

센서 데이터 기반 지능시스템 개발



슈퍼컴퓨팅응용센터

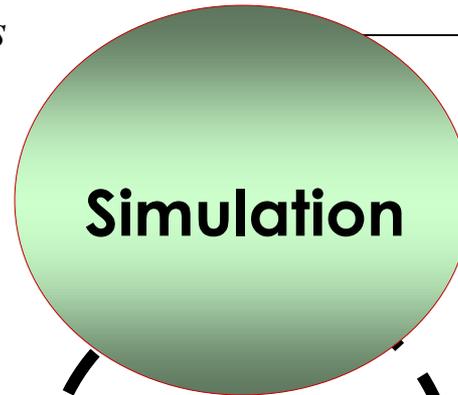
정민중 공학박사

jeong@kisti.re.kr

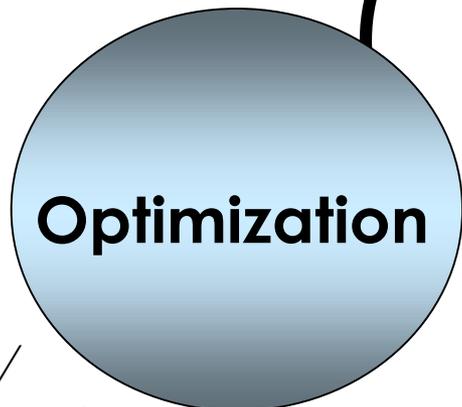
Change of Research Background

Physics-based Simulation

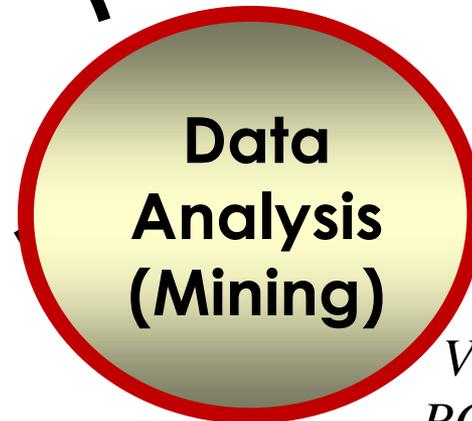
*Finite Element Analysis
Computational Fluid
Dynamics
Agent Based Modeling
Moving Particles*



**Computer
Environment**



*Gradient Decent /
Evolutionary Algorithm
Artificial Neural Network
Particle Swam Optimization*



*Clustering
Visualization
PCA / Isomap
Support Vector Machine
Self Organizing Map
Deep Neural Network*

IOT 센서 기반 시스템 안전성평가 연구

INTERNATIONAL JOURNAL OF PRECISION ENGINEERING AND MANUFACTURING, Vol. 11, No. 1, pp. 23-29
10.1007/s12541-010-0030-6

FEBRUARY 2010 / 23

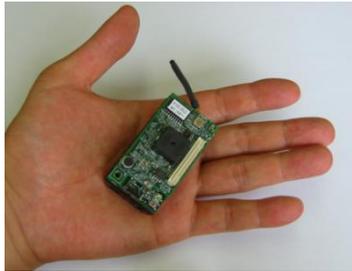
A Feasibility Study of Damage Tracking through the Diffusive Communication of Wireless Sensors

Minjoong Jeong¹, Jong-Goo Bae² and Bong-Hwan Koh^{2*}

¹ Supercomputing Application Team, Korea Institute of Science and Technology Information, Daejeon, South Korea, 305-306
² Dept. of Computer Science, Dongguk Univ.-Seoul, 26, Pil-dong, Jung-gu, Seoul, South Korea, 100-715
³ Dept. of Mechanical, Robotics and Energy Engineering, Dongguk Univ.-Seoul, 26, Pil-dong, Jung-gu, Seoul, South Korea, 100-715
* Corresponding Author. E-mail: bhkoh@dongguk.edu, TEL: +82-2-2260-6091, FAX: +82-2-2263-9379

KEYWORDS: Wireless Sensor Network, Damage Detection, Diffusive Communication

Wired Sensors vs Wireless Sensors



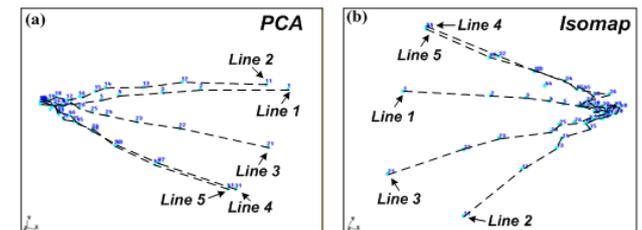
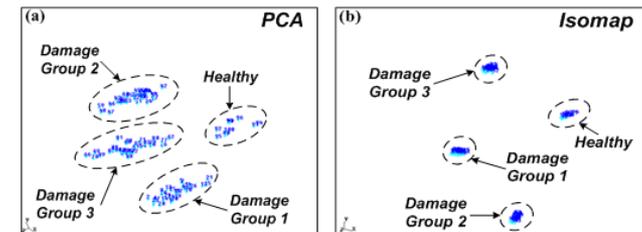
STRUCTURAL CONTROL AND HEALTH MONITORING
Struct. Control Health Monit. 2014; **21**:590-602
Published online 16 July 2013 in Wiley Online Library (wileyonlinelibrary.com). DOI: 10.1002/stc.1587

Isomap-based damage classification of cantilevered beam using modal frequency changes

Minjoong Jeong¹, Jong-Hun Choi² and Bong-Hwan Koh^{2,*}

¹ Supercomputing Center, Korea Institute of Science and Technology Information, 335 Gwahakro, Yuseong-gu, Daejeon 305-306, Korea

² Department of Mechanical, Robotics, and Energy Engineering, Dongguk University-Seoul, 26-3 Pil-dong, Jung-gu, Seoul 100-715, Korea

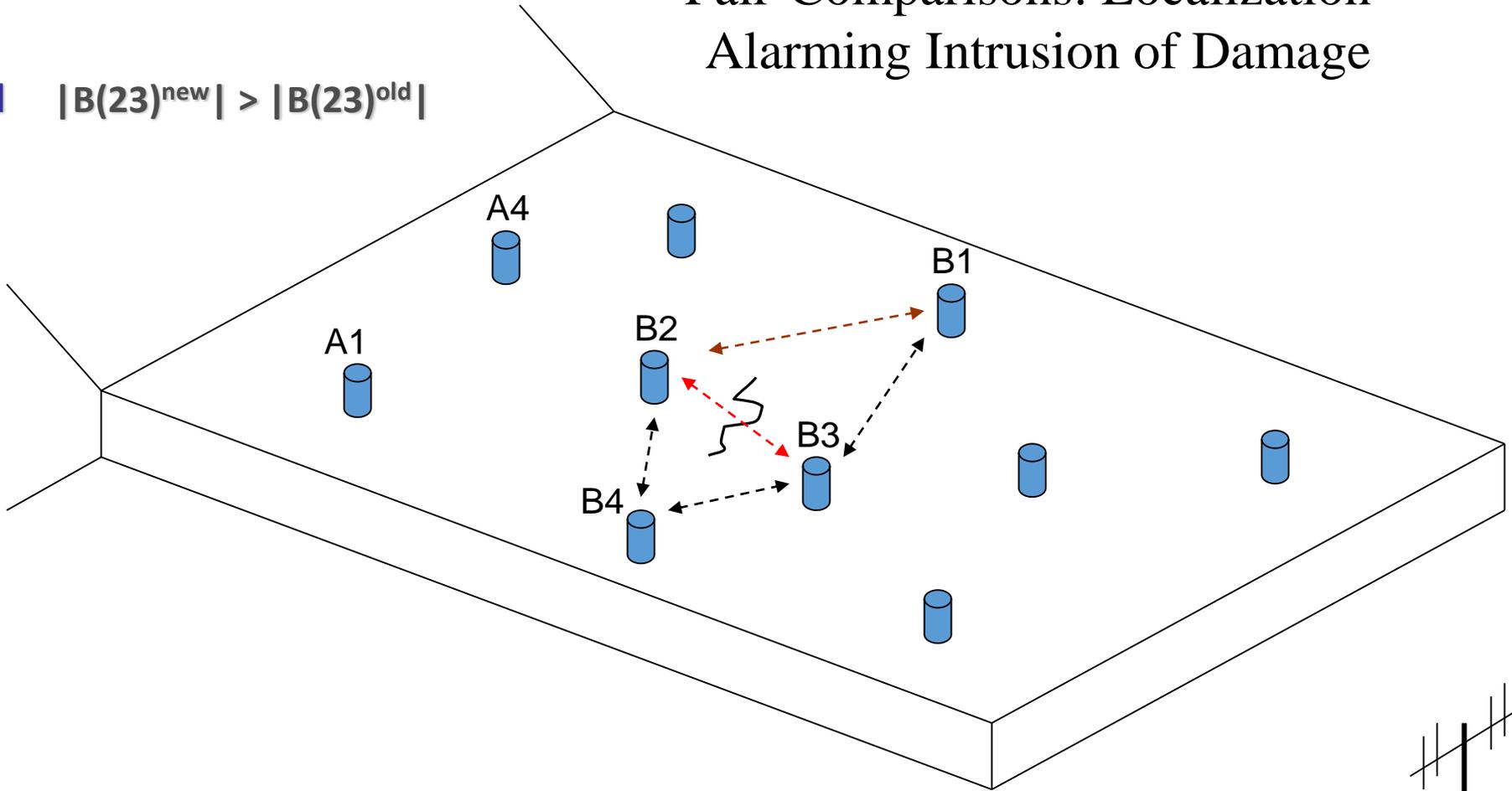


Surveillance and Intrusion Detection

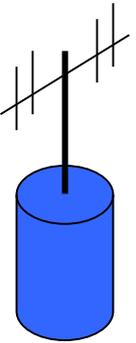
Pair-Comparisons: Localization

Alarming Intrusion of Damage

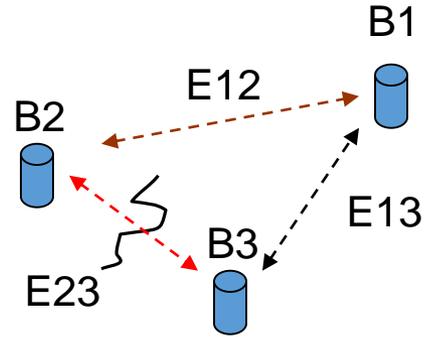
□ $|B(23)^{new}| > |B(23)^{old}|$



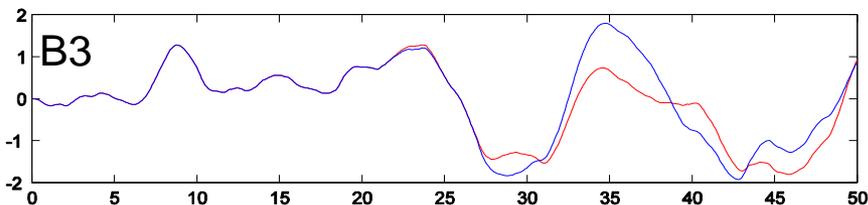
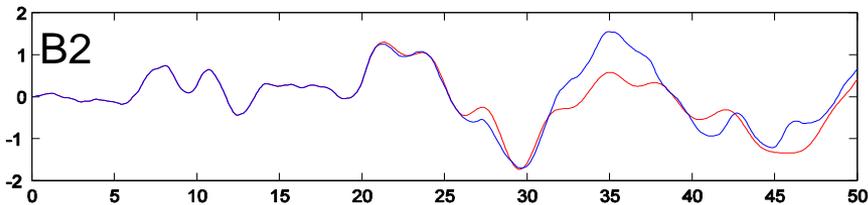
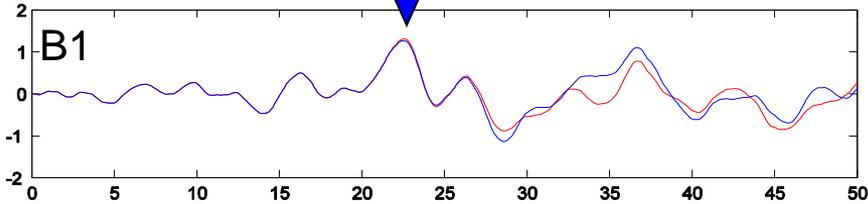
- Minimize the amount of communication between sensors
- Damage-triggering reconfigurable sensor network
- Find the shortest routing and relay current readings to the base station



