



Through ultrasound data analysis
AI solution for machine failure diagnosis

Watch Bat v1.0

Information



Mobius 무한한
Victory 승리
Lab 연구

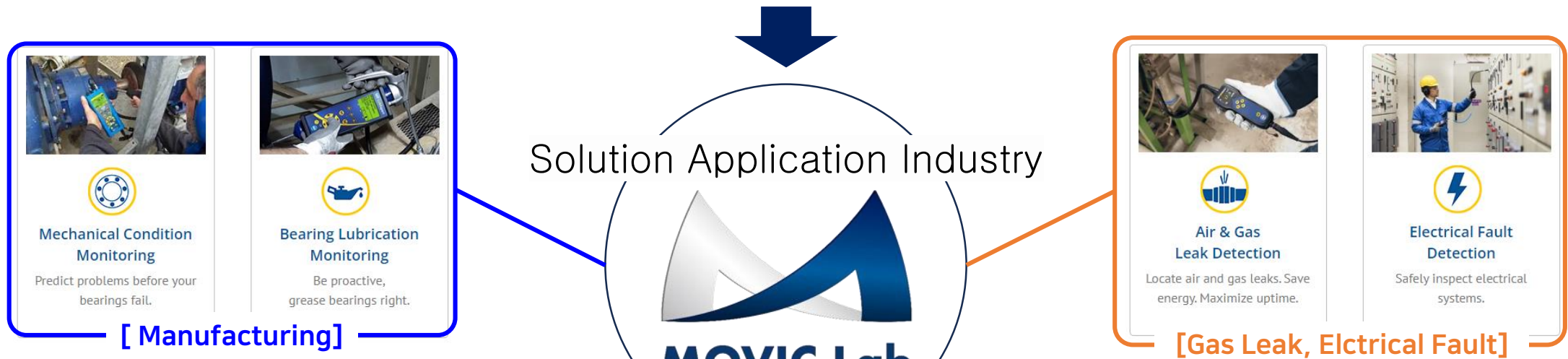
| | | | |
|-----------------|--|------------------------------|--------------|
| Member | 17 | Date of establishment | 2017. 10. 24 |
| Location | - HQ : Incheon, Incheon Startup Park - Research center : Seoul, Yangje AI HUB | | |

MOVIC Lab Co., Ltd. provides smart factory solutions based on AI technology.

In particular, the main service is AI solutions for detecting equipment abnormalities.

It has the advantage of providing time series data analysis and high-performance deep learning algorithms for various industrial signals (current, voltage, vibration, temperature, humidity, etc.).

AI-based Machine failure prediction



- | | | | |
|-------------------|--------------|-----------------|--------------|
| Secondary Battery | Display | Semiconductor | etc |
| Notching | TMP Pump | TMP Pump | Actuator |
| Mixer | Vacuum Robot | Milling machine | Cutter Shaft |
| Ultrasound W/D | | | |

