선반에서 기계 학습을 통해 공구 마모 진단을 위한 빅데이터 수집 장치 개발

팀명 : 홍대 위아
팀원 : 정석준 정승원 한태연
지도교수 : 맹상진

2023.11.17
제 8회 정밀공학 창의경진대회

목차

1. 연구 목적

공구 마모
진단 시스템

! 과도한 비용
! 장치 호환성

중소 가공 업체

▶ 기존 선반에서 사용 가능한 저가형의 공구 마모 진단 기기 개발 ◀

2. 센서 선정

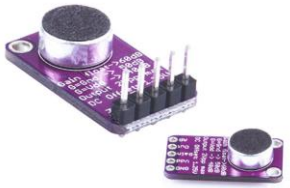
HL-380

고가형

CRY333-T1

AC214-1D

저가형



GY-MAX9814

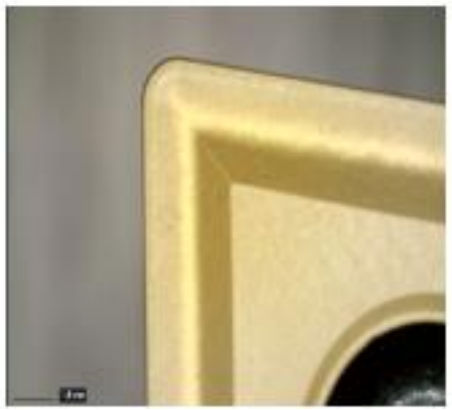
DFR0052

DAQ

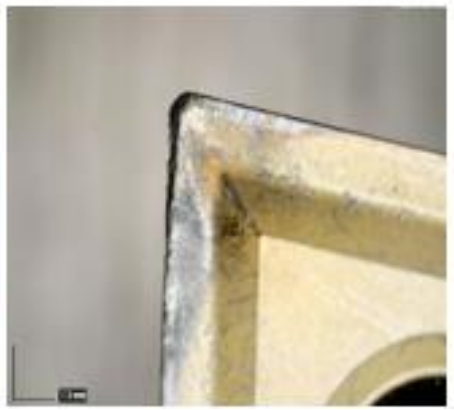
Rotation Speed	900 rpm
Feed Rate	0.24 mm/rev
Depth Of Cut	2 mm
Insert	CNMG120408B25-NC3030
Workpiece	S45C

2. 센서 선정 공구 마모 판단 기준

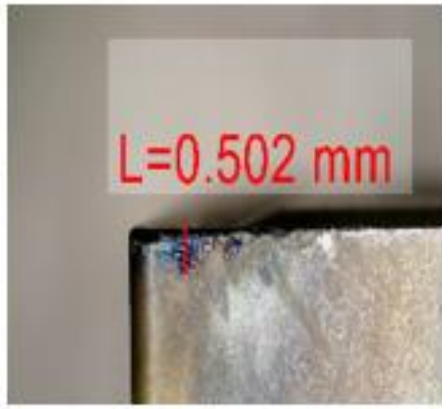
$VB = 0.3mm$ 이상 or $VB_{max} = 0.5mm$ 이상[1)]