Decoupled Damage Function

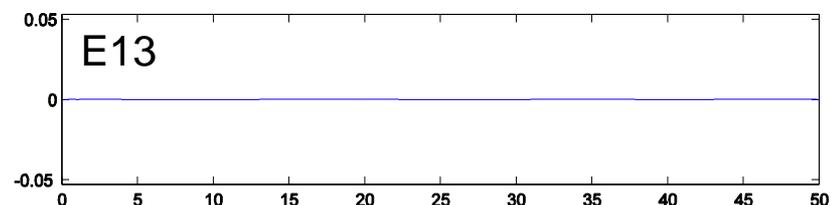
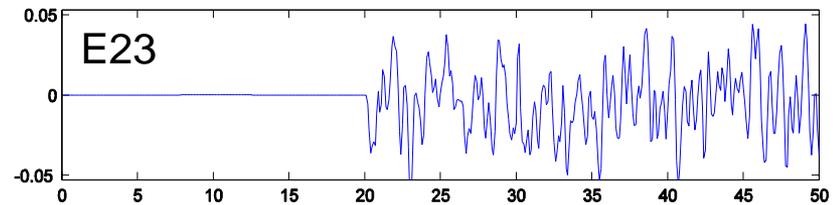
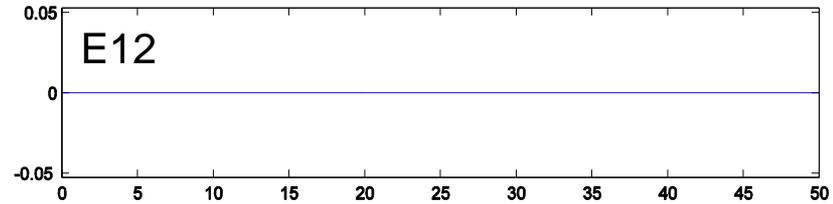


Initiation of Damage



Time (sec)

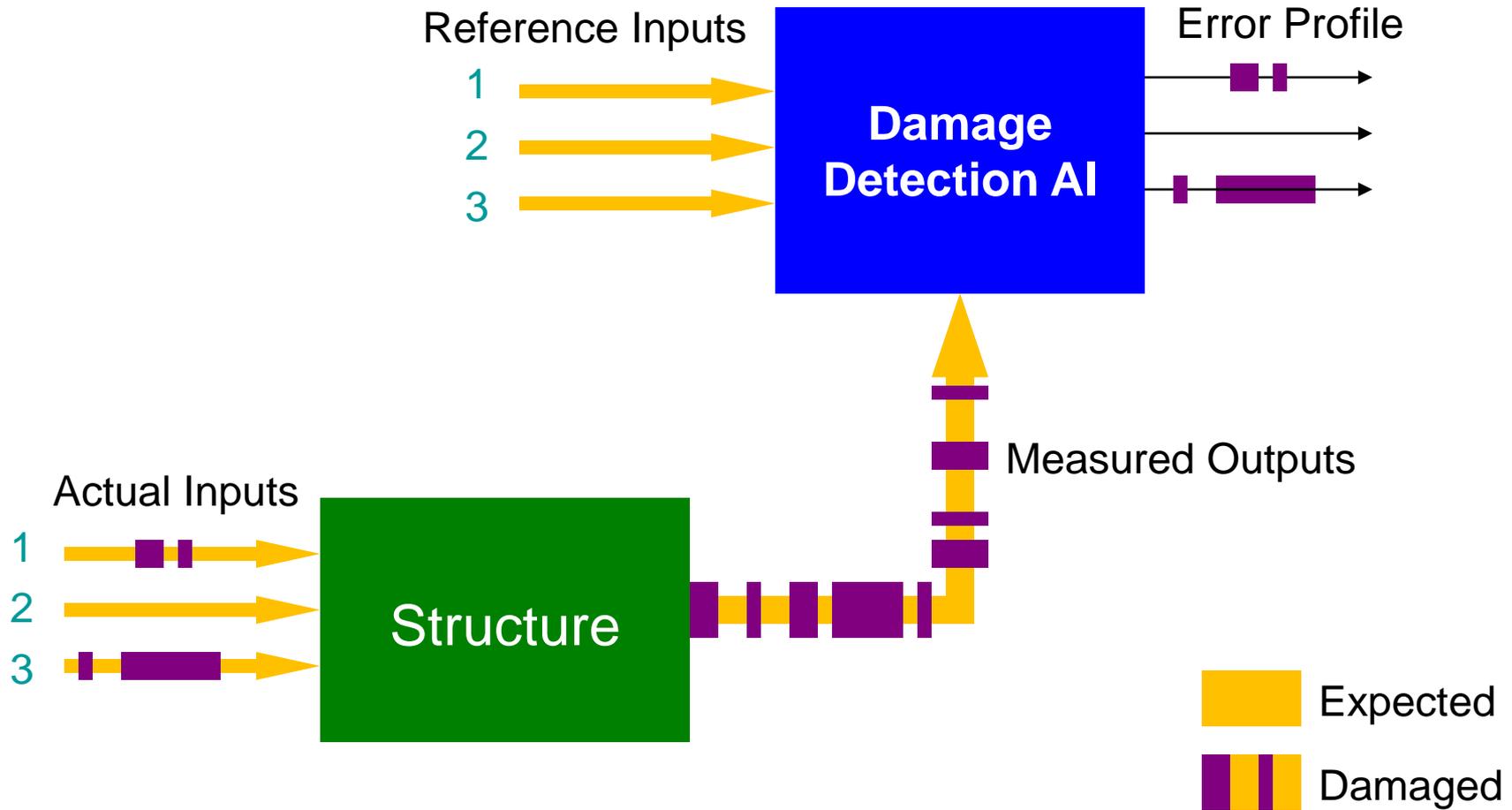
Error Function



Time (sec)



Damage Detection AI



센서 데이터 기계학습 현장 응용 사례



Article

Nondestructive Inspection of Reinforced Concrete Utility Poles with ISOMAP and Random Forest

Saeed Ullah ¹, Minjoong Jeong ^{2,*} and Woosang Lee ³

¹ University of Science and Technology (UST), 217 Gajeong-ro, Yuseong-gu, Daejeon 34113, Korea; saeedonline12@gmail.com

² Korea Institute of Science and Technology Information (KISTI), 245 Daehak-ro, Yuseong-gu, Daejeon 34141, Korea

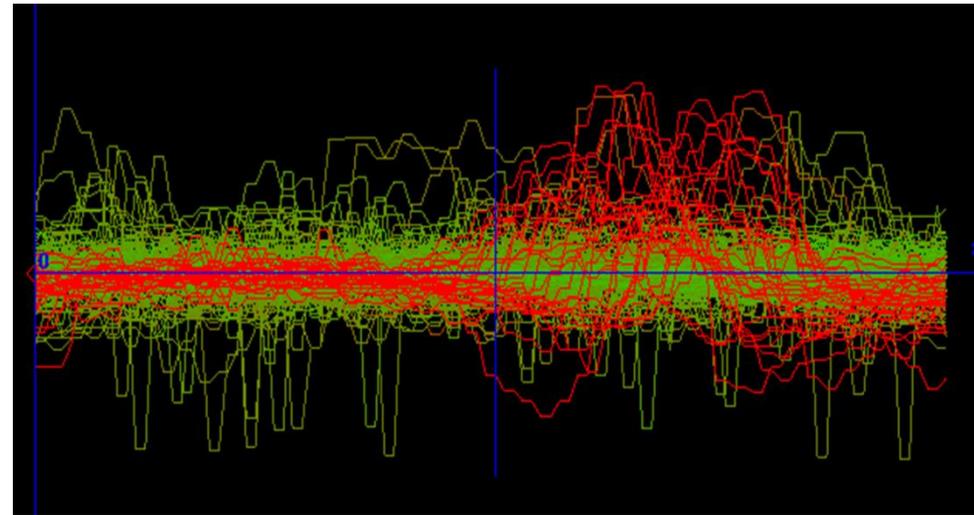
³ Smart C&S Co., Ltd., Yongsan-dong, Yuseong-gu, Daejeon 34141, Korea; smartcs@chol.com

* Correspondence: jeong@kisti.re.kr; Tel.: +82-42-869-0632

Received: 1 August 2018; Accepted: 10 October 2018; Published: 15 October 2018



Mobile version of the recognition system for structural health monitoring



Panel

기계학습 진행중

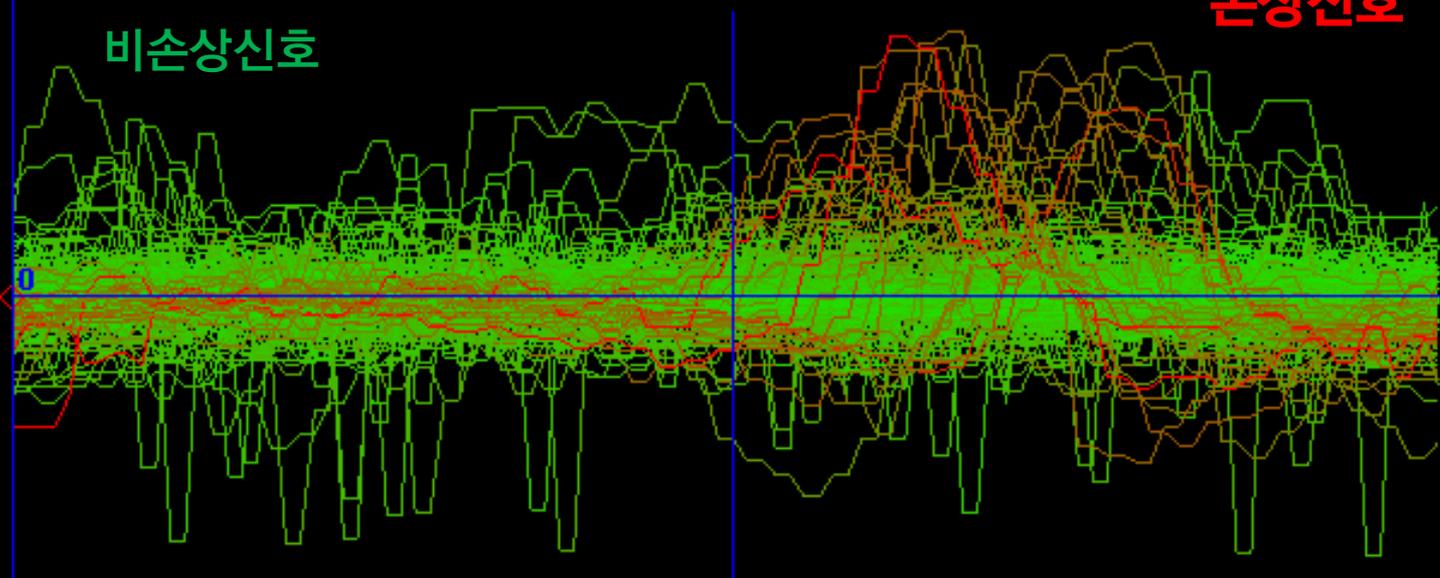
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비손상신호

손상신호

0

x=100.