New Business planned on 2025

Applicable to facilities and parts where **friction** and **conflict** occur

Development Background

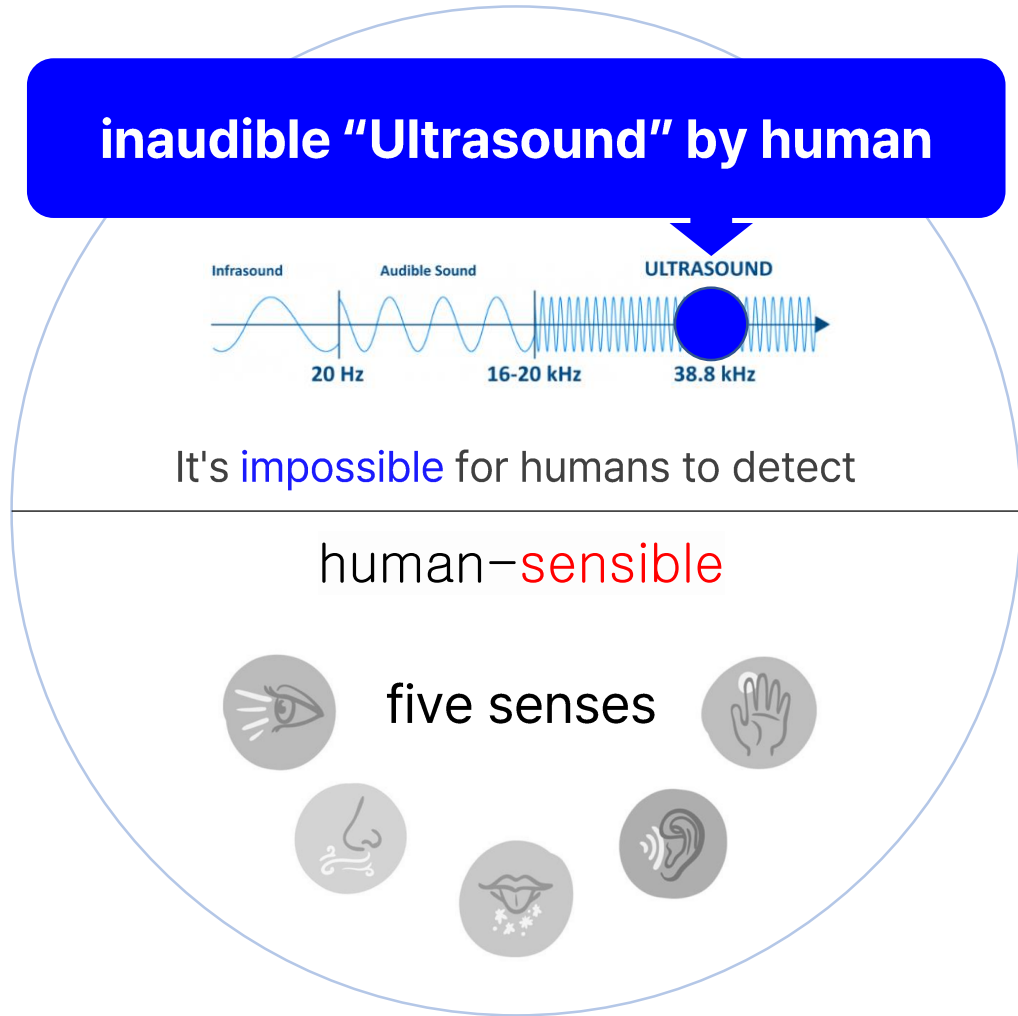
WHY Ultrasound?

- Inspiration from nature

'Dangers' perceived by animal hearing



Dog : ~ 44,000Hz
 CAT : ~ 79,000Hz
 Human : 20 ~ 20,000Hz



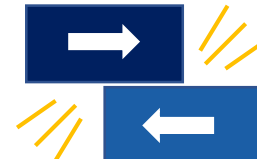
Development Background

Ultrasound Diagnosis


- Ultrasound occurs due to **physical and electrical defects** and is used to diagnose problems in various fields

< Principle of ultrasound generation >

1. Physics




<Friction>




<impact>


2. Electrical Fault





<Corona, Arc fault>


< Apply to a wide range of fields >






Mechanical Condition Monitoring
Predict problems before your bearings fail.





Bearing Lubrication Monitoring
Be proactive, grease bearings right.






Air & Gas Leak Detection
Locate air and gas leaks. Save energy. Maximize uptime.






Electrical Fault Detection
Safely inspect electrical systems.


[Manufacturing]






Steam Trap Testing
Keep your steam clean, safe and energy-efficient.





Hydraulic systems monitoring
Detect leakage, by-passing and blockages.

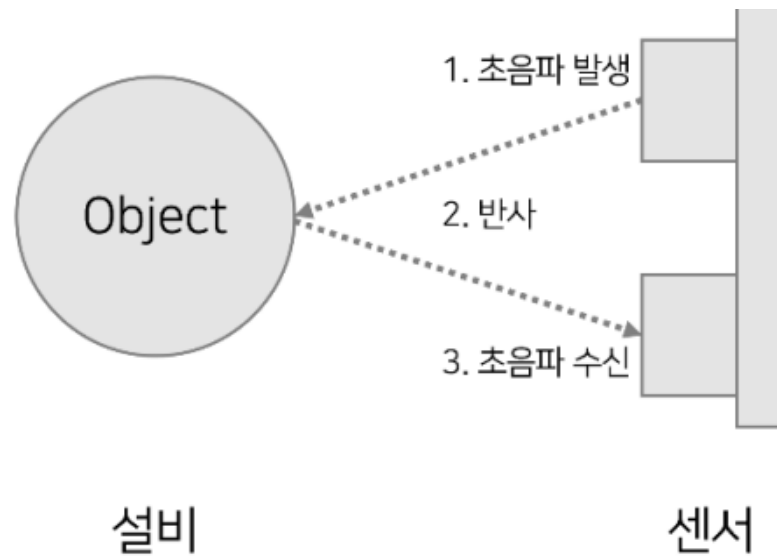



Valve condition monitoring
Detect leaks and blockages, maintain flow and prevent waste.




