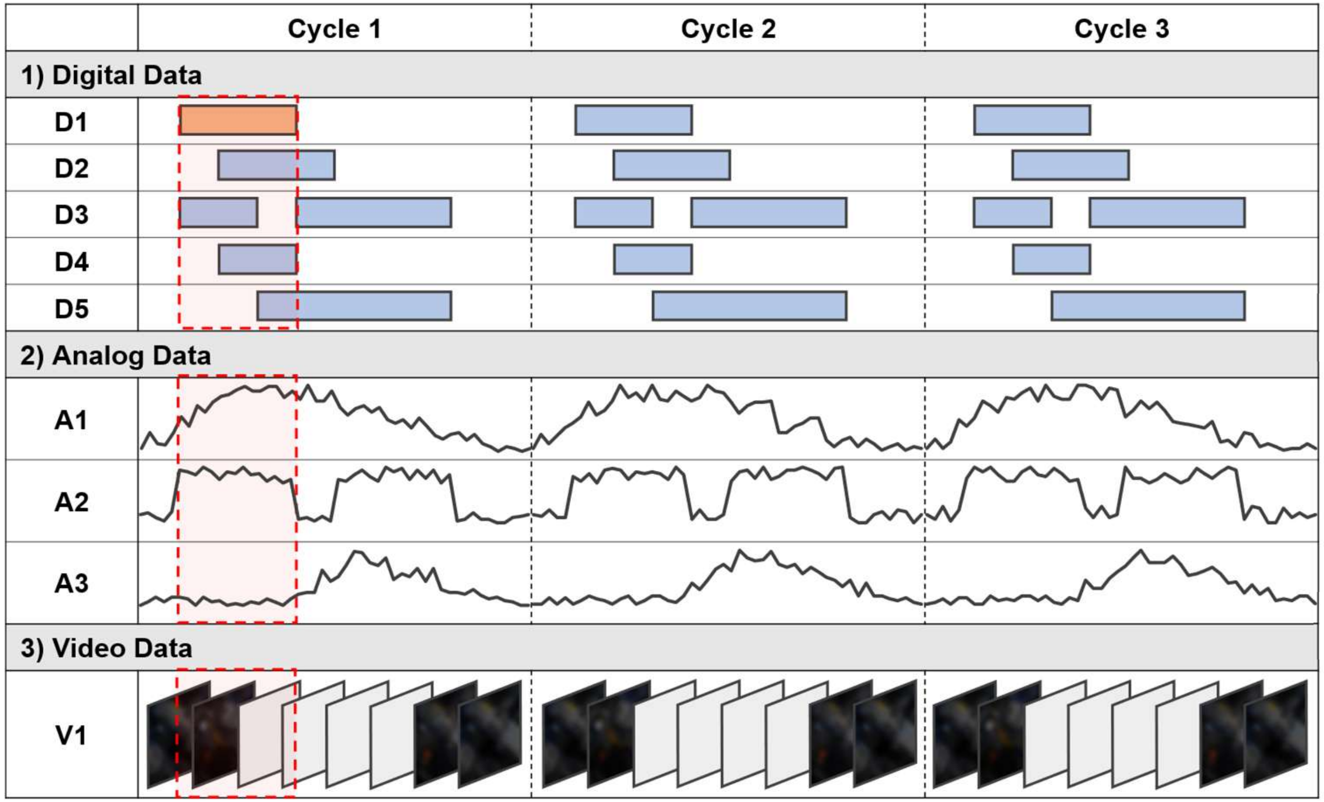
Function Integrated Analysis

Integrated Analysis of PLC, Sensor, Image(FMVS), and Inspection Data



Function Integrated Analysis

1) Data Segmentation



▶ 1-1) Digital Data
- Data gathering from PLC
- Control Log Chart ON(1), OFF(0)
- Cyclic and connection sequence
- Identify internal machine operation change