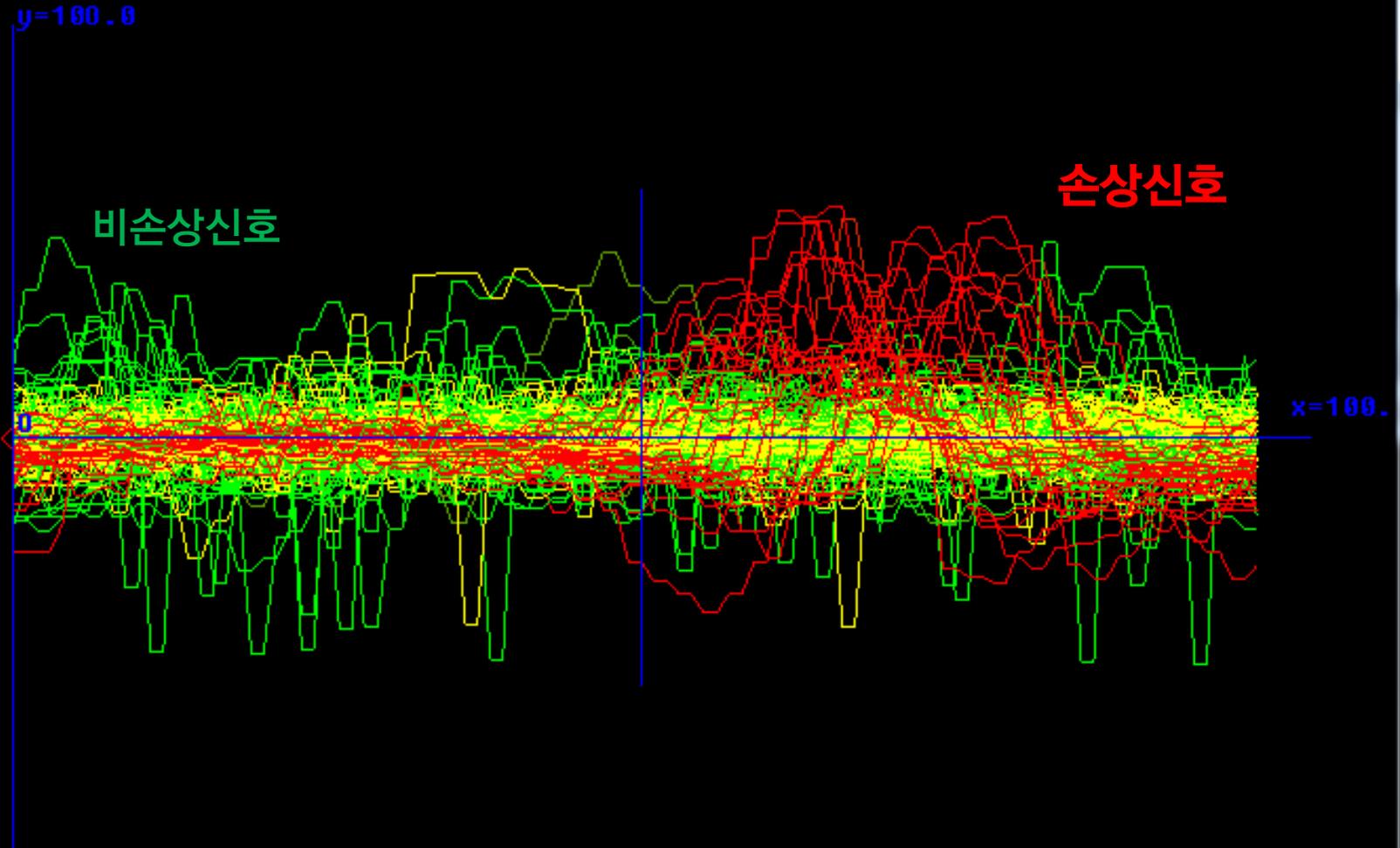
Panel

기계학습 완료

y=100.0

비손상신호

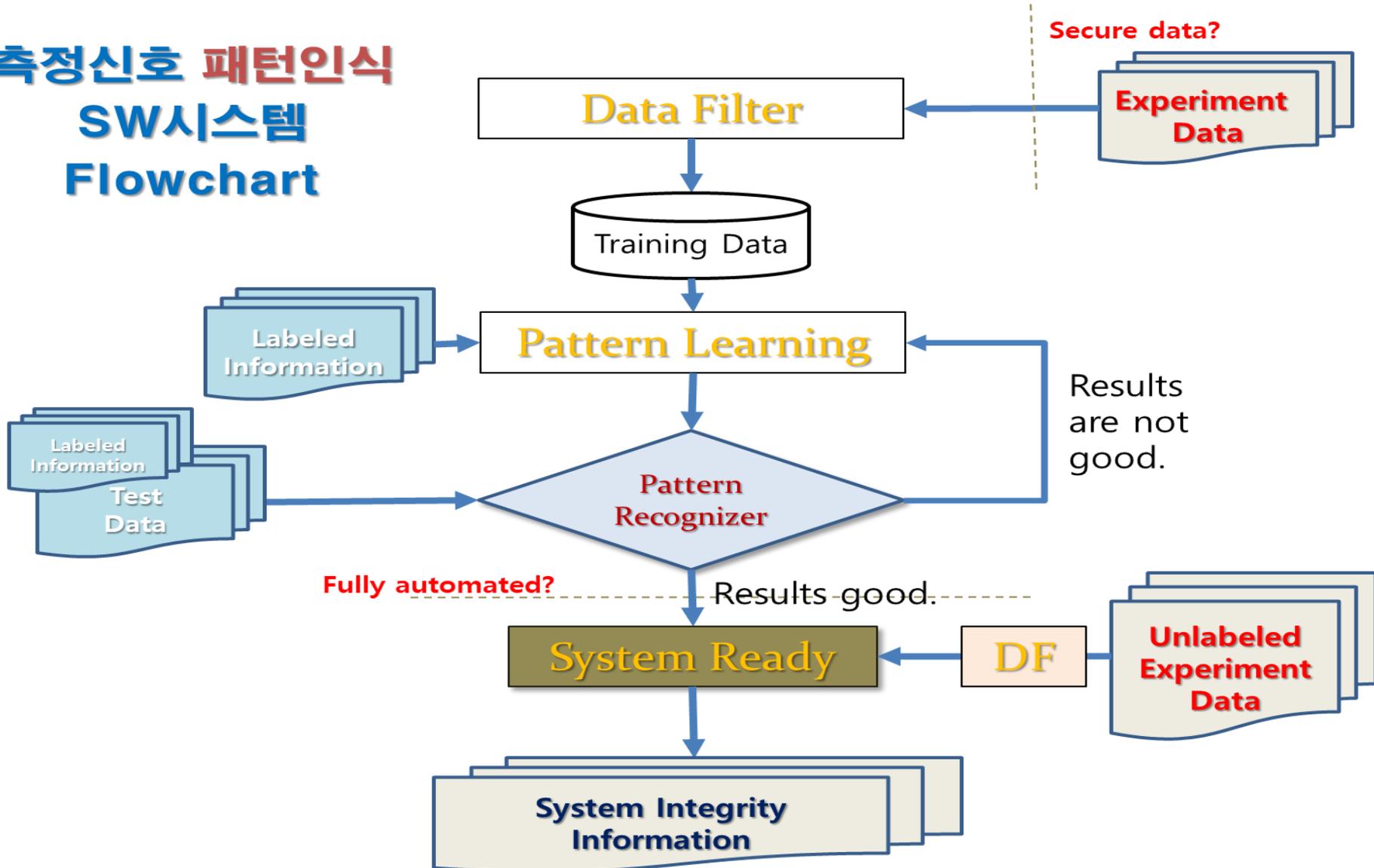
손상신호



x=100.0

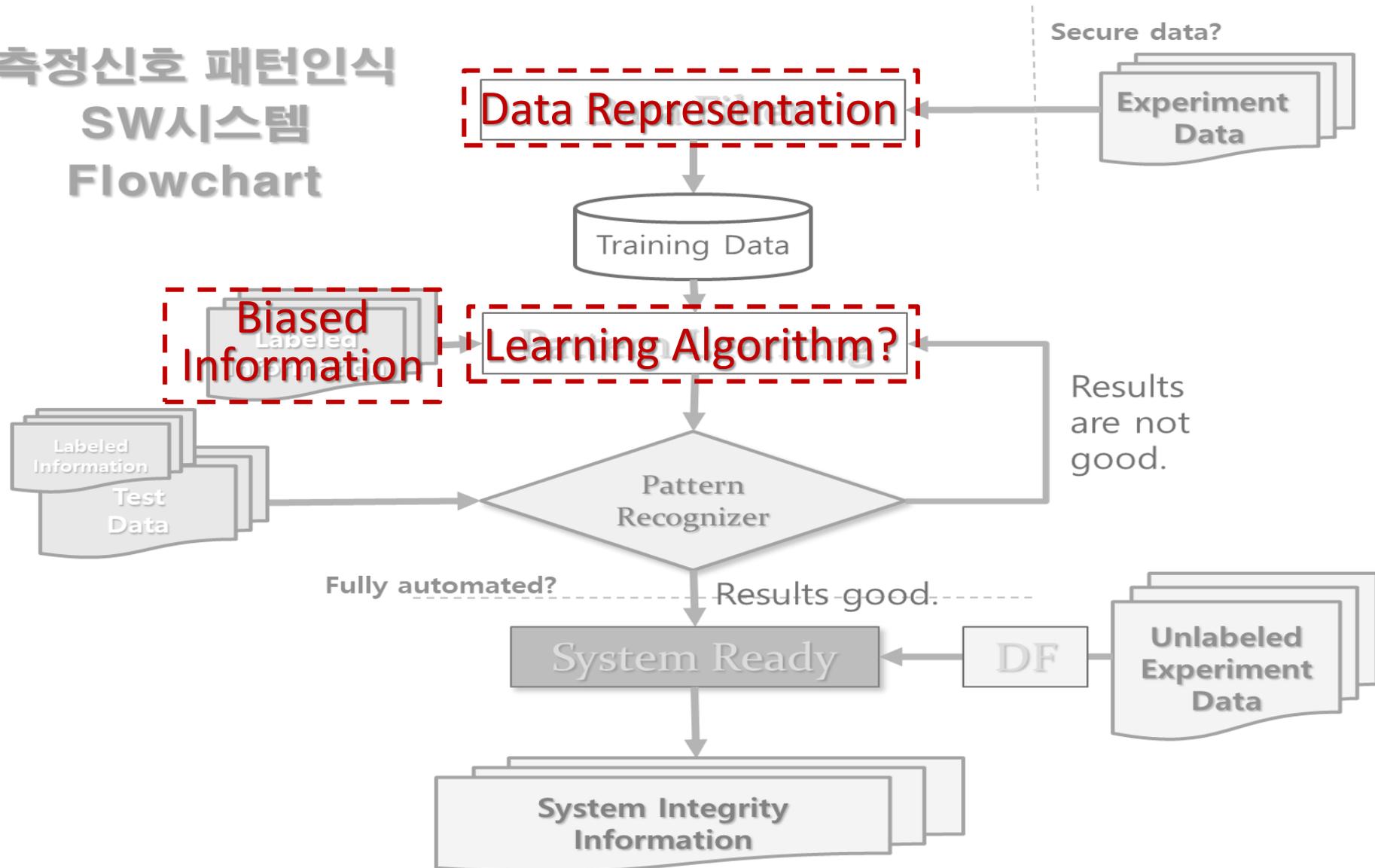
기계학습 패턴인식 시스템 구현

측정신호 패턴인식 SW시스템 Flowchart



기계학습 패턴인식 시스템 구현 - 실제적용

측정신호 패턴인식 SW시스템 Flowchart

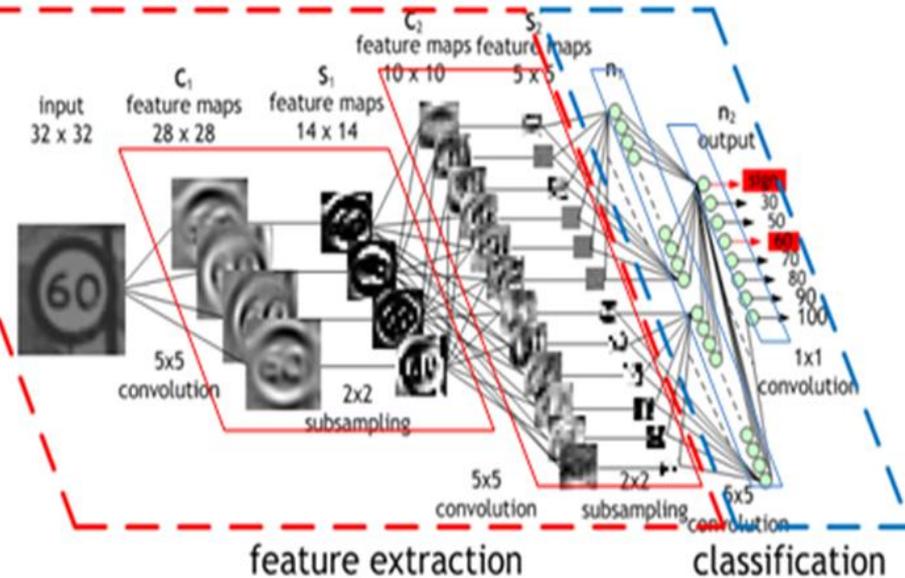
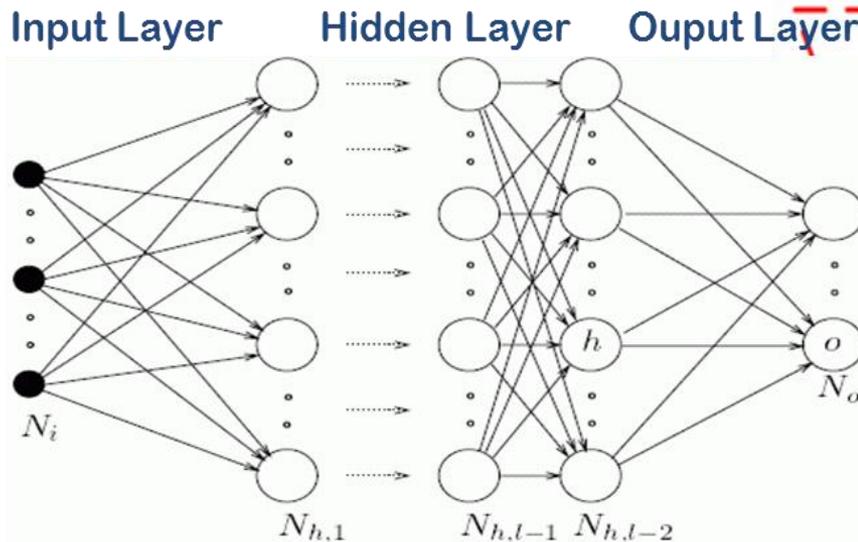


Machine Learning Algorithm – DNN 사례

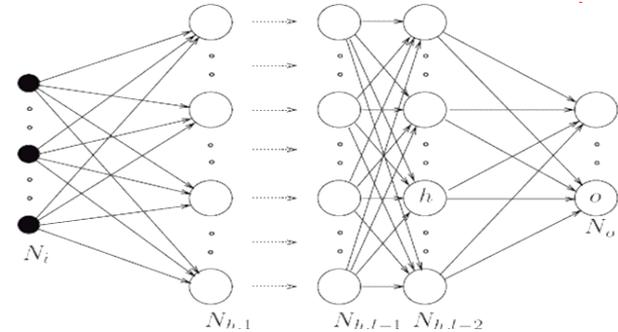
손상인식 심층신경망(Deep Neural Networks)

$$C_F(X, U, V) = \sum_{k=1}^K \sum_{i=1}^n u_{ik}^m \text{dis}(\vec{x}_i - \vec{v}_k)$$

n is the number of data patterns, K is the number of clusters.

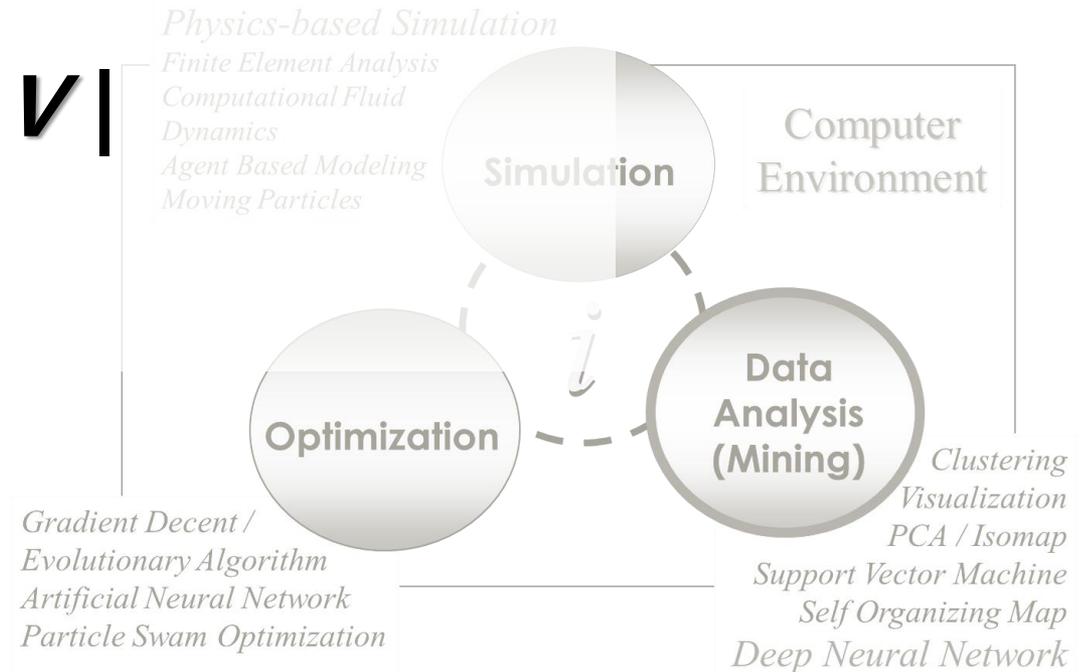


$$C_F(X, U, V) = \sum_{k=1}^K \sum_{i=1}^n u_{ik}^m \text{dis}(\vec{x}_i - \vec{v}_k)$$



Find U^*

Minimize $|V_{\text{real}} - V|$



영상 센서 기반 시스템 안전성 평가 - 지능화

도시철도 터널영상
사용자관리 | 지역관리 | 환경설정 | 내정보관리 | 운행기록조회

태릉입구역 기준 164.00m/759.00m (33997.00m)

리포트 관리

호선: 전체 | 검색 기준: 운행 시간 | 리포트 기록시간 | 검색 기간: 2010-10-01 ~ 2010-11-03 | 검색

번호	호선	운행 날짜	카메라 위치	제목	설명	아이디	이름	기록 날짜	현재역
58	8	2010-10-12	전차선 좌측	부식 및 오물 확인		admin	관리자	2010-10-15 13:47:18,037	모란
59	8	2010-10-12	선로 좌측	침목훼손	침목훼손 확인	admin	관리자	2010-10-14 13:44:04,447	복정
60	8	2010-10-12	선로 우측	침목훼손	침목훼손 확인	admin	관리자	2010-10-14 13:43:30,037	복정
61	8	2010-10-12	선로 좌측	침목훼손	침목훼손	admin	관리자	2010-10-14 13:42:03,943	복정
