

# Machine defect monitoring system for Smart Factory

**Predictive Maintenance solution:**  
Improve reliability, performance, and safety

# 2020



**WE OFFER**

Machine defect monitoring  
system for Smart Factory

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Machine defect monitoring system for Smart Factory

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## 02

### Product Outline

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# MACHINE DEFECT MONITORING SYSTEM

Mobilio monitors machine defects to keep the production process running smoothly. In the event of a sudden problem with a factory machine or equipment, we got an idea and started to develop a product because there was a big disruption in production, and by attaching Mobilio's S\_Trender to the machine, it can detect vibration and predict abnormalities. A statistical algorithm is applied to monitor the equipment status in real time for 24 hours and provide a diagnosis and response solution. Mobilio's data analysis service is used in various industrial processes such as automobiles, robots, semiconductors, subways, and ships



# Company Overview

## Overview

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**Title :** sales & marketing manager

## Major achievements



- K-water agreement
- Railway Technology Research Institute Agreement
- Seoul Transportation Corporation Agreement
- Korea Atomic Energy Research Institute family company
- East-West Power-East-West Power Innovation Partner Agreement
- Korea-Russia innovation platform agreement
- Korea Institute of Machinery and Materials cooperation



# OUR HISTORY

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Mobilio, a smart factory company that analyzes big data based on IoT, We are growing into a global company through cooperation with various overseas companies.

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**CES 2020**



Visit 2019, 2020  
International CES

**15 PATENTS**



registration of a license

**8 OFFICES**



Overseas Certification  
and Venture  
Certification, Affiliated  
Research Institute

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**2017**



the grand prize of a  
start-up contest

**2018**



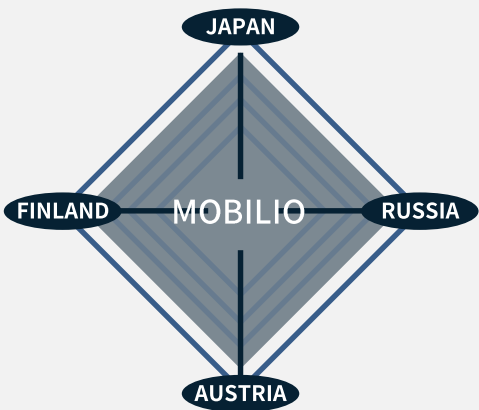
Visit  
'Electronica 2019' in  
Muenchen

**2019**



Participate in Silicon  
Valley Accelerator

# Overseas Branch



Mobilio, which has already received love calls from German IT telecommunications companies and Chinese automakers, is expanding its business worldwide.



# “Our Vision for Smart Factory”

Mobilio is a specialized engineering company that analyzes various data generated in factory facilities to find and inform early maintenance defects.

As a leader in smart factory, we are providing a system that digitizes the analog signal of the factory in progress and monitors the factory production situation anytime, anywhere through the cloud system. In addition, it aims to provide various information that may occur in the future through big data analysis system and artificial intelligence beyond preservation of factory facilities.



# OUR CLIENTS

Mobilio is working on projects in cooperation with large-scale clients.

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Smart Navy

Subway Door

Subway Compressor

Marine Crane STS/Gantry

K-WATER Turbine



# SMART NAVY

## ENGINE/ RADAR

- Awarded the grand prize at the STARTUP contest hosted by the Korean Navy and the Korea International Trade Association
- Navy Smart Navy project in progress





# Subway Door

- › Seoul Transportation Corporation door failure detection system in progress
- › Failure detection algorithm development using artificial intelligence in progress  
*(Refer to page 17 for details)*





# Subway Compressor

- Seoul Metro (METRO) main air compressor failure diagnosis
- Development of main air compressor fault diagnosis tester with Korea Railroad Research Institute



# K- water Turbine

- K-water agreement in 2020
- Installation and supply of products (S-trender) received
- Turbine monitoring system construction