Underground tanks tightness testing
Collect and amplify the ultrasounds generated by leaks.

Ultrasound non-destructive UT test (transmit + receive)



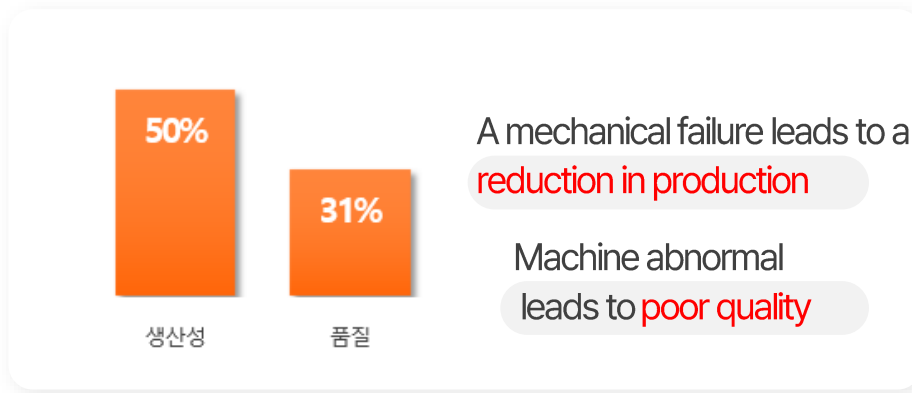
Moviclab Ultrasound Diagnosis (~~transmit~~ + receive)



Necessity

Importance of manufacturing facility management

- Since the **damage caused** by mechanical failure is great, it is very important to take **good care of the machine** to prevent it
- It is essential to proactively detect signs of equipment failure in real time and '**predictive maintenance**' **before failure occurs**



출처: AT Kearney, Plant Service 자료(설비보전관리시스템, 한중덕 2017)

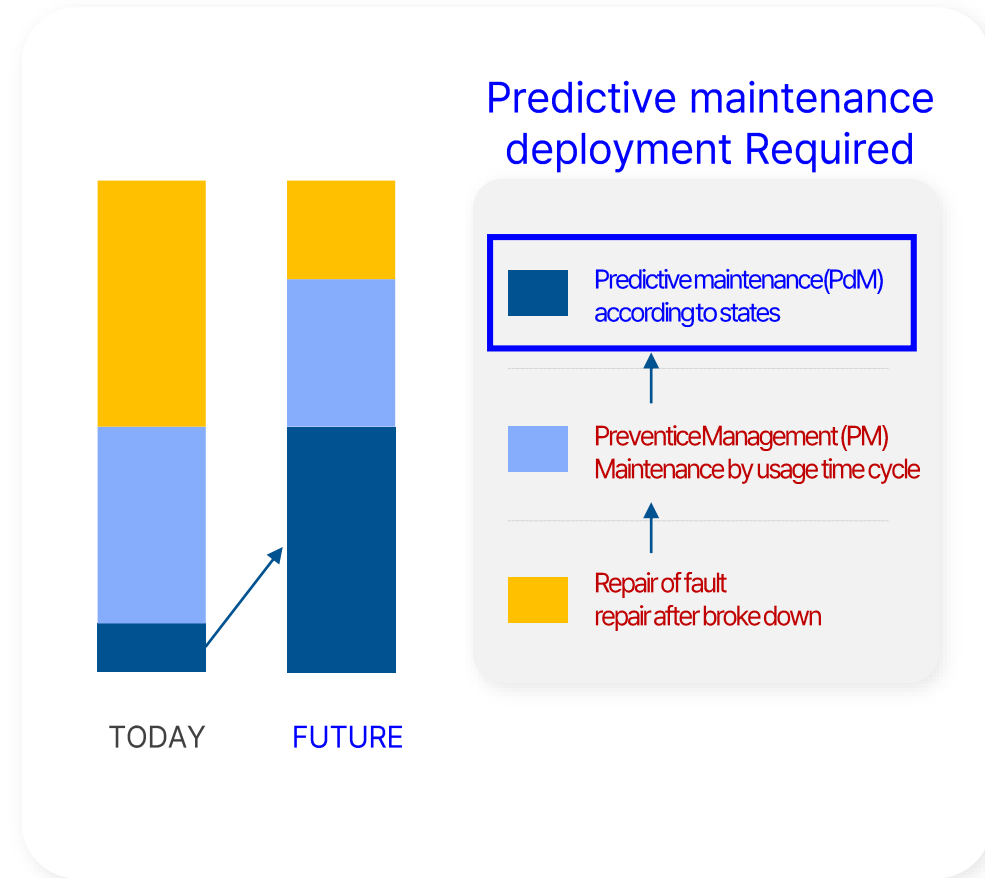
Failure of manufacturing machines results in **astronomical economic losses**