62	8	2010-10-12	선로 좌측	침목훼손	침목훼손 확인 필요	admin	관리자	2010-10-14 13:18:10,970	수진
63	8	2010-10-12	선로 우측	스파이크롤림	스파이크 롤림 확인	admin	관리자	2010-10-14 13:10:42,167	모란
64	8	2010-10-12	구조물 우측	이상 유무 확인	이상 유무 확인	admin	관리자	2010-10-12 16:55:55,170	암사

01:00

도시철도 터널영상

도원역 기준 225.67m/983.00m (18733.33m) 2010-10-12 09:56:30

인지 지능화 필요

아이디 : admin
이름 : 관리자
호선 : 8
카메라 정보 : 선로 우측
영상위치 : 모란->수진 225.67m
운행 날짜 : 2010-10-12
리포트 기록 날짜 및 시간 : 2010-10-14 13:10:42.167

도시철도 터널영상

계림역 기준 943.73m/1235.00m (4368.73m) 2010-11-05 07:10:37

도시철도 터널영상

계림역 기준 943.73m/1235.00m (4368.73m) 2010-11-05 07:10:37

아이디 : admin
이름 : 관리자
호선 : 8
카메라 정보 : 선로 우측
영상위치 : 모란->수진 225.67m
운행 날짜 : 2010-10-12
리포트 기록 날짜 및 시간 : 2010-10-14 13:10:42.167

도시철도 터널영상

계림역 기준 943.73m/1235.00m (4368.73m) 2010-11-05 07:10:37

도시철도 터널영상

계림역 기준 943.73m/1235.00m (4368.73m) 2010-11-05 07:10:37

아이디 : admin
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카메라 정보 : 선로 우측
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리포트 기록 날짜 및 시간 : 2010-10-14 13:10:42.167

도시철도 터널영상

계림역 기준 943.73m/1235.00m (4368.73m) 2010-11-05 07:10:37

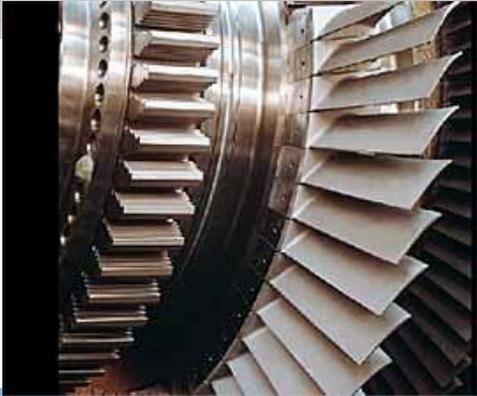
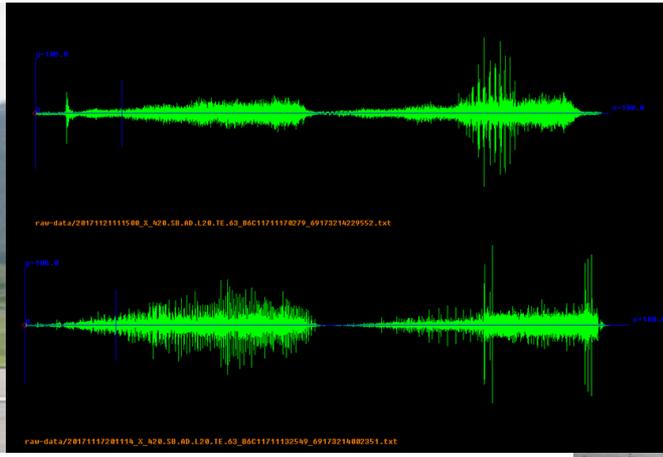
계림역 기준 943.73m/1235.00m (4368.73m) 57.60km/h

카메라 속도: 1

방향: (좌) (우) (상) (하)

검색: [검색] [리포트] [운행기록]