▶ 1-2) Analog Data
- Collected from sensors (e.g., temperature, pressure, vibration)
- Cyclic Patterns
- External Sensors Data

▶ 1-3) Image Data
- Camera Data
- Image Division by Frame Unit
- Detect Physical Changes in Machine Components

Based on digital data, extract analog and image data separately for the specified control interval

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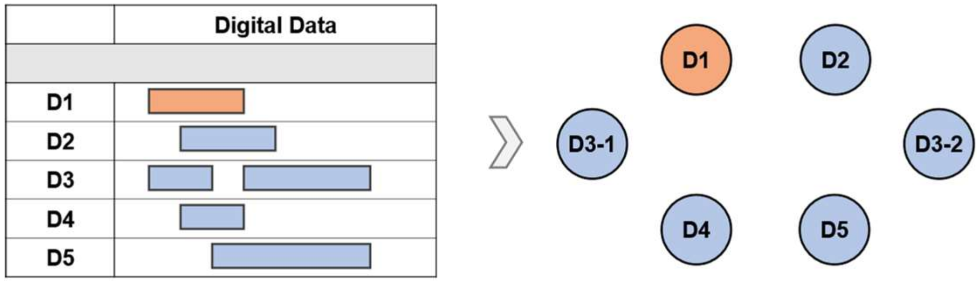
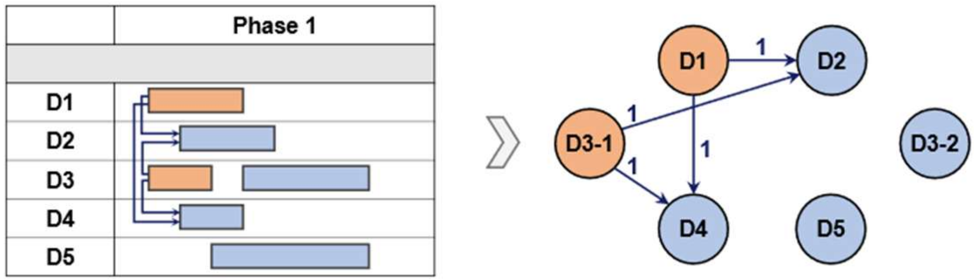
Function Integrated Analysis

2) Generating Adjacent Matrix



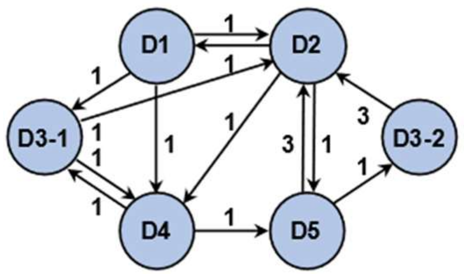
▶ 2-1) Node Generation

- Each contact point is represented as a node
- Additional nodes are created according to the number of operations occurring within a single cycle



▶ 2-2) Connect Adjacent Nodes

- From the start time of the previous node → to the start time of the next node
- The edge weight is defined as the time difference between the two operation start points
- This process is repeated until no further successor nodes exist