철강업회 "포스코현대제철 고로 멈추면 8000억 손실"

5년간 원전 고장정지 54건, 전력판매 손실액 2조2480억원

707억 피해본 여수산단 정전, 전기설비 고장맞

| 구분 | 수년 | 발생건수 | 정지시간 | 손실액 | 총계 |
|------|-------|---------|-----------|-----------|-------|
| 13 | 373 | 51,459 | 733,758 | 785,237 | 785 |
| 14 | 430 | 100,947 | 163,324 | 264,271 | 264 |
| 15 | — | 121,274 | 96,623 | 217,897 | 213 |
| 16 | 1,050 | 179,567 | 393,599 | 577,166 | 578 |
| 17총계 | 44 | 86,113 | 305,432 | 401,565 | 401 |
| 소계 | 1,915 | 540,360 | 1,696,736 | 2,246,096 | 2,246 |



Limitations of past approaches

- It is difficult for humans to **accurately diagnose** the condition of the machine, and existing sensors are difficult to identify **precursor symptoms**

Depends on skilled person



- Lack of **consistency**
- It takes a **long time** to develop **know-how**
- Difficulty in **assetization of knowledge**

Vibration sensor



- **Instal restriction by contact sensor**
- Intermittent signals make it difficult to analyze

Electric current sensor



- Abnormal signal is generated **just before the failure**, limiting the precautionary preparation
- **Overcompetitive** risk due to **low-cost** sensors

Solution

New solution 'Ultrasound acoustic data'

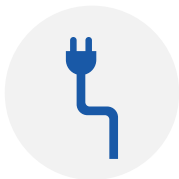
- ① High-precision data analysis enables **predictive maintenance** and detection of precursor symptoms
- ② Contactless Installation wide range of application



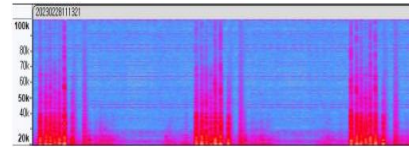
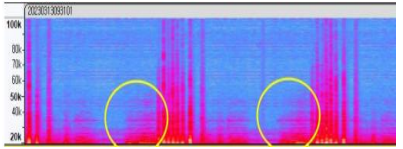
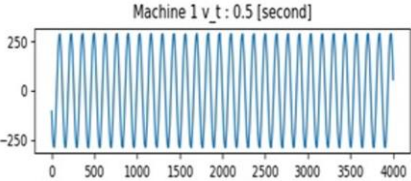
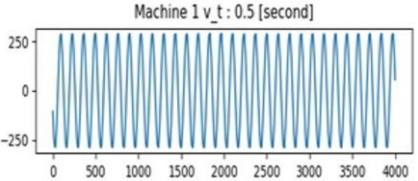
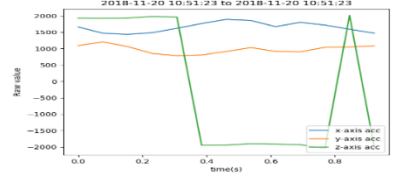
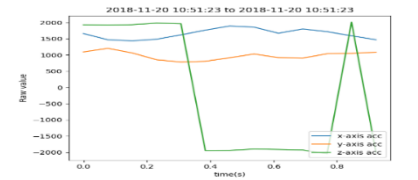
Ultra sound



Vibration

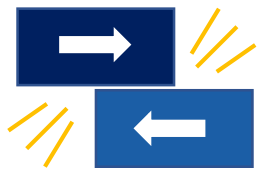


Current

| | Normal State | Abnormal State | ① Micro change Detection | ② Contactless Installation |
|--|---|--|---|--|
| |  |  | Possible-> Predominator symptom detection (100K/sec, precise analysis) | Possible-> High versatility (Rotating M/C, Non-Rotating M/C) |
| |  |  | Impossible (1 analysis / 1 minute) | <Impossible> - Curved surface - High Temperature surface |
| |  |  | Impossible (1 analysis / 10 minute) | < Impossible > - Very short difference between anomaly detection and actual failure |

1. Identify precursor symptoms

- Detects minute changes (preventive symptoms) before vibration occurs and performs predictive maintenance
- Reduce defective products and increase productivity