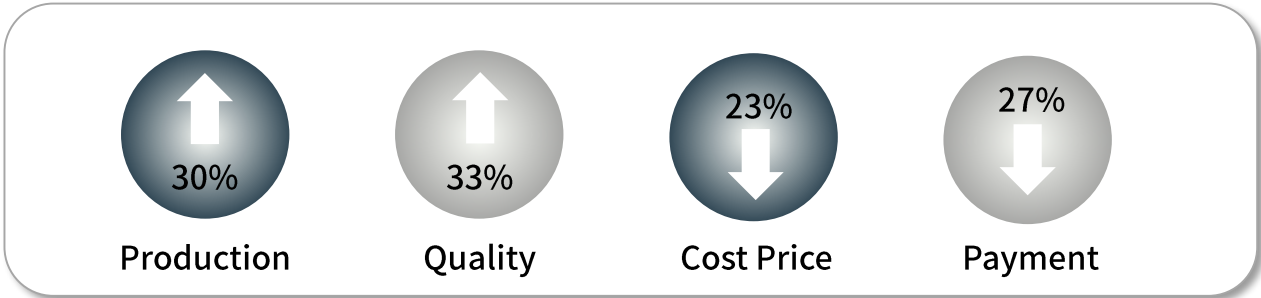
# Marine crane STS/ Gantry

- Awarded the Excellence Prize in the Commercialization of the Marine and Fisheries Startup Contest held on October 14, 2020 (Director's Prize of the Institute of Marine Fisheries Science and Technology Promotion)

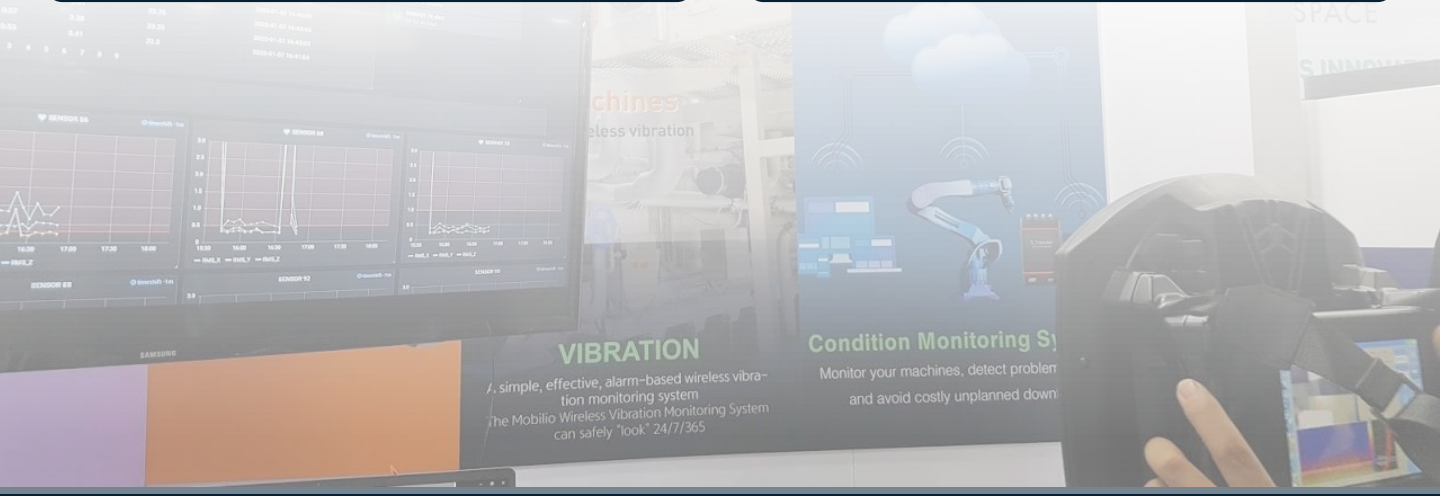
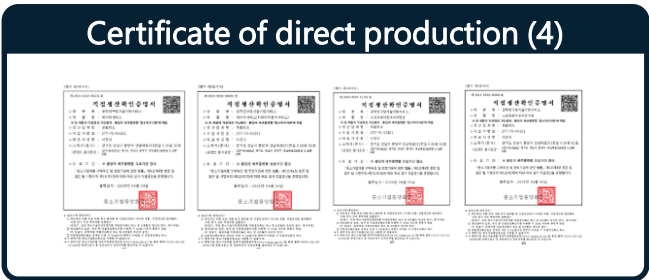