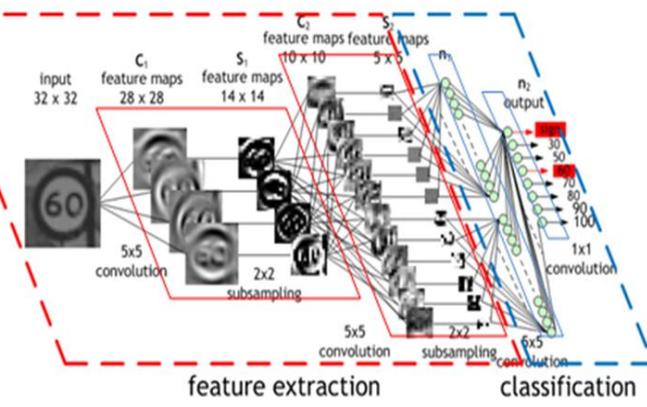
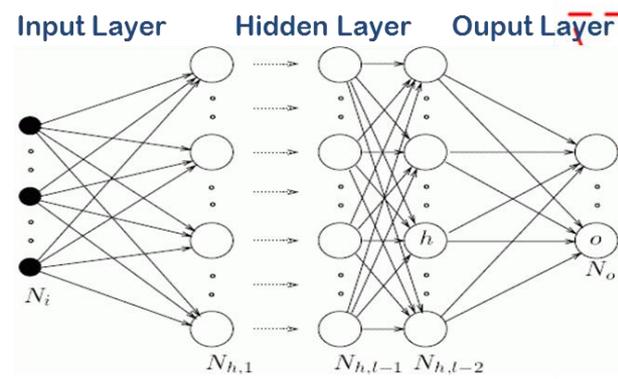
센서 기반 시스템 안전성 평가 - 지능화



손상인식 심층신경망(Deep Neural Networks)

$$C_F(X, U, V) = \sum_{k=1}^K \sum_{i=1}^n u_{ik}^m \text{dis}(\vec{x}_i - \vec{v}_k)$$

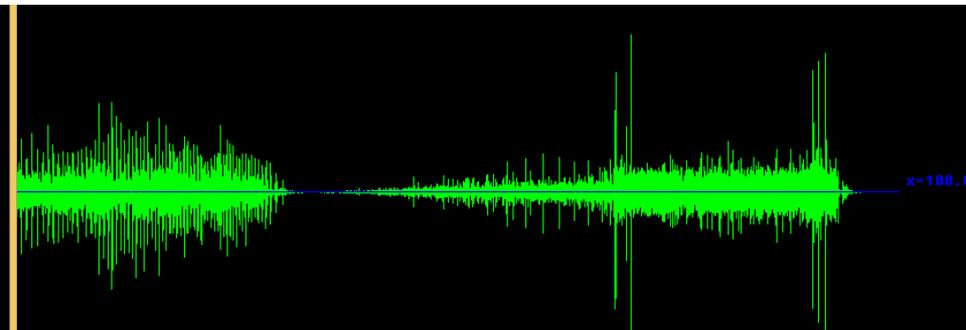
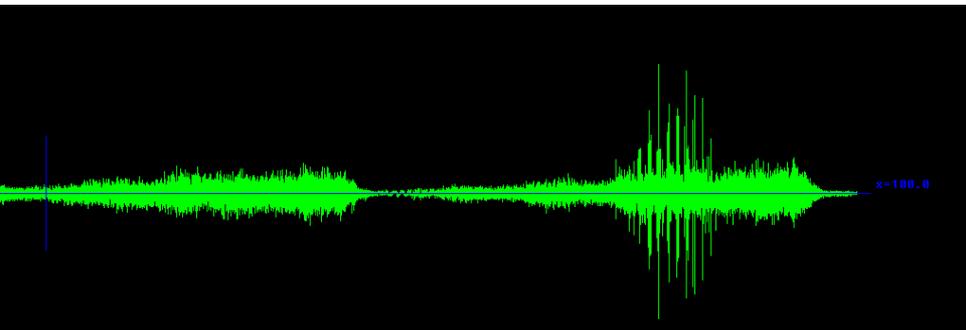
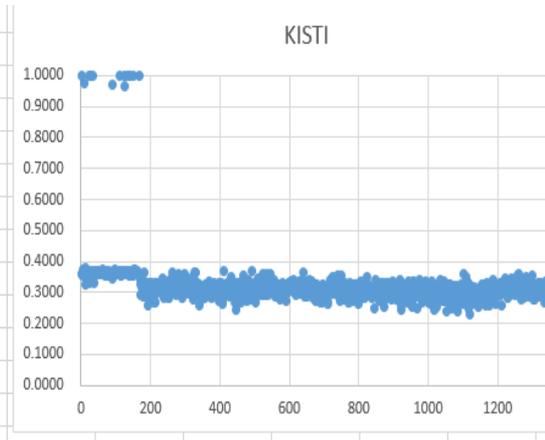
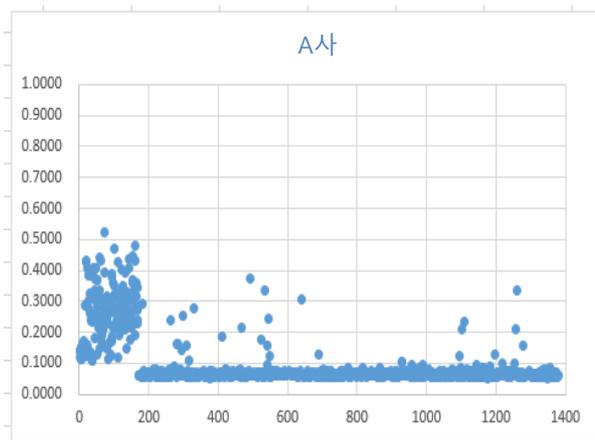
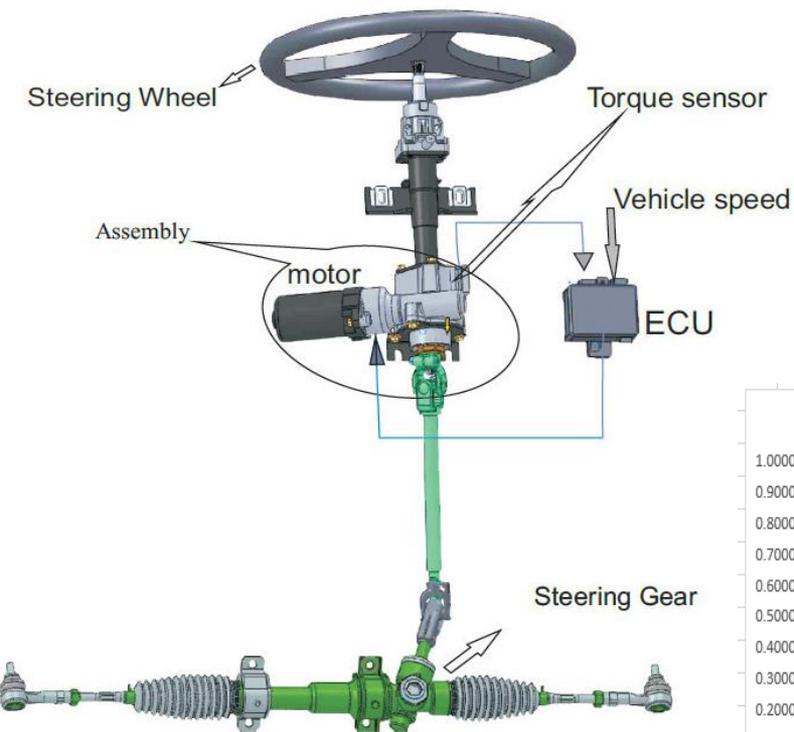
n is the number of data patterns, K is the number of clusters.



음향 데이터를 이용한 EPS(MDPS) 평가시스템

전동식 파워 스티어링 시스템
EPS(Electronic Power Steering)
현대자동차 MDPS(Motor Driven Power Steering)
모터, 센서, ECU 등으로 구성

조향각 센서 정보 속도 정보 등을 바탕으로 ECU에서 최적의 힘을 계산 모터 제어



사례: 선박 인명 안전관리 분야



CORNERS - 상항연기이러먼티비T 서비스 - 관제 SW

운영 사이트 : 이서부호

2018.11.01 (목) 13:42:27

경계대피

소통 0 | 생사상태 0

D Deck
C Deck
B Deck
A Deck
Main Deck

“Heeling Acceleration Model”

경정사 변화 감지

경정사 변화가 감지되었습니다.
대피 개시를 진행하시겠습니까?

대피 개시 | 취소

2018-12-19 13:42:27에 대피개시가 실행되었습니다.

CORNERS - 상항연기이러먼티비T 서비스 - 관제 SW

운영 사이트 : 이서부호

2018.11.01 (목) 14:11:30

경계대피

소통 0 | 생사상태 0

C Deck
B Deck
A Deck
Main Deck
Secord Deck

태피대피부족
안전
경계 요청

CORNERS - 상항연기이러먼티비T 서비스 - 관제 SW

운영 사이트 : 이서부호

2018.11.01 (목) 14:11:37

경계대피

소통 0 | 생사상태 0

C Deck
B Deck
A Deck
Main Deck
Secord Deck

A Deck 스티이션 6개/브타데이터 2개

대피 개시

폭도타입 관여 시간은
04:55
입니다.

재설정 | 상황 종료

CORNERS - 상항연기이러먼티비T 서비스 - 관제 SW

운영 사이트 : 이서부호

2018.11.01 (목) 14:11:42

경계대피

소통 0 | 생사상태 0

C Deck
B Deck
A Deck
Main Deck
Secord Deck

A Deck 스티이션 6개/브타데이터 2개

대피 개시

폭도타입 관여 시간은
04:50
입니다.

재설정 | 상황 종료

“Real-time Routing Model”

2018-12-19 14:11:42에 대피개시가 실행되었습니다.

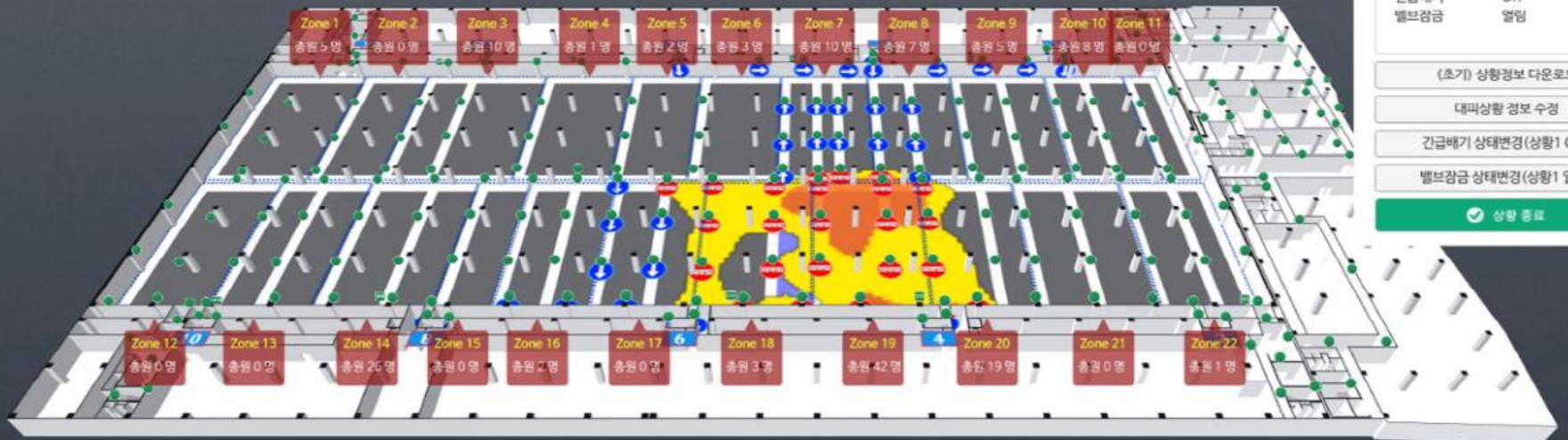
사례: 공장 유해가스 누출관리 분야



3F Station 236개/LoRa GW 12개

인원 계수 팝업 On

“Real-time Gas Diffusion Model”



“Real-time Evacuation Routing Model”

상황 발생



상황 경과 시간 00:31:51

상황발생정보 Bay별 농도 정보

가스

발생시간 2017.04.18 14:45
 발생위치 3F EP-8 Bay F14
 누출물질 F2
 누출위치 캐비닛-VMB 1/2 배관
 누출량 3단계 (50%~100%)
 긴급배기 On
 밸브잠금 열림