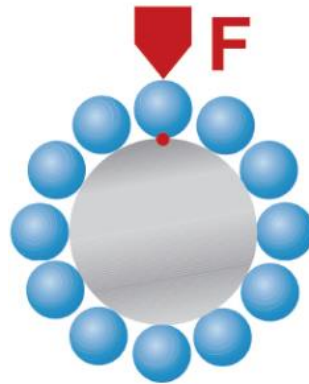


<Friction>



<Impact>

Metal Friction & impact
-> 'Generate Ultrasound'



베어링 마찰 누적



<Early abnormality >

- Bearing friction
- Generate Ultrasound

Ultrasound : O
Vibration : X

<Problem Occurred>

- > Crack of bearing
- > Lubricating oil failure -> M/C failure

Ultrasound : O
Vibration : O

2. 'Non-Contact' Install

- Equipment that is difficult to install sensors such as vibration or current (equipment excluded from diagnosis)



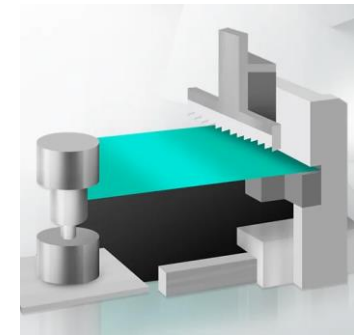
<Curved Surface>



<Hi temperature Surface>
(over 70 degrees)