# WHY MOBILIO?

## Introductory effect



## IP & Certificates



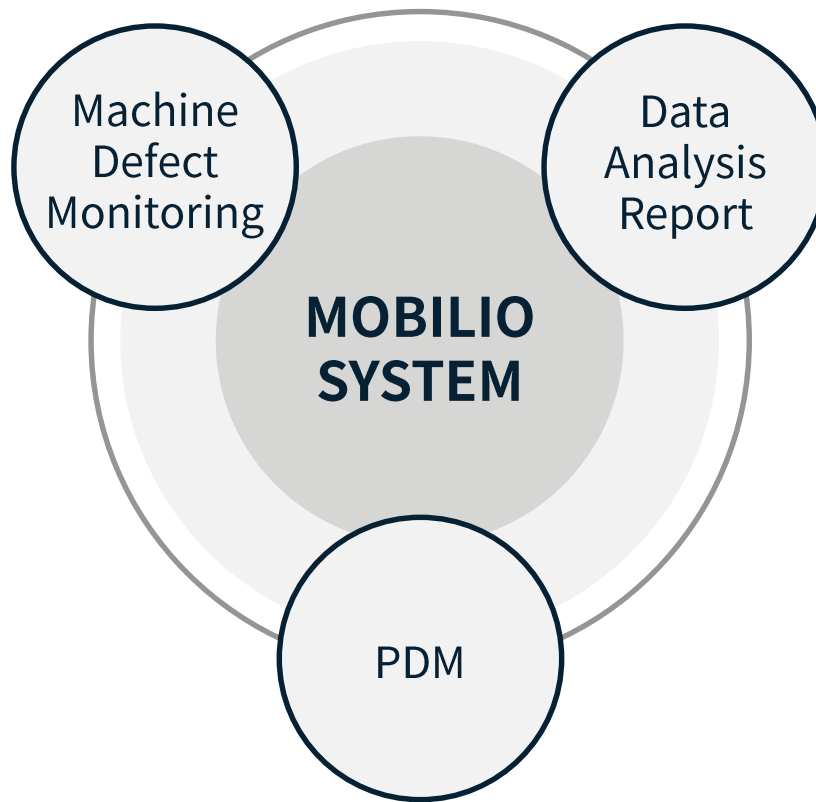
### VIBRATION

A simple, effective, alarm-based wireless vibration monitoring system. The Mobilio Wireless Vibration Monitoring System can safely "look" 24/7/365

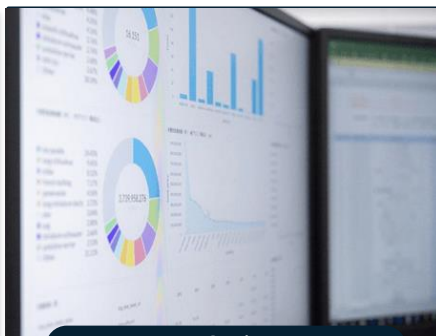
### Condition Monitoring System

Monitor your machines, detect problem and avoid costly unplanned down

# MOBILIO SYSTEM


**Machine Defect Monitoring**

A sophisticated interconnected system of sensors, monitors, circuits, hardware and software to collect, record, analyze and communicate data about elevator operation 24/7.


**Data Analysis Report**

The process of detecting data as summaries of information to monitor how various areas of the business are performing. Analytics is the process of exploring data and reports to extract meaningful insights, which can be used to better understand and improve business performance.


**PDM**

Physical Distribution Management is a process that uses physical parameters in a highly reliable way to help you identify time to failure. It means that it has already started to fail, but the machine is still working.

# Product Outline



## Model : S-Trender

- 4 channel DAQ device
- Sample rate: :51.2Hz
- Voltage : 100~200VDC
- Battery Li-ion Battery, 3000mAh 11.1V
- Case Size : 170 x 100 x 50 mm
- Weight : Approx. 1.3kg



## Model : M-Trender

- 4 channel DAQ device + tacho
- Sample rate: :51.2 Hz
- Voltage : 100~200VDC
- Battery Li-ion Battery, 3000mAh 11.1V
- Case Size : 170 x 100 x 50 mm
- Weight : Approx. 1.3kg



## Software : VIBOT

- Condition-based maintenance (CBM) is a maintenance strategy that monitors the real-time condition of an asset to determine what maintenance needs to be performed. Unlike preventive maintenance, which uses things like calendar-based maintenance or other means to determine when to schedule and perform maintenance, condition-based maintenance



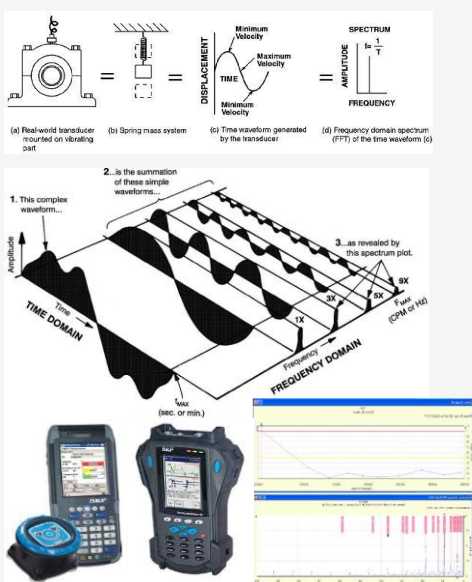


Example

- Dynamic : sensitivity : 100mV/g
- Acceleration range : 80g peak
- Frequency range : 0.5~14000hz
- Resonance frequency : mounted , nominal 30 khz .
- Voltage source : 25Vdc
- Bios voltage : 12Vdc
- Grounding : case isolated internal shielded.
- Temperature range : -50 o C~ 120 o C
- Vibration limits : 500g peak
- Shock limit : 5000g peak
- Mounting : internal 1/4 28 thread mounting stud provided. M8 x 1.25 metric thread.
- Mounting torque : 24 in-ibs (2.9 Nm)