(초기) 상황정보 다운로드

대피상황 정보 수정

긴급배기 상태변경(상황1 On)

밸브잠금 상태변경(상황1 열림)

상황 종료

기구를 아이콘 별

- 평상시
- 기구물 정상 작동
- 기구물 장애 발생

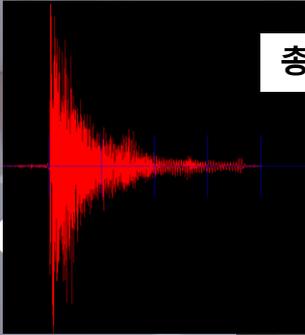
18

- 비상 상황 시
- ➔ 진입 가능 지역
- ⊘ 진입 불가 지역

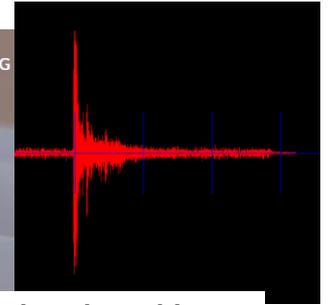
치안안전 – 총성인지 대피시스템 적용 사례

CORNERS

HOME SMART SAFETY DIGITAL TWIN ISSUE CONTACT US KOR ENG



총성인지 기계학습



비총성인지 기계학습



IOT 펌웨어 개발

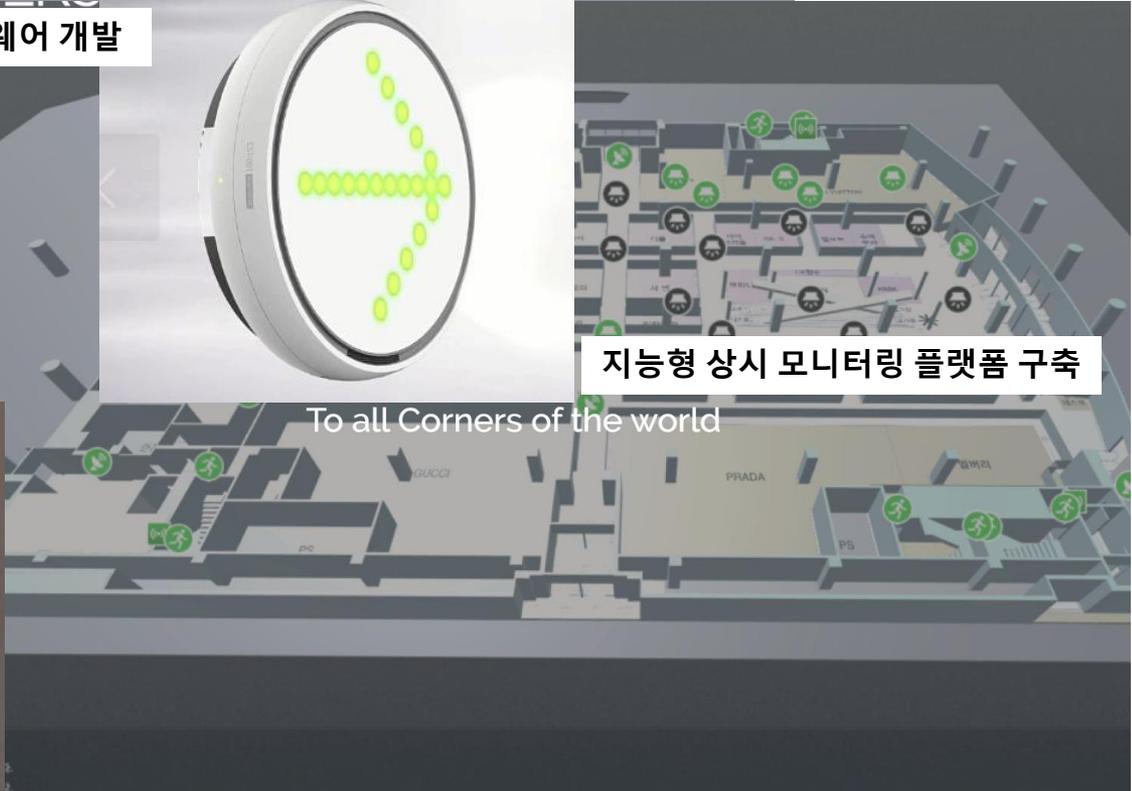


지능형 상시 모니터링 플랫폼 구축

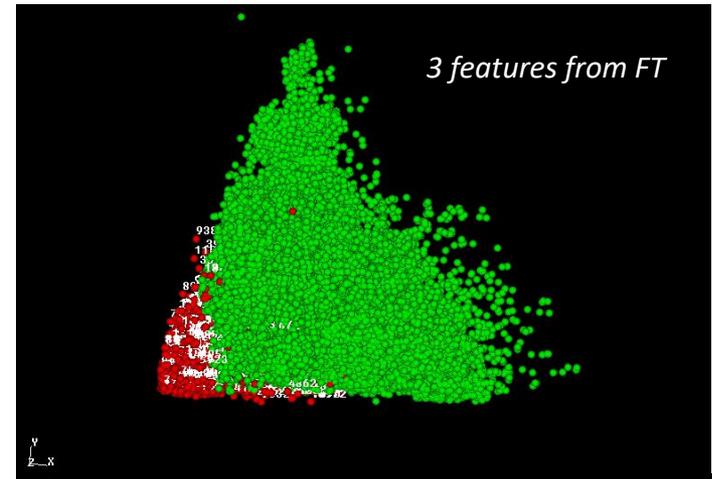
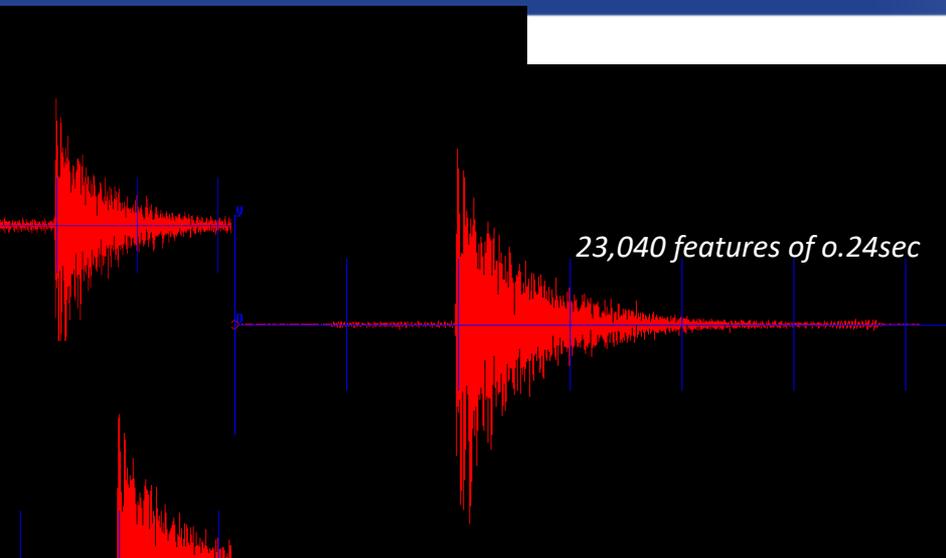
피난 대피 경로 최적화



To all Corners of the world

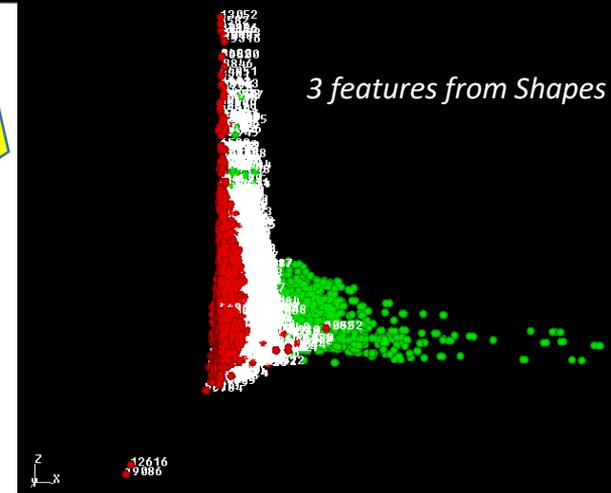
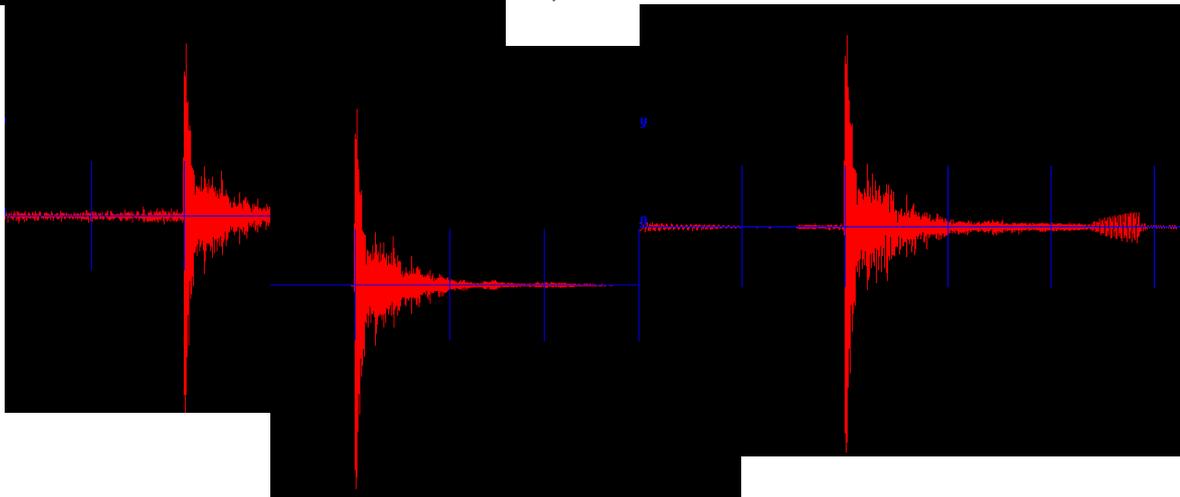


총성인지 기계학습 – ML with 78,690 Samples



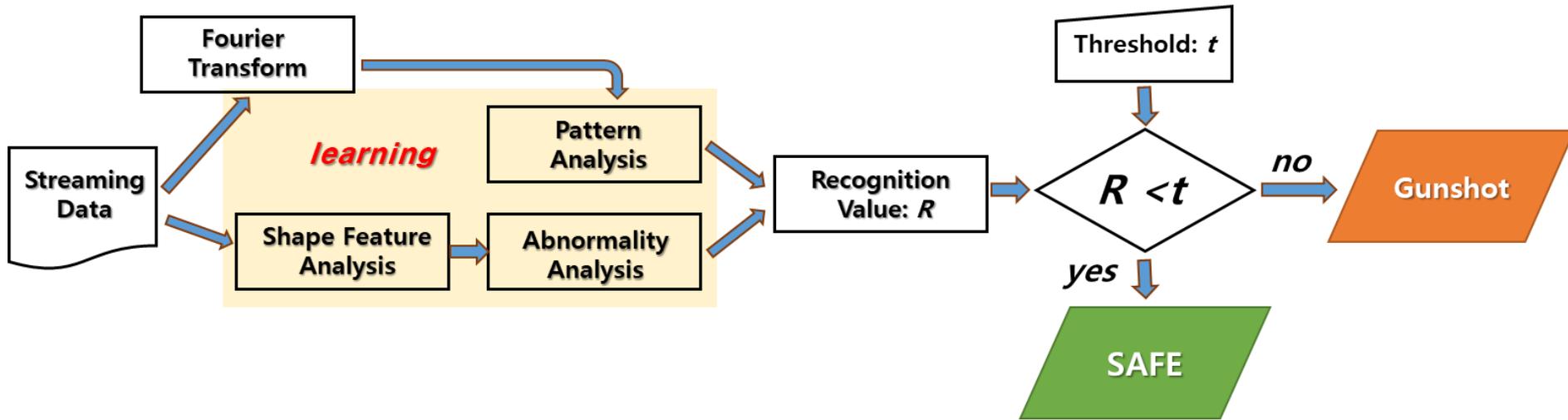
ML for Pattern Recognition

The central text is surrounded by four blue arrows pointing towards it from the top-left, top-right, bottom-left, and bottom-right directions. Additionally, two yellow arrows point away from the text towards the right, one pointing towards the '3 features from Shapes' plot and another pointing towards the 'The One Feature for Decision-Making' text.