<Micro Machine>

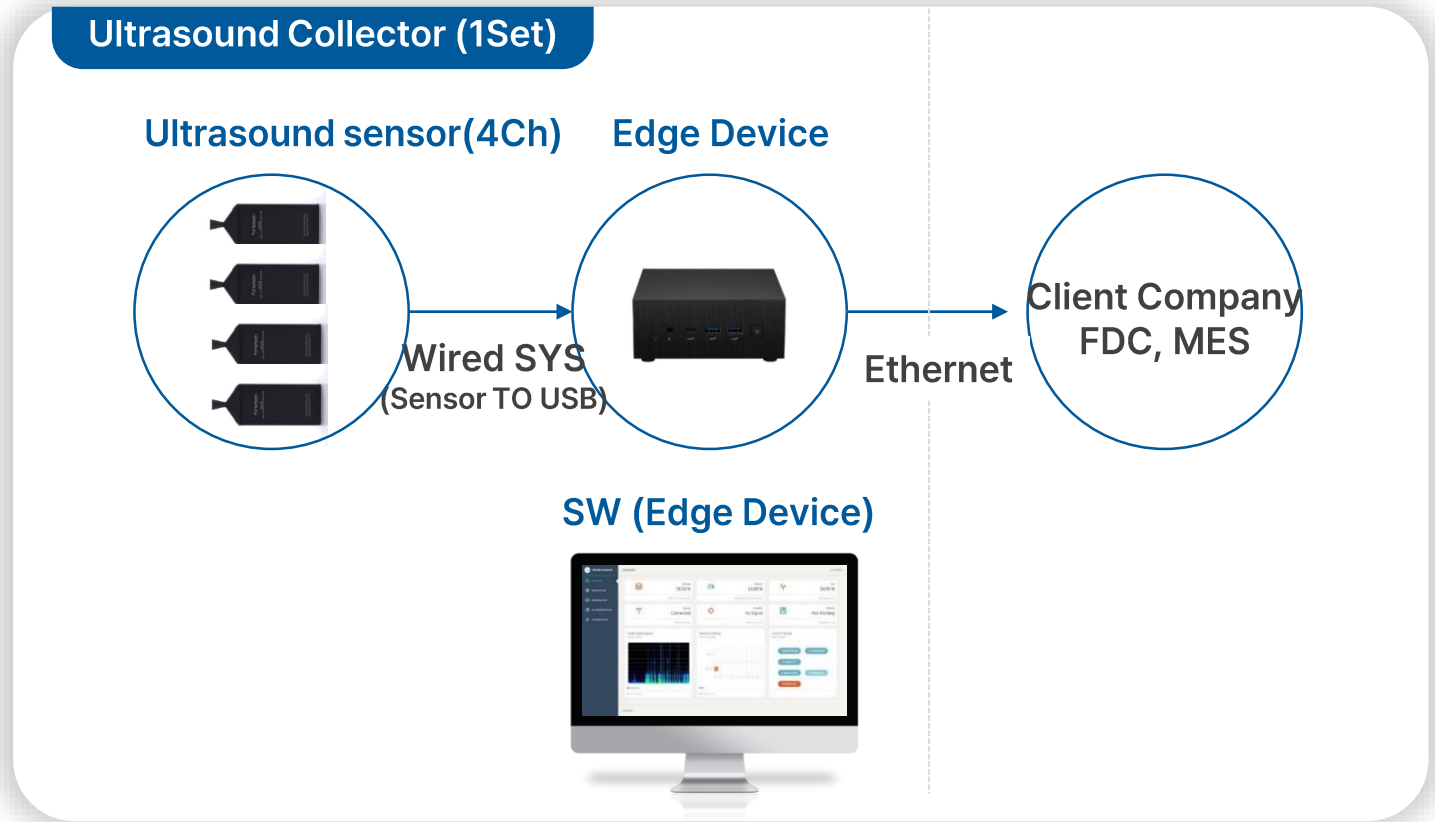


<Linear motion Machine>

1. Product description

▶ WatchBAT

Easy and convenient machine diagnosis is possible with the 'AI fault diagnosis service of manufacturing machines' based on **ultrasound acoustic data** from the machine



Sensing of Ultrasound

- **Contactless** installation on target point

Data Collection and Conversion

- Data collection and transfer (TCP/IP, Modbus)
- Include **AI engine & MLOps**

Data Analysis and Diagnostics

- Analysis RAW data
- Transfer result of analysis

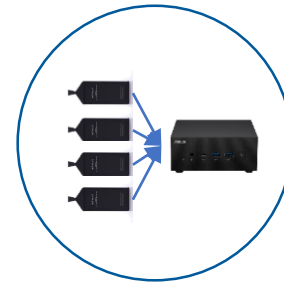
1. Product description

▶ WatchBAT

Easy and convenient machine diagnosis is possible with the 'AI fault diagnosis service of manufacturing machines' based on **ultrasound acoustic data** from the machine

AI Diagnosis Service

Ultrasound Collector(1Set)



x N

Gateway



Server



Integrated Monitoring System



Sensing of Ultrasound

- **Contactless** installation on target point

Data Collection and Conversion

- Data collection and transfer (TCP/IP, Modbus)
- Include **AI engine & MLOps**

Data Analysis and Diagnostics

- **Integrated management** by machine/sensor
- **Abnormal Detection AI Engine**
- **Classification AI Engine**
- **Remaining useful life Prediction AI E/G**

Service

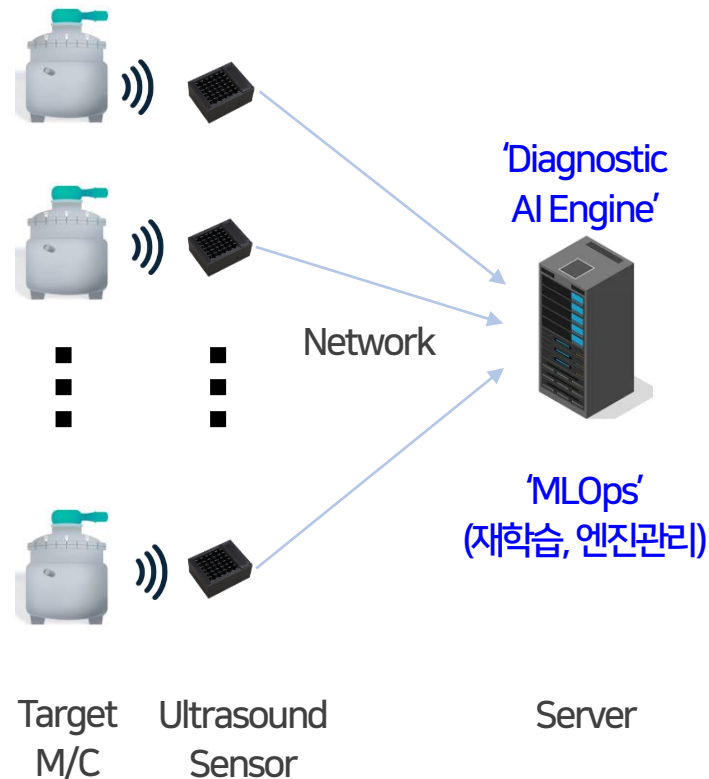
Mechanical fault diagnosis service

- Provide the factory's machine manager with a service to diagnose (AI engine) the condition of the machine, such as normal, abnormal operation, and timing of failure

< Major Client >

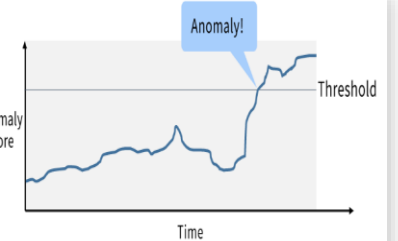
| | |
|---------------------|------|
| Secondary - Battery | |
| Display | |
| Semi-conductor | |
| Car & ETC | |