## Predictive Maintenance in Industry 4.0

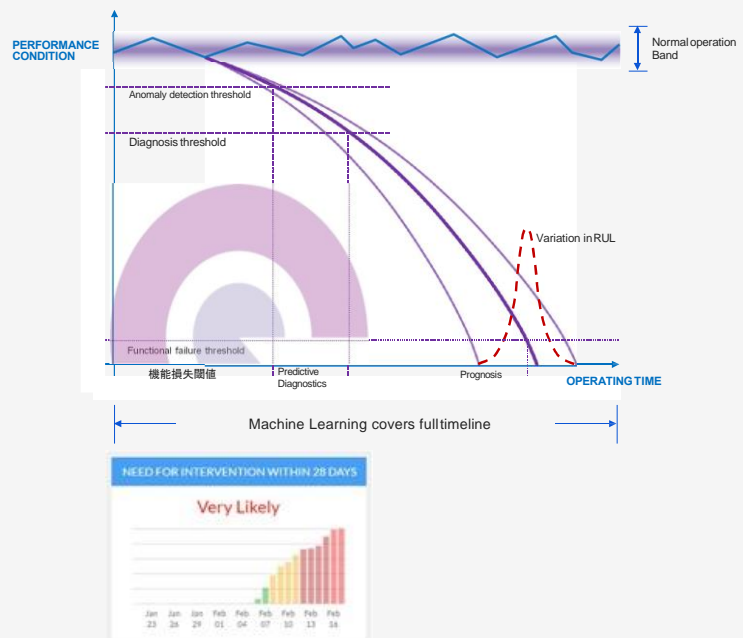
## Prognostics: Remaining Useful Life



Slide 18

08-26

2



## ● CBM (Condition-based monitoring system)

Vibration analysis and condition monitoring (CM) are important ingredients in all of these goals. Vibration analysis, if applied correctly, can provide identification of specific problems that routinely prevent these goals from being achieved. Furthermore, vibration analysis can be used as part of root cause analysis efforts within a facility. It is very important to identify what is causing specific problems to routinely occur and eliminate those causes.

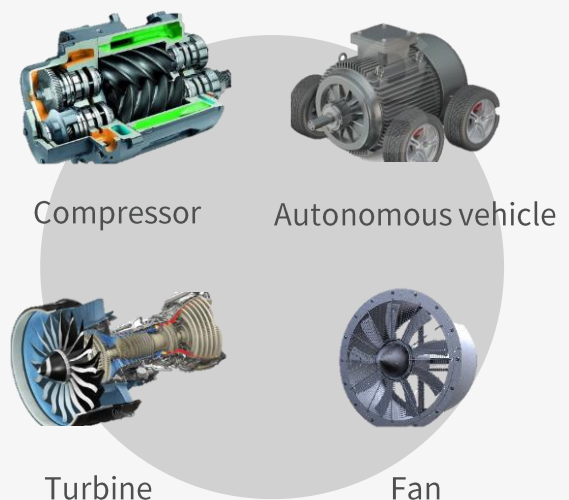


## ● Monitoring system + Consulting

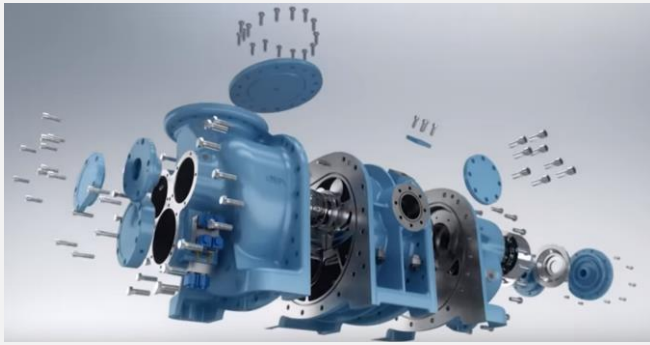
Mobilio provides monitoring system and also offer consulting service to clients



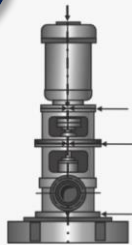
- **Employess** : No need expert
- **Manager** : Expense and risk down
- **Company** : History data like airplane black box