The One Feature for Decision-Making 20

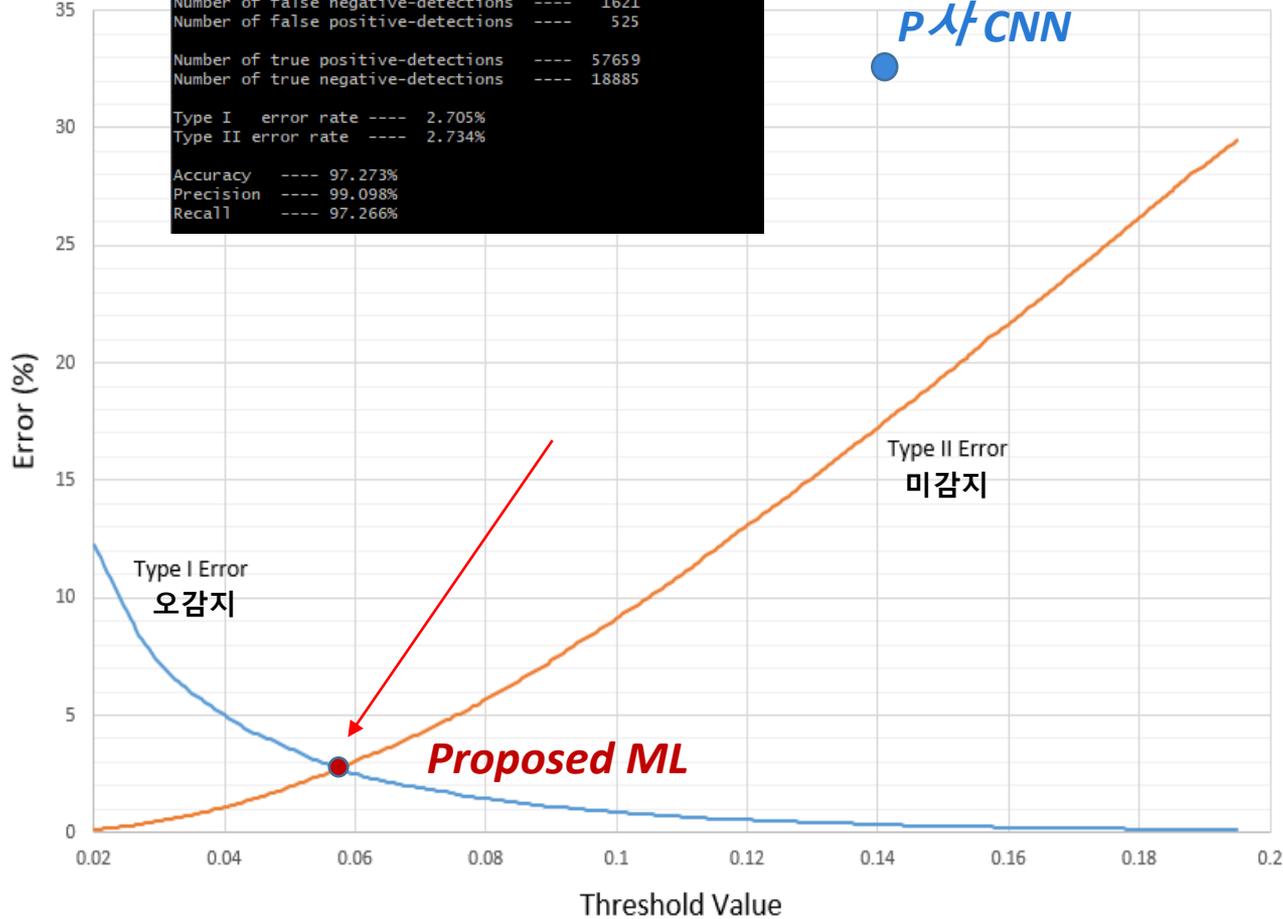
실시간 센서 데이터 처리 총성인지 과정



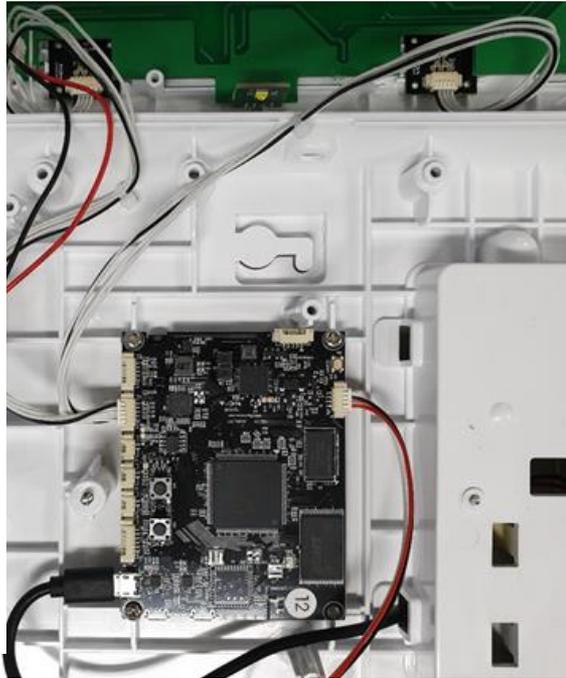
총성인지 최적화 및 지능형 IOT 제작

```

Read 78690 samples! The threshold is 0.0575, and TN 19410.
Number of negative detections ---- 20506
Number of false negative-detections ---- 1621
Number of false positive-detections ---- 525
Number of true positive-detections ---- 57659
Number of true negative-detections ---- 18885
Type I error rate ---- 2.705%
Type II error rate ---- 2.734%
Accuracy ---- 97.273%
Precision ---- 99.098%
Recall ---- 97.266%
    
```



IOT 지능화를 위한
학습된 정보를
펌웨어로 전환

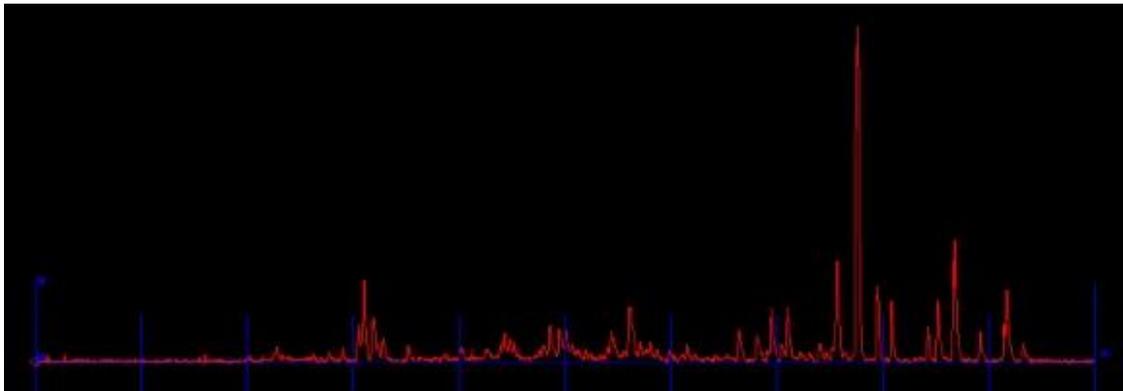
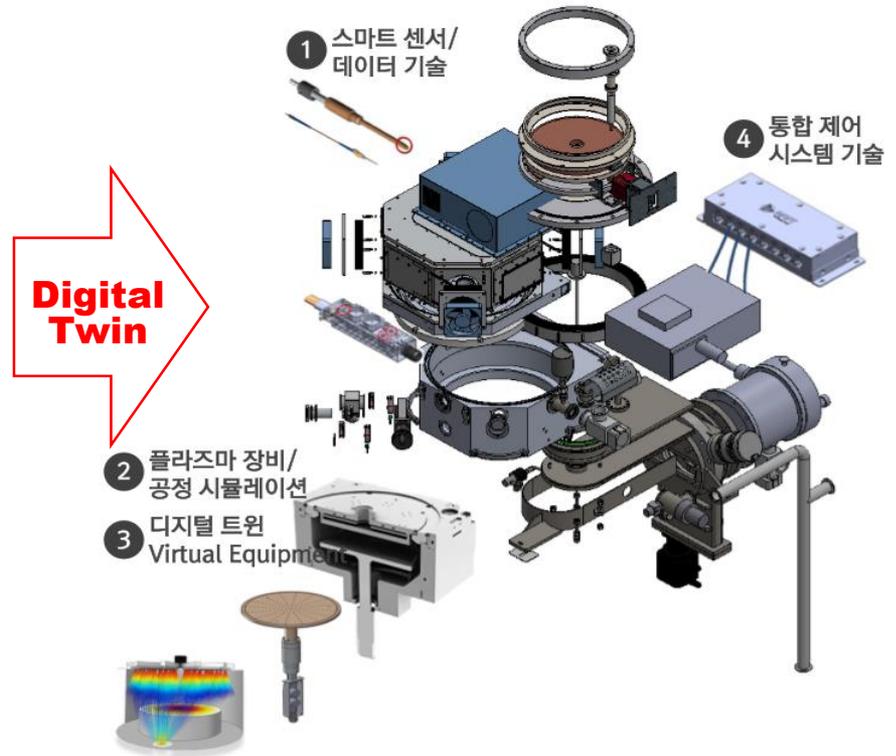


HW규격 : Cortex-A5 Quad-core @ 1.00GHz
 NAND Flash 256MB, DDR3-RAM 256MB
 USB to Serial 2EA(전원/통신보드와 연결 케이블 포함)
 DMIC 2EA(마이크 연결 케이블 포함)