<SYSTEM Configuration>



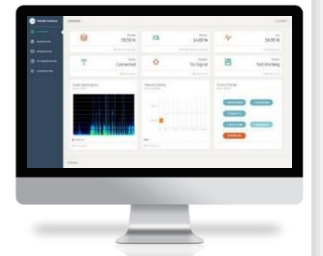
< AI Service >

Learn "Normal-state" data to score the degree of abnormality in facility condition



① Alarm when the threshold is exceeded

The data that was accumulated up until then by learning patterns



② Classification Service

③ Remaining Useful life Prediction Service

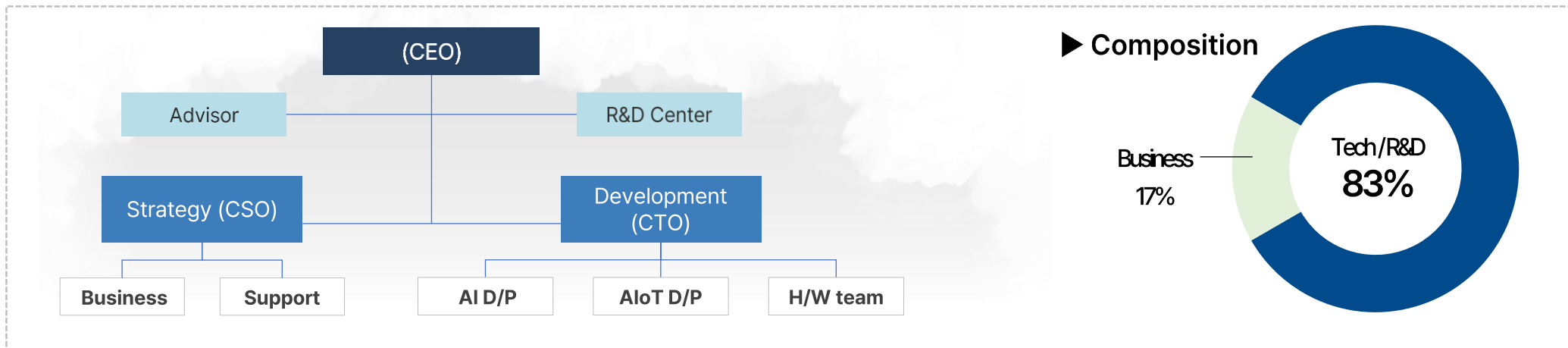
'Bearing Crack'
'Remaining 30%'

Organization

▶ A technology-oriented company that solves problems in manufacturing sites that have not been solved in the existing way with ultrasound waves and AI technology

It consists of digital signal processing experts (AI doctorate level), and the IT and R&D sectors account for more than 80% of the total workforce..

(Ultrasound Dignosis Expert(CEO), Advanced Development team(CTO), Business Strategy and Financial Planning(CSO))



CEO 이원근

신호처리 전문가/사업총괄

- 주식회사 모빅랩 대표 이사
- 인하대학교 전자공학과 박사(수료)
- 현 중소기업기술정보진흥원 스마트공장 표준기술자문위원



CTO 김동희

개발총괄

- 숭실대학교 컴퓨터공학과 박사(수료)
- (전) 판도라티비 개발 본부장
- (전) 시디네트워크 연구소장
- (전) 클루넷 CTO(상장사)



CSO 한기덕

사업전략, 재무기획

- 인하대학교 경영학과
- 농심그룹 재무&경영지원 담당
- 사업기획, 운영총괄
- 투자 전략 및 재무관리

Patent and certification

► Patent and certification

Own ability to develop the latest AI technologies and systems

Based on this, we are preparing technical barriers as well as protecting technical skills by securing intellectual property