	D1	D2	D3-1	D3-2	D4	D5
D1	0	1	1	0	1	0
D2	1	0	0	0	1	1
D3-1	0	1	0	0	1	0
D3-2	0	3	0	0	0	0
D4	0	0	1	0	0	1
D5	0	3	0	1	1	0

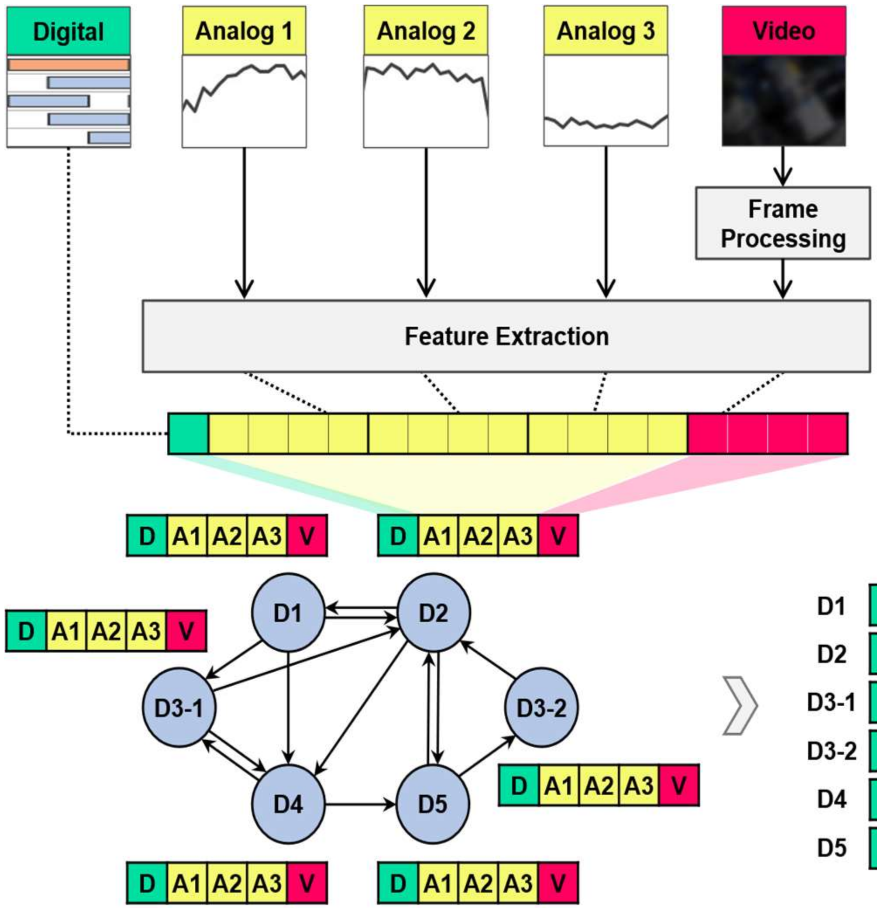
▶ 2-3) Generating Adjacent matrix

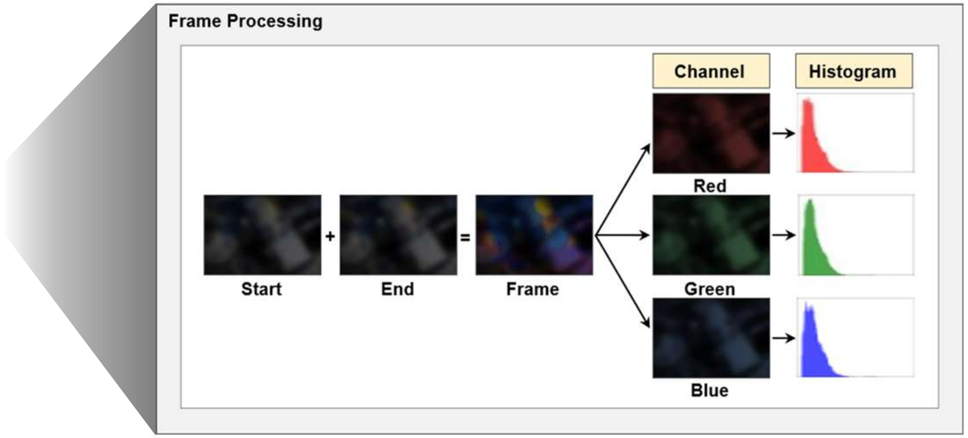
- Construct a directed and weighted adjacency matrix
- Includes both the start and end points of control operations (forward and reverse directions)