minimize

Type I and II Errors

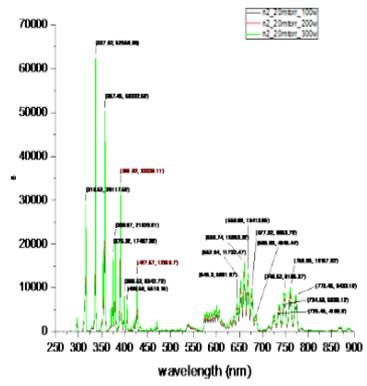
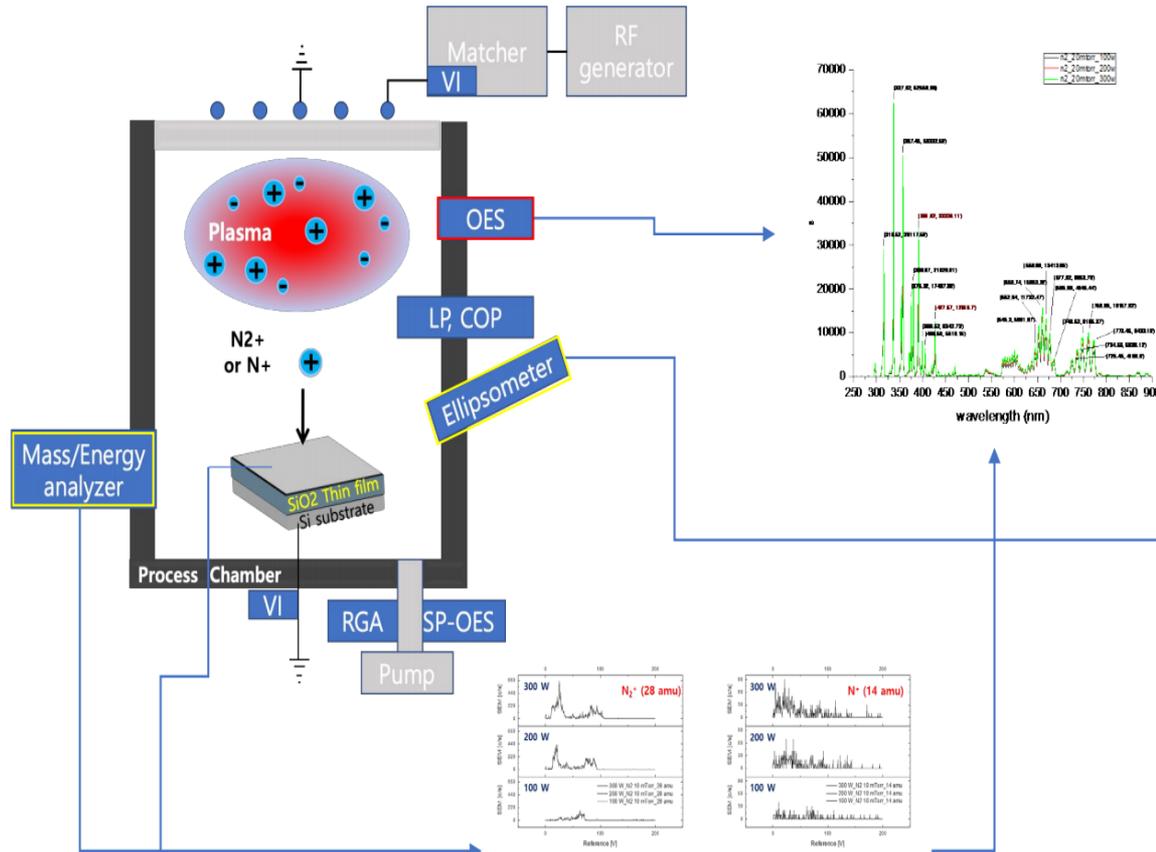
센서데이터 분석 지능화 - 플라즈마 반도체공정장비



- 수많은 부품과 상황에 대한 거대한 데이터 및 계산량
- 디지털트윈을 이용한 시스템 개선 및 실증

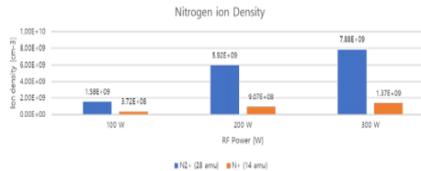
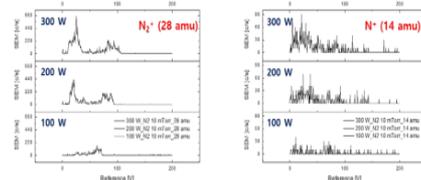
[모니터링/예측] 박막 내부 질소 농도 : 질소 이온 밀도

KFE 김종식박사 자료

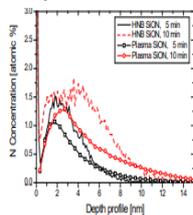


3-1. OES, SP-OES
-> 질소 이온 밀도 (N^+ , N_2^+) 환산
(2. 와 비교)

3-2. Ellipsometer
: 질소 농도 증가 -> 유전상수 증가
증가 -> 굴절률 증가



1. XPS or SIMS
-> 박막 질소 농도 측정

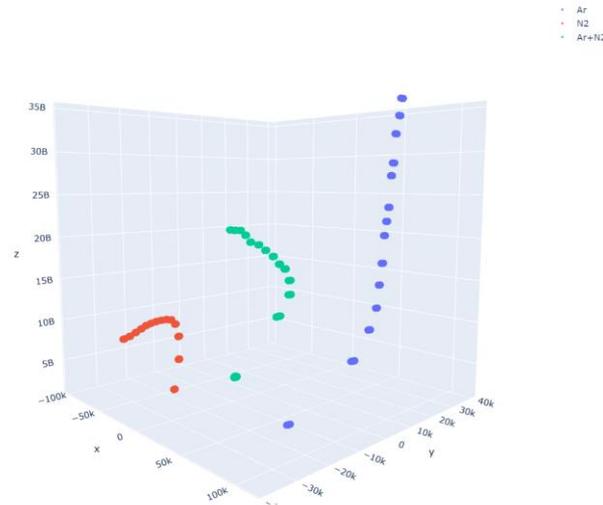
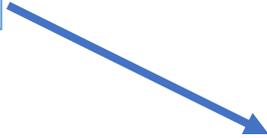
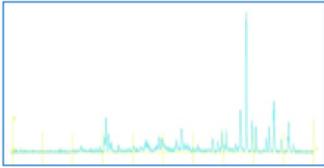


2. EQP/PSM/RGA, COP, ...
질소 이온 밀도 (N^+ , N_2^+) 측정

4. 박막 질소 농도 측정값 비교
(1. 과 3-1. 1. 과 3-2. 비교)

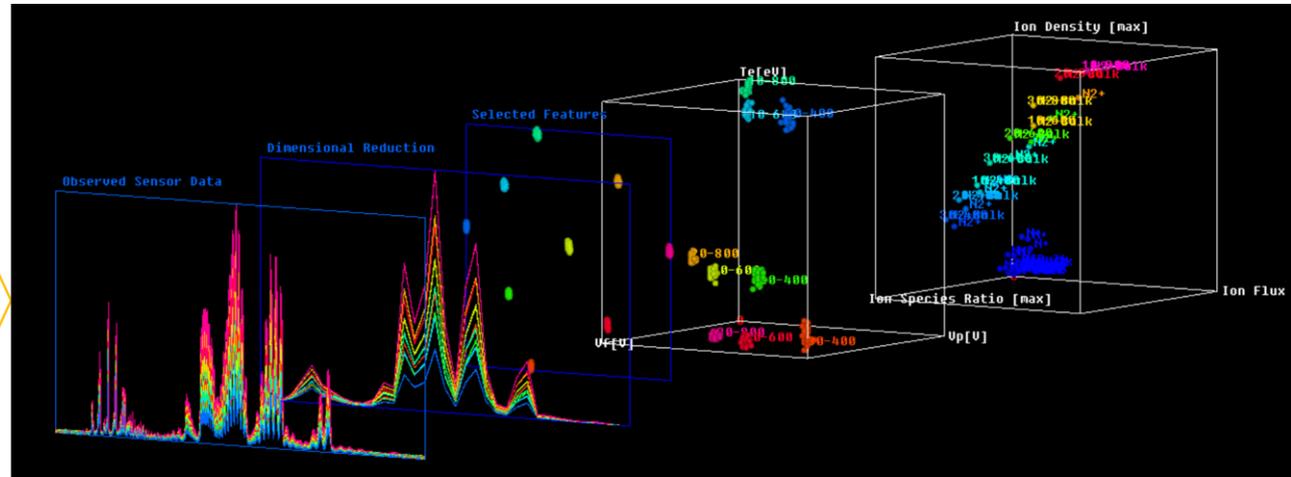
5. 박막 질소 농도 측정
-> OES/SP-OES

데이터 분석 지능시스템 개발



Multi-dimensional Visualization of Plasma E.I.

- 센서데이터-차원축소-특성추출-가상계측 다차원가시화 실시
- 머신러닝 성능평가 및 Digital Twin 구현에 활용



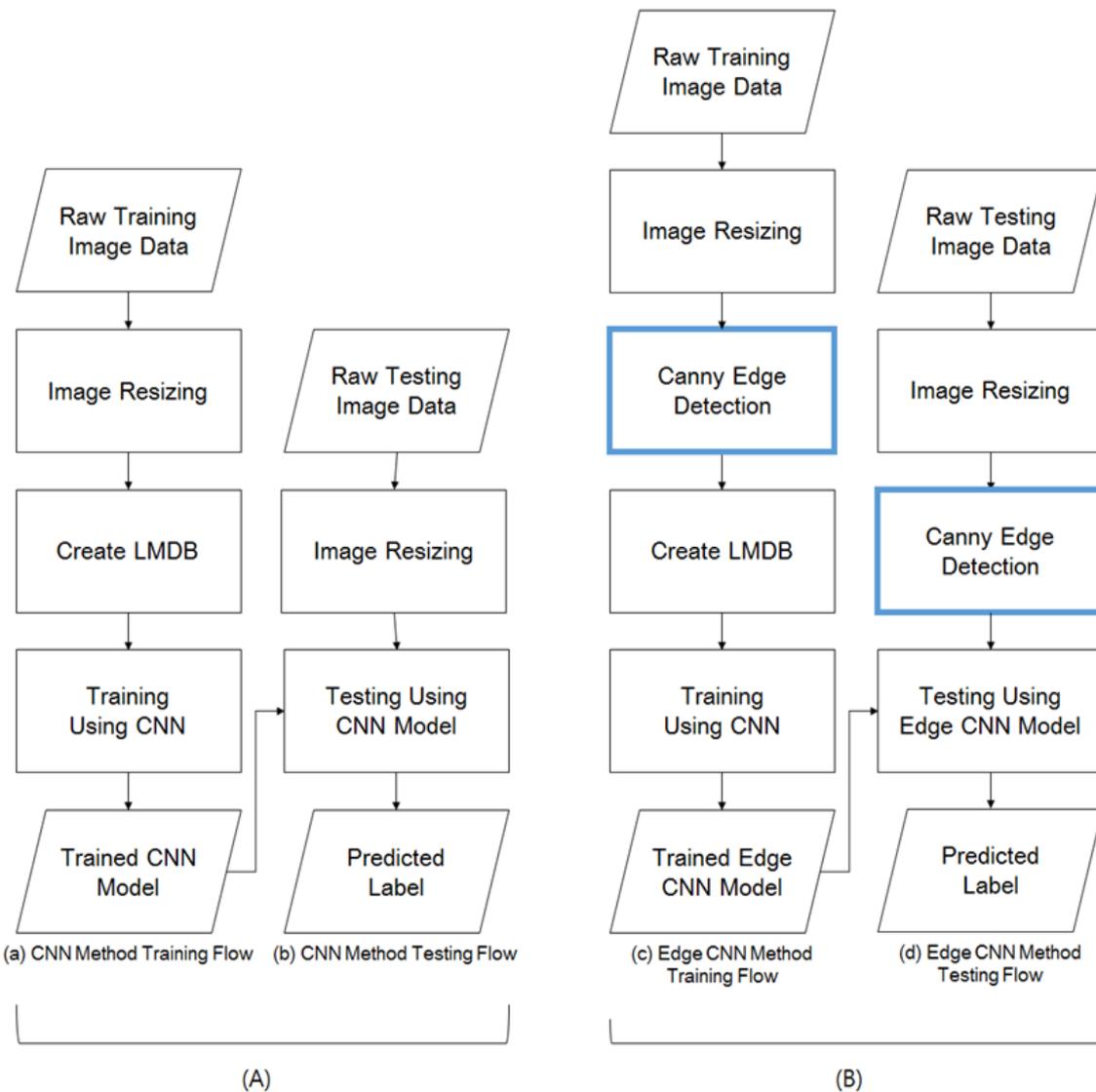


감사합니다.

jeong@kisti.re.kr

Deep CNN for Embedded Environment

KISTI-아주대 공동연구



	Personal Computer	Embedded Device
OS	Ubuntu 14.04 LTS	Linux 4 Tegra 24.2.1
GPU	2×GeForce GTX 970 ^a (4 GB RAM)	256-core Maxwell GPU (4 GB RAM)
CPU	Intel® Core™ i7-5930K @ 3.50 GHz (6Core, 15M)	Quad 64-bit A57 cores + Quad 64-bit A53 cores
RAM	64GB DDR4	4GB LPDDR4
Storage	3 × Seagate 1TB HDD	16 GB eMMC

1TPlops / 10W

Design of Machine Learning System