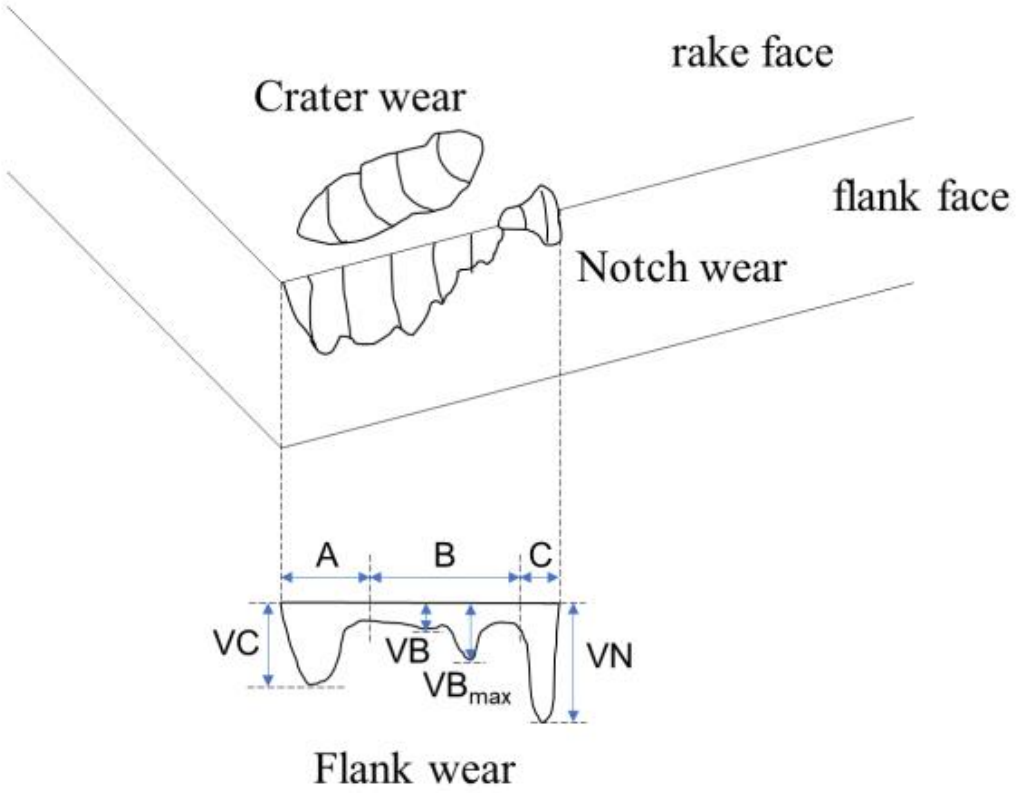
정상(Rake face)



마모(Rake face)



마모(Flank face)

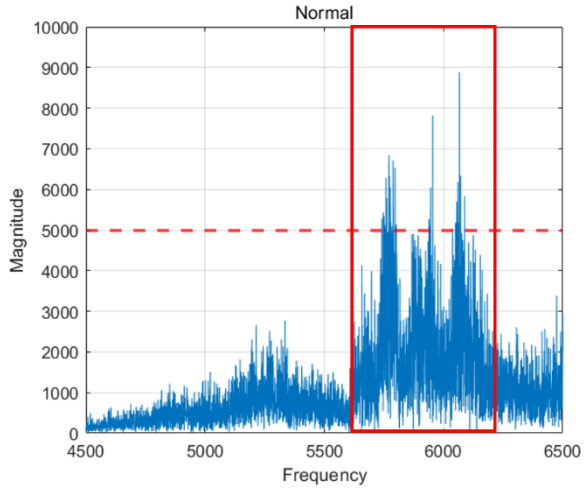


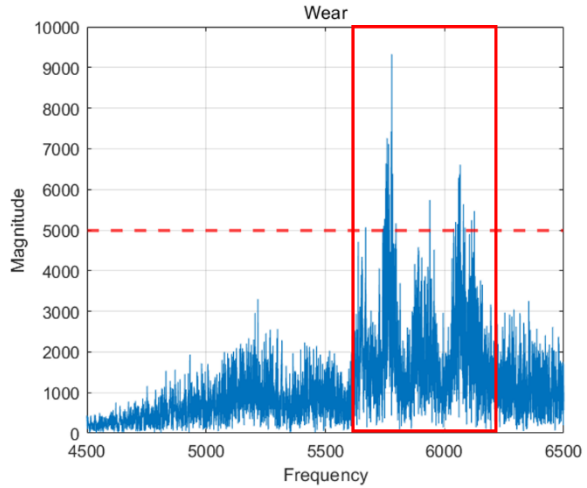
1) Jeong Han Ko, Young Tae Kim, Sang Jo Lee, Research about Tool Wear Monitoring in CNC Lathe Machining(1), Journal of the Korean Society of Precision Engineering,Vol.17, No.12, 54-60, 2000

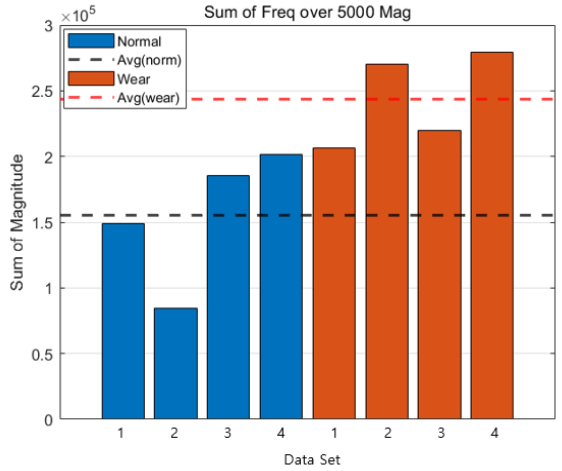
2. 센서 선정 센서 성능 비교 실험 between 2 Vibration Sensor