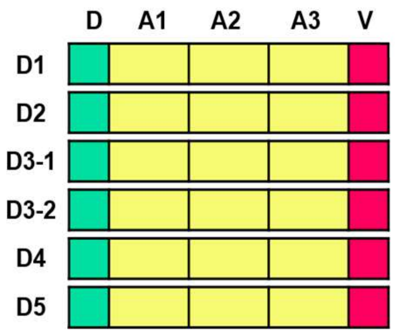
Generate an adjacency matrix representing edges and weights connecting nodes in both forward and reverse directions

Function Integrated Analysis

3) Generating Feature Matrix







▶ 3) Feature Matrix Generation

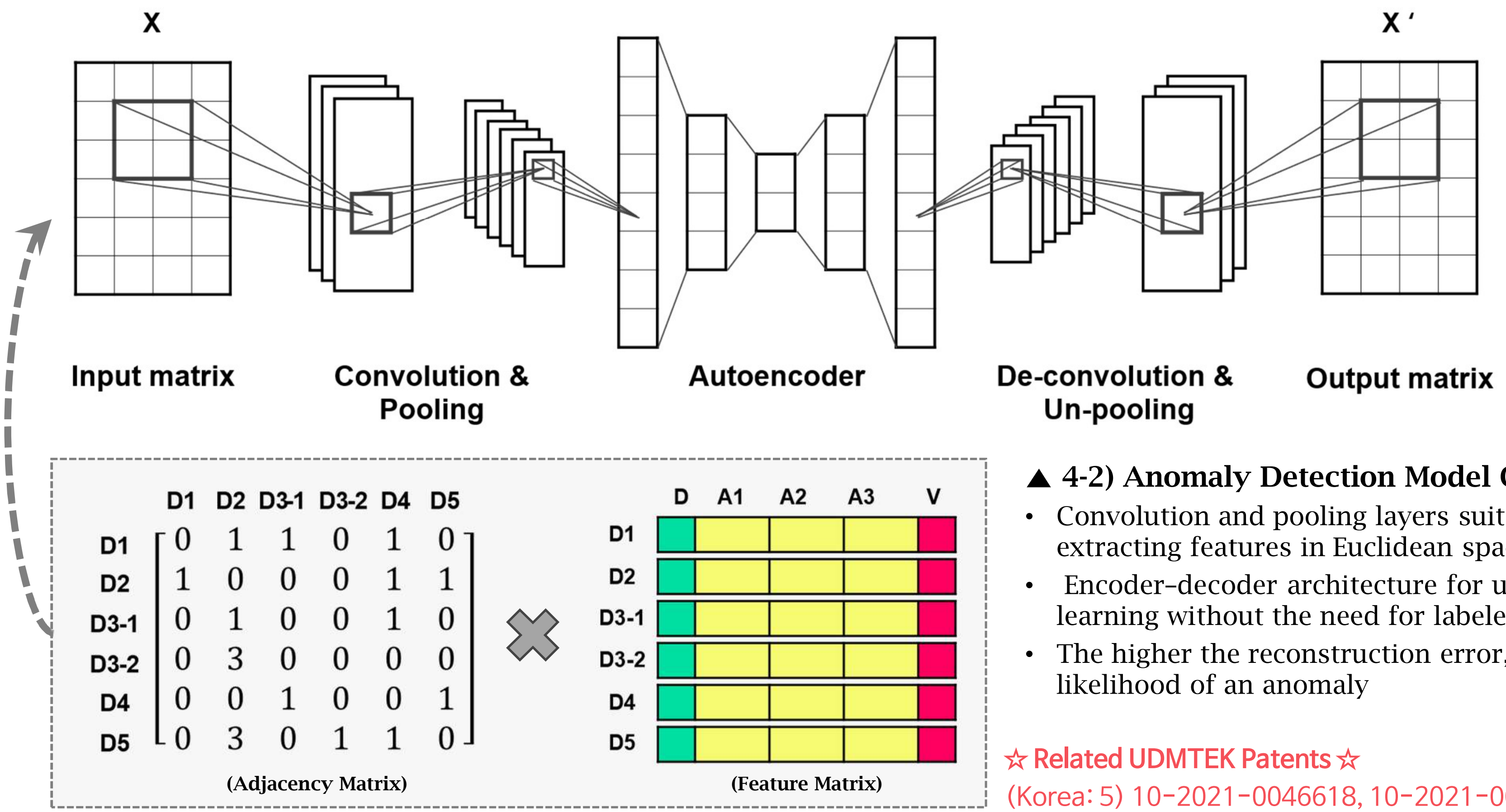
- Extract features for each node based on data type:
- Digital: Operation time
- Analog: Control interval pattern
- Image: Frame-based start/end timing and corresponding R/G/B values
- Each node's features are stored as a feature vector
- All feature vectors are aggregated to form the final feature matrix