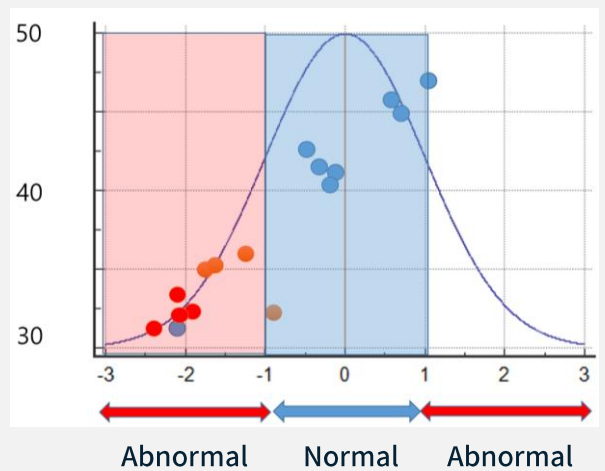
## Company F & C



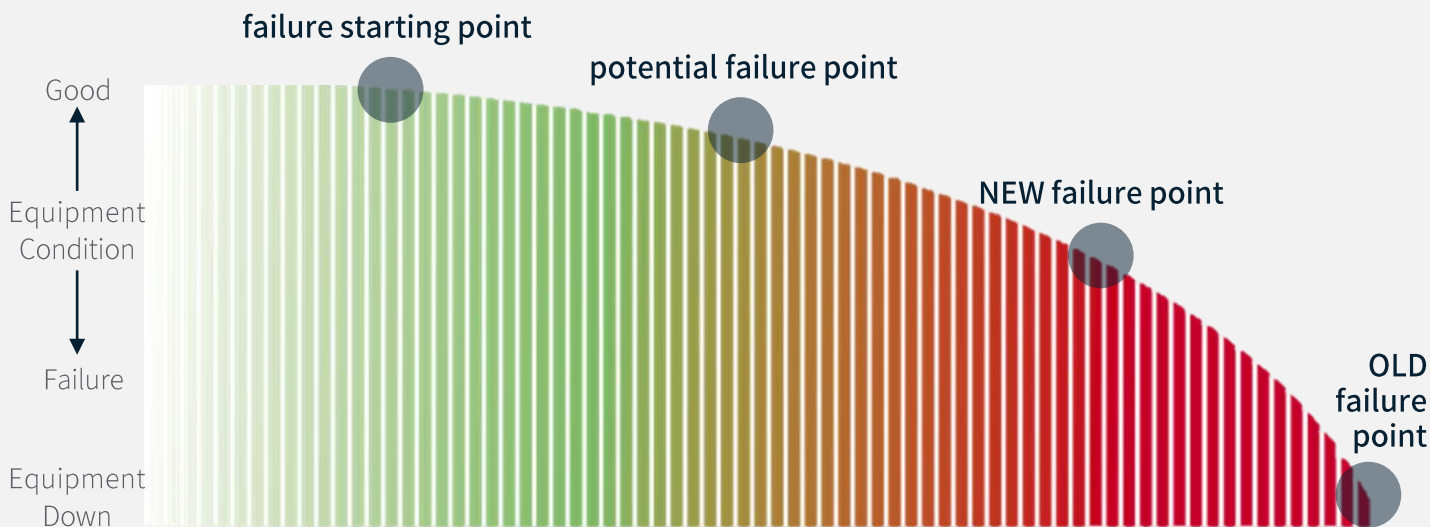
Velocity Severity		Velocity Range Limits and Machine Classes						
mm/s RMS	in/s Peak	Small Machines Class I	Medium Machines Class II	Rigid Supports Class III	Flexible Machines Class IV			
0.28	0.02	Good	Good	Good	Good			
0.45	0.03							
0.71	0.04							
1.12	0.06	Satisfactory	Satisfactory	Satisfactory	Satisfactory			
1.80	0.10	Unsatisfactory (alert)						
2.80	0.16	Unsatisfactory (danger)	Unsatisfactory (alert)	Unsatisfactory (alert)	Unsatisfactory (alert)			
4.50	0.25		Unsatisfactory (danger)	Unsatisfactory (danger)	Unsatisfactory (danger)			
7.10	0.40		Unacceptable (danger)	Unacceptable (danger)	Unacceptable (danger)	Unacceptable (danger)		
11.20	0.62	Unacceptable (danger)	Unacceptable (danger)	Unacceptable (danger)	Unacceptable (danger)			
18.00	1.00							
28.00	1.56							
45.00	2.51	Unacceptable (danger)						