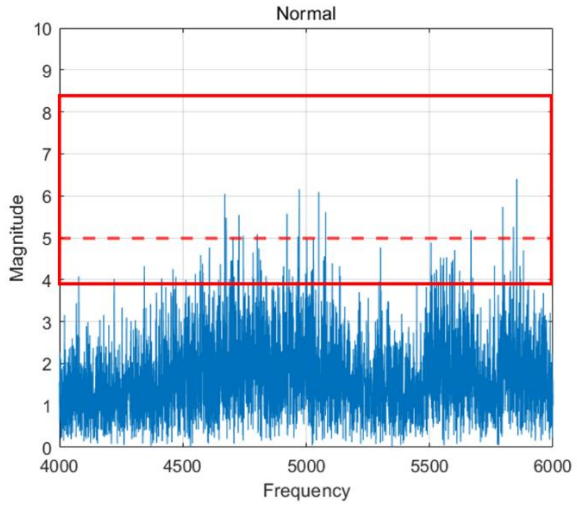
가속도계

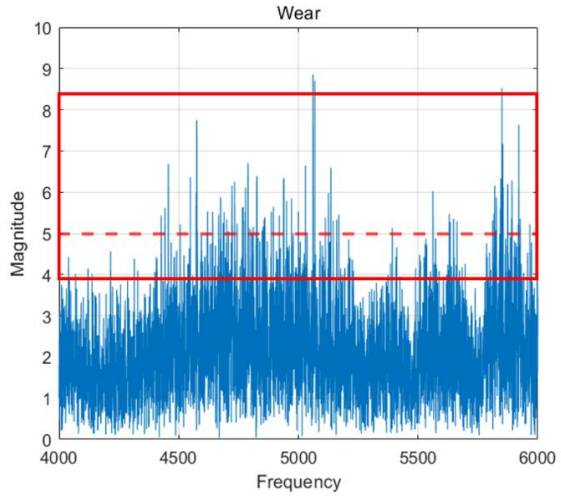
피에조 센서

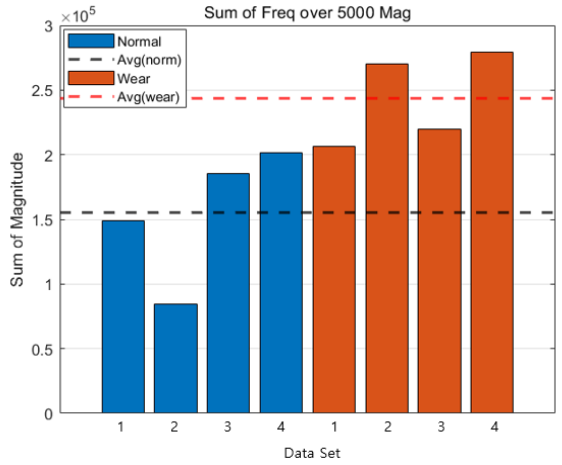






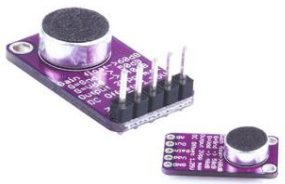




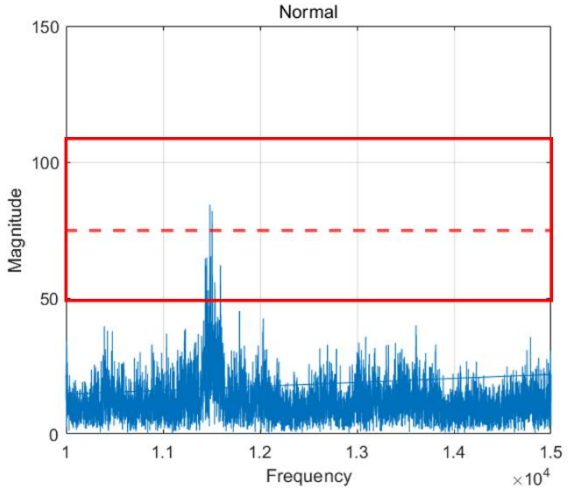


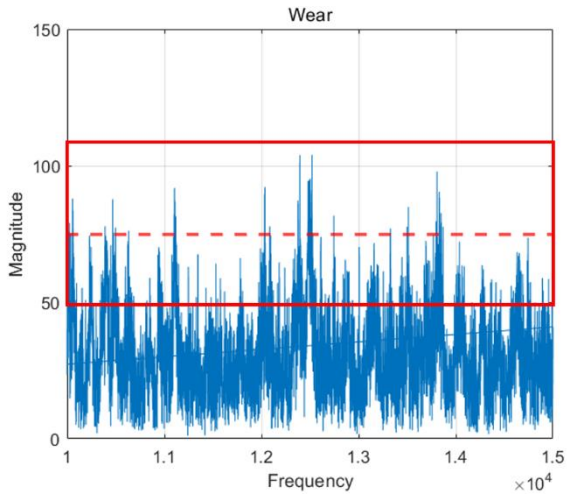
2. 센서 선정 센서 성능 비교 실험 between 2 Microphone Sensor