Generate a feature matrix to distinguish between normal and abnormal states based on differences in data patterns

Function Integrated Analysis

4) Anomaly Detection Model Construction

Convolutional Autoencoder



▲ 4-1) Input Matrix Generation for the Model

- Matrix multiplication between the adjacency matrix and the feature matrix
- Results in the final graph-structured input data

▲ 4-2) Anomaly Detection Model Construction

- Convolution and pooling layers suitable for extracting features in Euclidean space
- Encoder–decoder architecture for unsupervised learning without the need for labeled data
- The higher the reconstruction error, the higher the likelihood of an anomaly

☆ Related UDMTEK Patents ☆

(Korea: 5) 10-2021-0046618, 10-2021-0050982, 10-2021-0097053, 10-2024-0067503, 10-2025-0029505

(USA: 3) 17/658,553, 17/756,460, 17/813,738

(Japan: 1) 2023-564610

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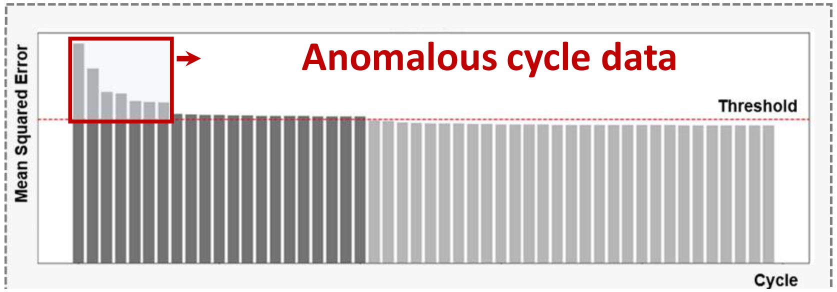
Function Integrated Analysis

5) Analysis Result

Model	Size of Kernel	Activation Function	Optimizing Function	Size of Filter	MSE
1	3	ReLU	Adam	8	0.1869
2	3	Tanh	RMSProp	32	0.1871
3	3	Tanh	Adam	32	0.1875
4	3	ReLU	RMSProp	16	0.1877
5	3	ReLU	RMSProp	32	0.1877
6	3	Tanh	RMSProp	16	0.1877
7	3	ReLU	Adam	16	0.1878
8	3	Tanh	RMSProp	8	0.1885
9	3	ReLU	Adam	32	0.1900
10	3	ReLU	RMSProp	8	0.1901
11	3	Tanh	Adam	16	0.1905
12	2	ReLU	Adam	32	0.1940
13	3	Tanh	Adam	8	0.1942
14	3	Sigmoid	RMSProp	32	0.1964
15	3	Sigmoid	Adam	32	0.1968
16	2	ReLU	Adam	16	0.1979

▶ Anomaly Detection Model

- Utilizes a Convolutional Autoencoder (CAE) architecture
- Optimal hyperparameter combinations are explored using grid search
- Key parameters include:
- (Convolutional) kernel and filter sizes
- (Autoencoder) activation functions and optimization algorithms
- Lower MSE (Mean Squared Error) indicates better model performance



▲ Model Analysis Results

- Select cycles with the highest MSE values from the entire prediction results
- If the MSE exceeds a defined threshold, the likelihood of anomaly increases (△)
- Threshold is defined as:→ Mean of all MSE values + (3 × standard deviation)
- Cycles flagged as anomalous require further root cause analysis

Optimize model hyperparameters to maximize prediction accuracy and train the model for anomalous cycle detection.