Patents

| 순번 및 구분 | 일자 | 출원국 | 출원 및 등록번호 | 지식재산권(특허)명 |
|---------|------------|-----|-------------------|---|
| 1 등록 | 2022.03.21 | 한국 | 10-2019-0169199 | 초음파 대역의 음향 신호를 수신하는 다채널 감지 센서를 구비한 설비 고장 예측 시스템 |
| 2 등록 | 2022.01.11 | 한국 | 10-2020-0110164 | 센서모듈 장치 |
| 3 등록 | 2021.11.05 | 한국 | 10-2019-0172349 | 사출 성형 설비의 고장 예측 시스템 및 방법 |
| 4 등록 | 2022.06.17 | 독일 | PCT/KR2019/017803 | 초음파 대역의 음향 신호를 이용한 설비 고장 예측 시스템 및 그 방법 |
| 5 출원 | 2021.12.17 | 한국 | 10-2021 0181480 | 수신호 영상처리 방법 및 이에 기반한 장치 제어 방법 |
| 6 출원 | 2021.12.07 | US | 17543,141 | 이상상태 탐지 모델을 생성하는 방법 |
| 7 출원 | 2021.10.20 | 한국 | PCT/KR2021/014759 | 센서의 임계치를 설정하는 방법 |
| 8 출원 | 2021.10.20 | 한국 | PCT/KR2021/014762 | 센서 시스템 |
| 9 출원 | 2021.05.06 | 한국 | PCT/KR2021/005656 | 이상상태 탐지 모델을 생성하는 방법 |
| 10 출원 | 2020.10.30 | 한국 | 10-2020-0143910 | 센서 시스템 |
| 11 출원 | 2020.10.28 | 한국 | 10-2020-0141605 | 이상상태 탐지 모델을 생성하는 방법 |
| 12 출원 | 2020.10.20 | 한국 | 10-2020-0137804 | 센서의 임계치를 설정하는 방법 |
| 13 출원 | 2020.08.26 | US | PCT-2019-0042US | 초음파 대역의 음향 신호를 이용한 설비 고장 예측 시스템 및 그 방법 |
| 14 출원 | 2019.12.16 | 한국 | PCT/KR2019/017803 | 초음파 대역의 음향 신호를 이용한 설비 고장 예측 시스템 및 그 방법 |
| 15 출원 | 2019.11.18 | 한국 | 10-2019-0147610 | 초음파 대역의 음향 신호를 이용한 설비 고장 예측 시스템 및 그 방법 |
| 16 출원 | 2019.10.28 | 한국 | 10-2019-0134701 | 설비 고장 예측 시스템 및 그 방법 |

Thesis

| 순번 | 등재 | 진행상황 | 기관 | 논문명 |
|----|------|-------|------|---|
| 1 | 2016 | 등재 완료 | ASK | Embedded Anomaly Detection System With Ultrasound Sensors |
| 2 | 2016 | 등재 완료 | ASK | Frequency Characteristics Analysis of Ultrasound Sensing Embedded System |
| 3 | 2016 | 등재 완료 | ASK | A-Real-Time Acoustic Signal Streaming System using RTSP |
| 4 | 2019 | 등재 완료 | MDPI | Appliance Classification by Power Signal Analysis Based on Multi-Feature Combination Multi-Layer LSTM |
| 5 | 2019 | 등재 완료 | FCV | Squeeze and Excitation Deformable Mask-RCNN for Instance-Level Semantic Segmentation |

Copyrights of SW

| 순번 | 등록번호 | 저작권명 |
|----|---------------|---|
| 1 | C-2020-014909 | 지능형 화재 감지 알고리즘 |
| 2 | C-2020-003756 | 화재 전조 증상 데이터 분석을 통한 지능형 화재 감지 알고리즘 |
| 3 | C-2021-023376 | 초음파 음향신호 분석을 통한 설비 이상 작동 감지 알고리즘 |
| 4 | C-2021-054348 | 초음파 음향신호 분석을 활용한 가열로 배기팬 작동 이상 감지 AI 솔루션 |
| 5 | C-2021-054349 | 초음파 음향신호 분석을 활용한 가열로 배기팬 작동 이상 감지 AI 알고리즘 |
| 6 | C-2022-048469 | 초정밀 리니어 액추에이터의 이상을 사전에 감지하는 AI 솔루션 |
| 7 | C-2022-048470 | 배터리 불량 검출을 위한 영상처리 AI 솔루션 |
| 8 | C-2022-048471 | 운동화 생산 공정(오븐)에서 운동화 내부의 온도를 검출하는 지능형 AI 솔루션 |

Certification of Research Center

| 순번 | 등록번호 |
|----|---------------|
| 1 | 제 2020110608호 |



Thank you

Frequently asked

1. How do you deal with ambient “noise” generated in a factory environment?

: Noise areas below 20 kHz that are heavily affected by external influences are excluded from the analysis.

2. What do you do with the external noise that comes from sound data over 20kHz?

: Consider the optimal location for collecting ultrasound data at the target point.

3. What if there is still collected external noise?

: Since the noise was generated during the process, it is recognized as an environmental variable and AI learned along with the target data.