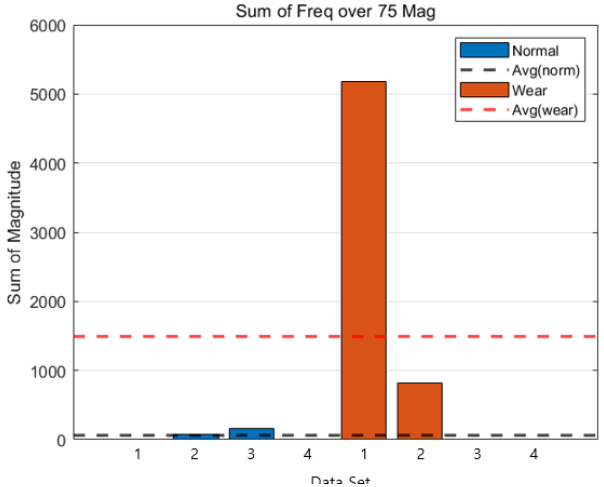
고가형

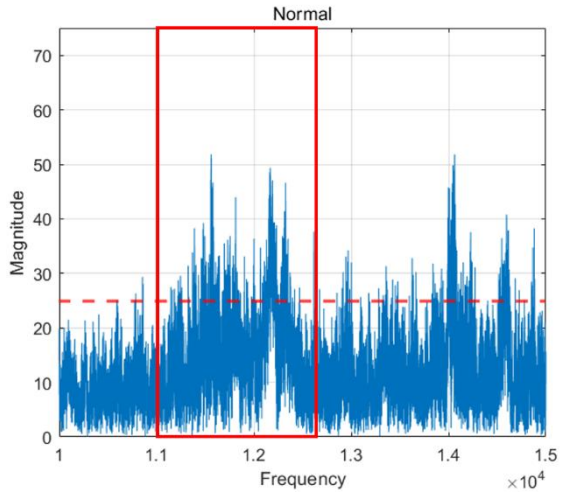


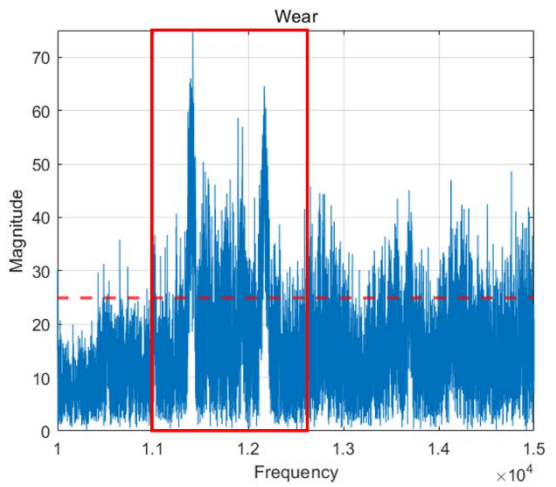
저가형

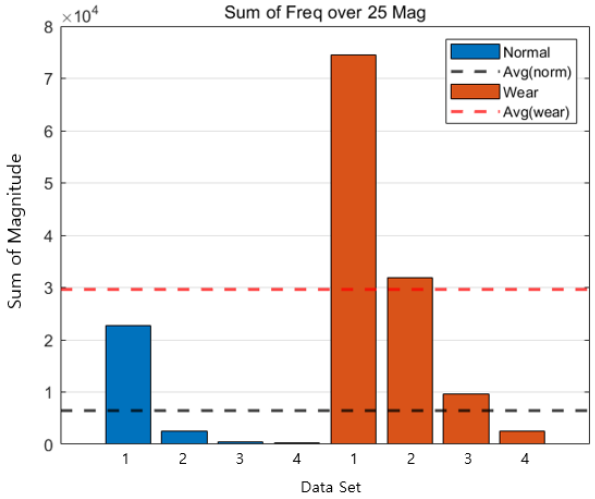












2. 센서 선정 신뢰도 검증

동일한 조건의 가공에 대해 일관된 데이터가 수집되는가?

	Kurtosis		Skewness	
	Mean	Std	Mean	Std
ACC	3.33	0.54	1.65	0.07
Piezo	2.31	1.14	1.14	0.31
Mic High	2.19	1.11	0.99	0.17
Mic Low	1.58	0.59	1.06	0.13

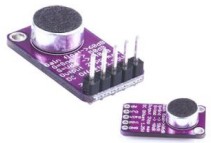
* High-performance sensor / Low-cost sensor