## Company S

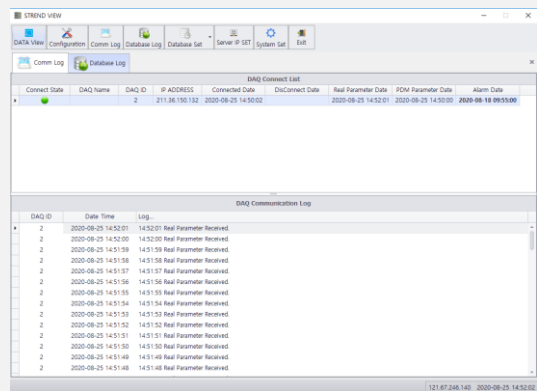


## Condition-Time Graph

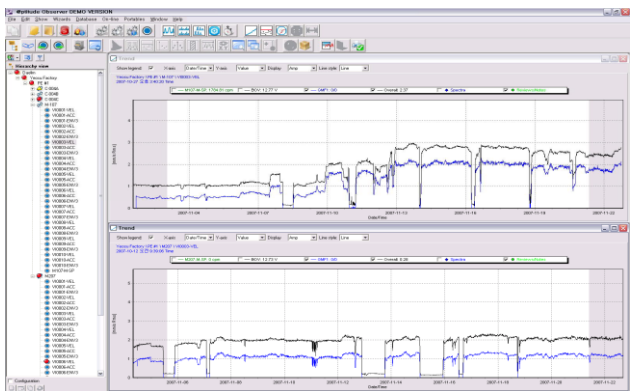




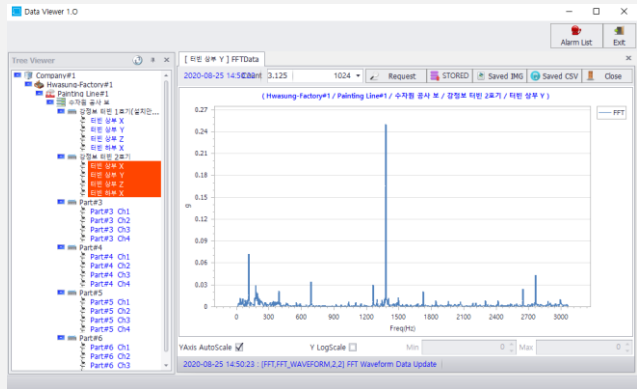
## Signal – Vibration Trend



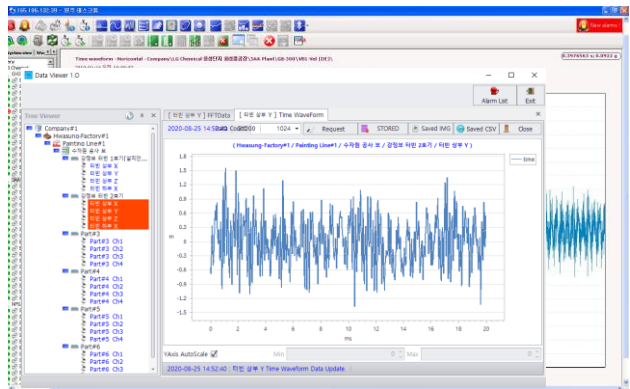
## Signal – Vibration Trend



## Signal – FFT



## Signal – Time Waveform



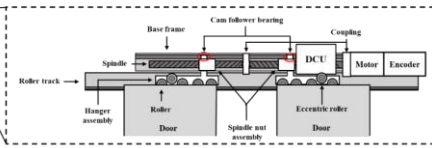
## Web dashboard



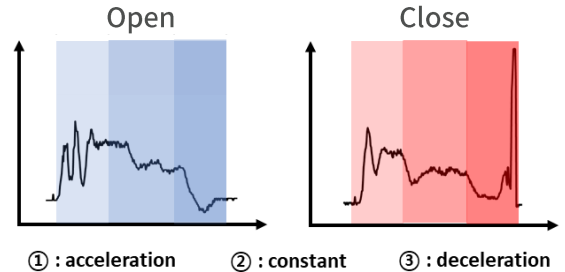
➤ Automatic generation of vibration analysis for facility defects through drawing input

# AI fault diagnosis algorithm

Machine defect monitoring system for Smart Factory



## Motor current signal



## Major component Failure status



Cam follower Bearing



Roller

## Resampling & TSA

- **Discrete signal separation**
  - Pass filters (high, low, band)
  - Resampling, TSA
  - AR filter, (S)ANC
- **Signal enhancement**
  - MED, Spectral kurtosis
- **Signal decomposition**
  - Wavelet transform
  - (E)EMD
  - VMD



## Time-based feature signal

- **Statistic based features**
  - Time domain
  - Others
- **Knowledge based features**
  - Amplitude at defect frequency
  - Other domain knowledge
- **Dimension reduction**
  - Principal component analysis (PCA)
  - Independent component analysis (ICA)