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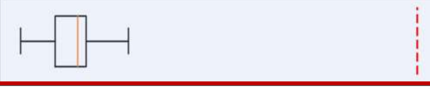
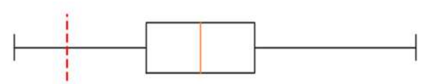
Function Integrated Analysis

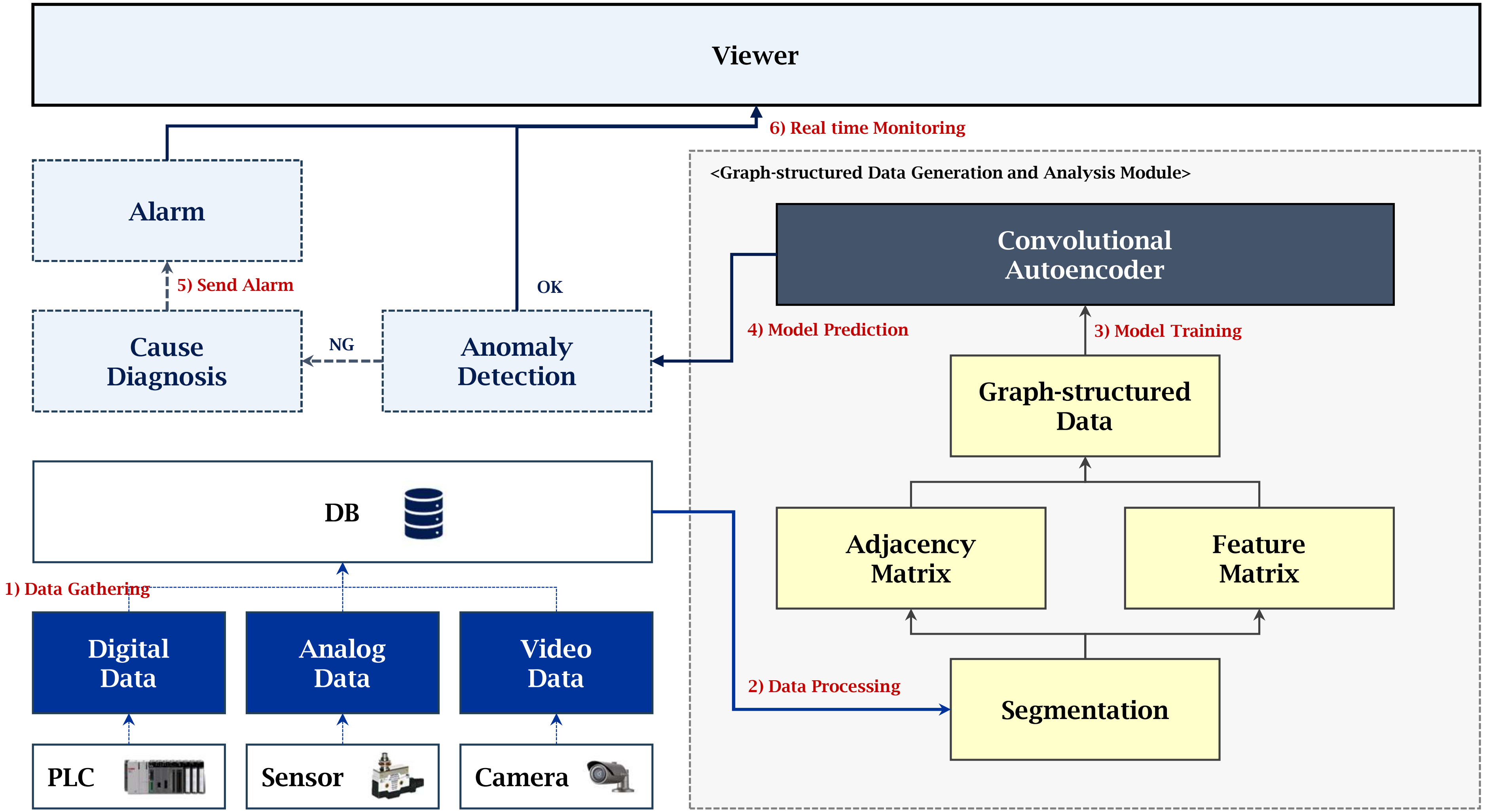
5) Analysis Result

Cycle	Type	Node	Variable	Feature	Plot	Distance	MSE
	Digital	Y1001	Duration	-		33.73	
0069	Digital	Y1009	Duration	-		31.85	0.308
	Digital	Y1035	Duration	-		29.19	
	Analog	Y1014	Coolant Temperature	Shape Factor		44.05	
1186	Analog	Y1014	Coolant Temperature	Root Mean Square		10.04	0.273
	Analog	Y1014	Coolant Temperature	Mean		10.03	
	Digital	Y1003	Duration	-		18.56	
0470	Digital	Y1009	Duration	-		12.99	0.240
	Analog	Y1014	Red	Standard Deviation		8.97	

Analyze multiple variables from various perspectives to identify and address the most influential root cause of the anomaly

Function Integrated Analysis

6) Implementation



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Function Integrated Analysis

Production Optimization through Integrated Analysis, Leading to Continuous Quality Innovation

<table>
<tr><th colspan="2">Technology</th><th>Summary</th><th>Effectiveness</th></tr>
<tr><td rowspan="6">Key Function</td><td rowspan="2">1) Signal Analysis</td><td colspan="2">Replay of process operations at timestamps associated with historical alarms and anomalies</td></tr>
<tr><td>- Reproduce historical PLC ladder logic at specific timestamps
- Visualize process flow through Gantt and Ladder views
- Replay linked process images for contextual analysis</td><td>- Fast alarm diagnostics to reduce downtime
- Root cause analysis of anomalies to prevent recurring failures and improve process reliability</td></tr>
<tr><td rowspan="2">2) Trend Analysis</td><td colspan="2">Operational Trend Analysis for Predictive Maintenance</td></tr>