3. 데이터 수집 장치 제작

CRY333-T1

AC214-1D

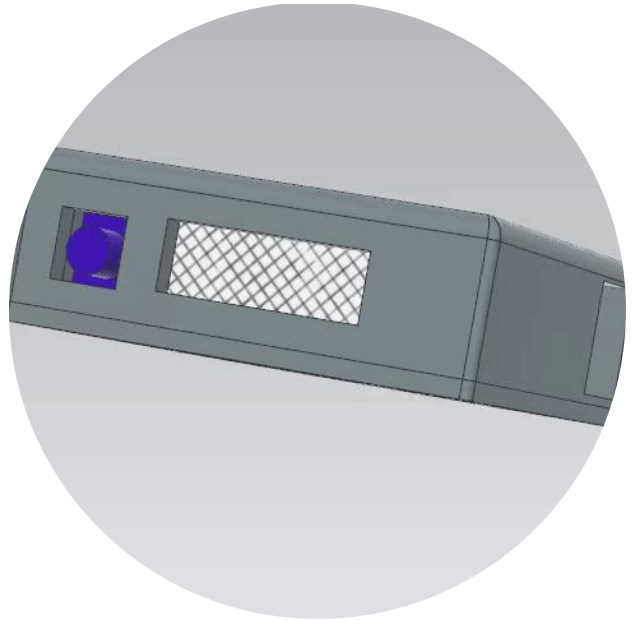
DAQ



GY-MAX9814

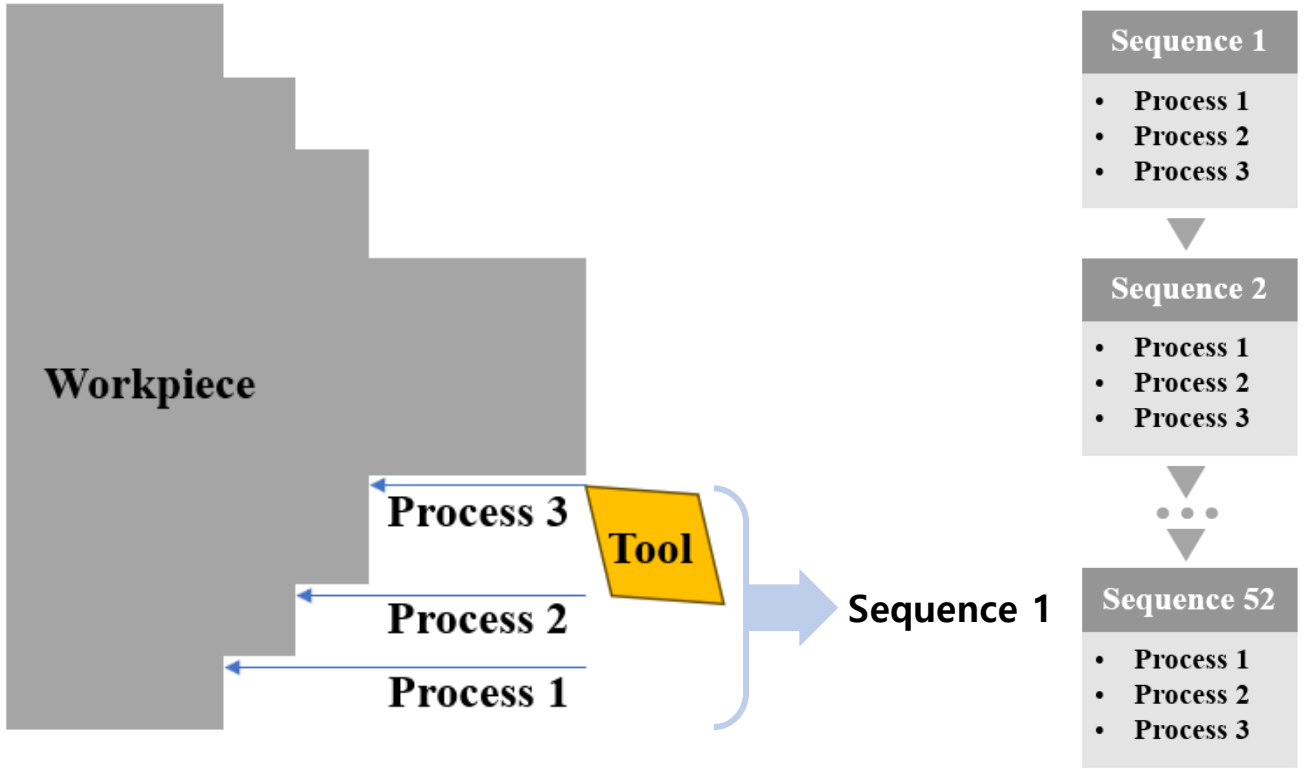
DFR0052

Raspberry pi



3. 데이터 수집 시퀀스 설계

What is Sequency?



Setup

	Spindle speed(rpm)	Feed rate(mm/rev)	Depth of cut(mm)	Length (mm)
Proess1	900	0.33	2	25
Proess2	900	0.24	2	20