## FDR & Scatter Matrix

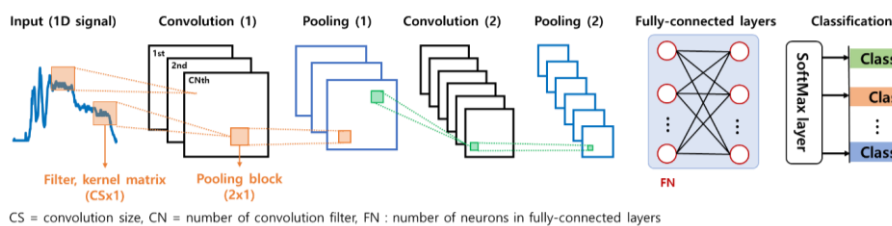
- **Feature evaluation**
  - Fisher discriminant ratio (FDR)
  - Scatter matrix
  - Divergence
- **Feature subset selection**
  - Sequential forward search (SFS)
  - Sequential backward search (SBS)
  - Exhaustive search



## K-nearest neighbor (kNN)

- **Machine learning algorithm**
  - Artificial neural network (ANN)
  - K-nearest neighbor (KNN)
  - Support vector machine (SVM)
  - Random forest (RF)
- **Validation algorithm**
  - Hold out cross validation
  - K fold cross validation
  - Leave one out cross validation

## Machine Learning : Automatic defect classification using CNN



## Confusion Matrix

		Confusion Matrix							
Output Class		1	2	3	4	5	6	7	8
		100%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100%
1	1	23	0	0	0	0	0	0	100%
1	2	0	17	0	0	0	0	0	100%
1	3	0	0	23	0	0	0	0	100%
1	4	0	0	0	19	0	0	0	100%
1	5	0	0	0	0	15	0	0	100%
1	6	0	0	0	0	0	47	0	100%
1	7	0	0	0	0	0	0	24	100%
1	8	0	0	0	0	0	0	0	100%
2	1	0	0	0	0	0	0	0	100%
2	2	0	0	0	0	0	0	0	100%
2	3	0	0	0	0	0	0	0	100%
2	4	0	0	0	0	0	0	0	100%
2	5	0	0	0	0	0	0	0	100%
2	6	0	0	0	0	0	0	0	100%
2	7	0	0	0	0	0	0	0	100%
2	8	0	0	0	0	0	0	0	100%
3	1	0	0	0	0	0	0	0	100%
3	2	0	0	0	0	0	0	0	100%
3	3	0	0	0	0	0	0	0	100%
3	4	0	0	0	0	0	0	0	100%
3	5	0	0	0	0	0	0	0	100%
3	6	0	0	0	0	0	0	0	100%
3	7	0	0	0	0	0	0	0	100%
3	8	0	0	0	0	0	0	0	100%
4	1	0	0	0	0	0	0	0	100%
4	2	0	0	0	0	0	0	0	100%
4	3	0	0	0	0	0	0	0	100%
4	4	0	0	0	0	0	0	0	100%
4	5	0	0	0	0	0	0	0	100%
4	6	0	0	0	0	0	0	0	100%
4	7	0	0	0	0	0	0	0	100%
4	8	0	0	0	0	0	0	0	100%
5	1	0	0	0	0	0	0	0	100%
5	2	0	0	0	0	0	0	0	100%
5	3	0	0	0	0	0	0	0	100%
5	4	0	0	0	0	0	0	0	100%
5	5	0	0	0	0	0	0	0	100%
5	6	0	0	0	0	0	0	0	100%
5	7	0	0	0	0	0	0	0	100%
5	8	0	0	0	0	0	0	0	100%
6	1	0	0	0	0	0	0	0	100%
6	2	0	0	0	0	0	0	0	100%
6	3	0	0	0	0	0	0	0	100%
6	4	0	0	0	0	0	0	0	100%
6	5	0	0	0	0	0	0	0	100%
6	6	0	0	0	0	0	0	0	100%
6	7	0	0	0	0	0	0	0	100%
6	8	0	0	0	0	0	0	0	100%
7	1	0	0	0	0	0	0	0	100%
7	2	0	0	0	0	0	0	0	100%
7	3	0	0	0	0	0	0	0	100%
7	4	0	0	0	0	0	0	0	100%
7	5	0	0	0	0	0	0	0	100%
7	6	0	0	0	0	0	0	0	100%
7	7	0	0	0	0	0	0	0	100%
7	8	0	0	0	0	0	0	0	100%
8	1	0	0	0	0	0	0	0	100%
8	2	0	0	0	0	0	0	0	100%
8	3	0	0	0	0	0	0	0	100%
8	4	0	0	0	0	0	0	0	100%
8	5	0	0	0	0	0	0	0	100%
8	6	0	0	0	0	0	0	0	100%
8	7	0	0	0	0	0	0	0	100%
8	8	0	0	0	0	0	0	0	100%
Target Class		1	2	3	4	5	6	7	8