<tr><td>- Anomaly prediction based on automatic detection of trend changes
- Signal trend analysis chart: Time-series forecasting based on historical data
- Daily chart: Detects detailed data variations over time</td><td>- Proactive anomaly detection reduces defects through timely maintenance
- Optimized maintenance scheduling lowers overall maintenance costs by avoiding unnecessary interventions</td></tr>
<tr><td rowspan="2">3) Pattern Analysis</td><td colspan="2">Master Pattern for Automatically Analyzing Irregularities in Process Cycles</td></tr>
<tr><td>- A master cycle pattern is created by aggregating multiple instances of cycle data
- Digital signals are analyzed using Gantt charts, while analog trends are evaluated through waveform analysis
- A classification-based AI model is employed to automate normal/abnormal cycle detection</td><td>- Reduce operator time by minimizing manual monitoring tasks
- Automatically detect irregular anomalies to enhance quality stability</td></tr>
<tr><td rowspan="2">Added Tech.</td><td rowspan="2">4) Integrated Analysis</td><td colspan="2">Integrated Analysis of Digital (PLC), Analog (Sensor), Image (FMVS), and Inspection Data</td></tr>
<tr><td>- Consider all data generated during a single operation cycle—digital, analog, and image
- Automatically detect anomalies from each type of data</td><td>- Maximize efficiency in quality, production, and equipment management through automated anomaly detection and classification
- Enhance root cause analysis accuracy for process defects through multi-source data analysis</td></tr>
</table>

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Unified Digital Manufacturing Technology

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Thank You