# Why Mobilio?

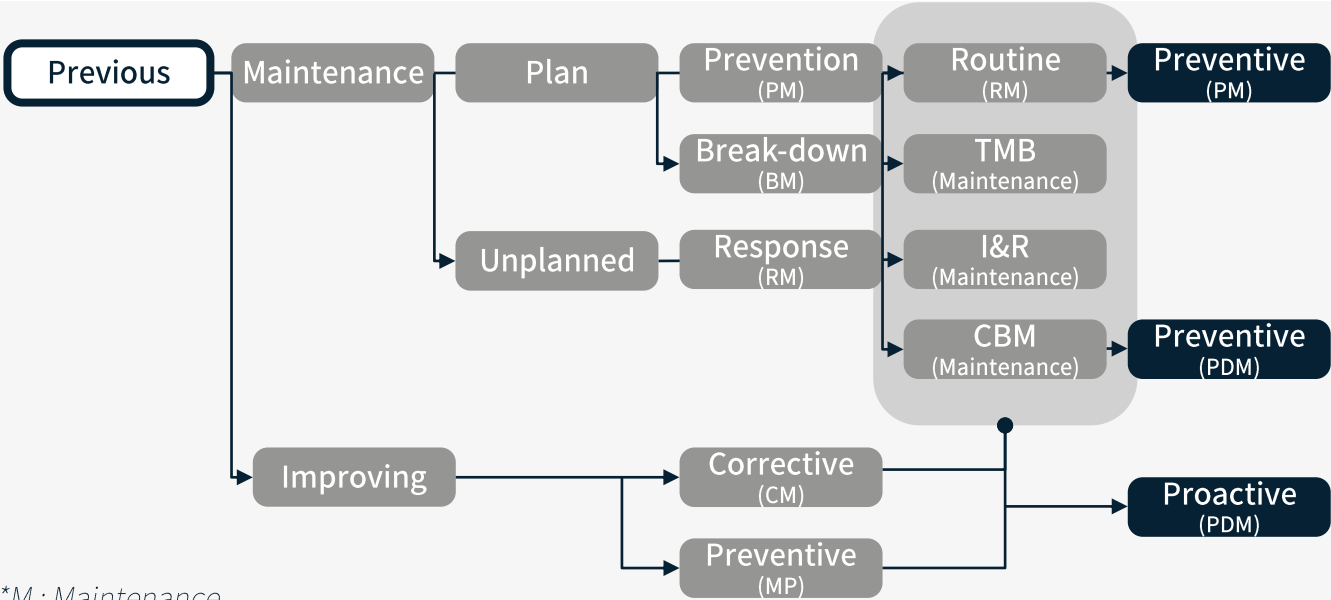
Our products can endure unpredictable conditions that negatively impact operation. Advanced condition monitoring techniques and experience are critical to reliably managing your assets.

A Mobilio integrated condition monitoring system enables operators to understand the M\_Trender. Dependable knowledge of the M-Trender enables continued operation and revenue generation when a defect is not significant, while mitigating the risk of run to failure, an unplanned outage or catastrophic event.

## Product value

Understand how your unit operates from day 1

Reliable continuous simultaneous condition monitoring for hardware, software, and sensor. and it enables you to understand issues weeks, or even months in advance.



\*M: Maintenance

# Why Mobilio?

## ●● Network-friendly and scalable

The powerful processor contains all configurations and algorithms with inputs from accelerometers on the hardware, software, and sensor.

This solution is equally applicable for one or much equipment. An entire equipment can be monitored locally from the office. Centralized management enables increased productivity,

## ●● Powerful diagnostics and intuitive displays

Comprehensive alarm, diagnostic, analytic and reporting capabilities provide a clear picture of equipment's safety and facilitate maintenance with actionable recommendations.

High resolution wave form data is collected for the general, bearing and gear measurements. Familiar navigation and filtering make it easy to access the information.

## ●● Customer value

Communication between the vibration system and the control system is Ethernet enabled.

Reduces non-critical vibration system diagnostic indications trips, noise-driven and transient vibration shutdowns/trips and nuisance vibration alarms/trips during start-up period.

Virtually every aspect of the M-trender's operation is software configurable, resulting in the most flexible system.

## — A web-link

- **Home page** : <https://www.mobilio.io>
- **Youtube** : <https://www.youtube.com/channel/UCYzxXy97uXt11y7UK5s0Hxw>
- **Facebook** : <https://www.facebook.com/mobilio.io>
- **Blog** : <https://blog.naver.com/mobilio2/>
- **Linkedin** : <https://www.linkedin.com/company/mobilio1>





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