Proess3	900	0.24	3	15

Insert : CNMG120408B25-NC3030
Workpiece : S45C

정상 공구 Sequence : **32회**
마모 공구 Sequence : **20회**

4. 데이터 분석 및 학습 전처리 과정

FFT & IFFT

Raw data

↓

FFT

↓

Noise Filtering

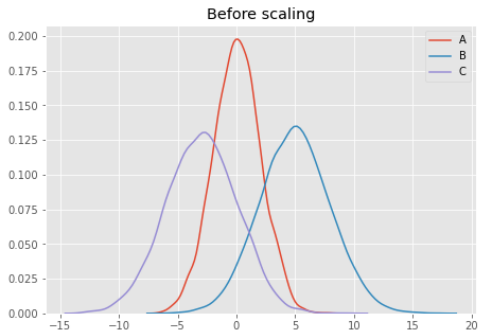
↓

IFFT

↓

Filtered data

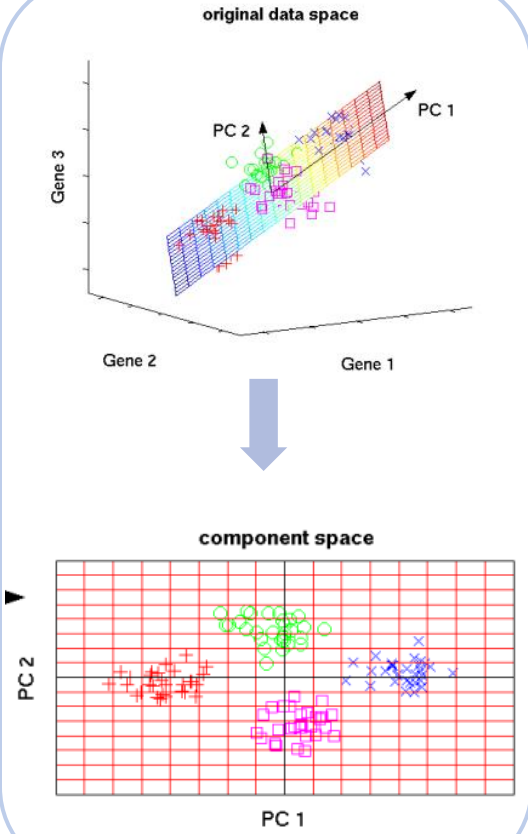
Standard Scaling



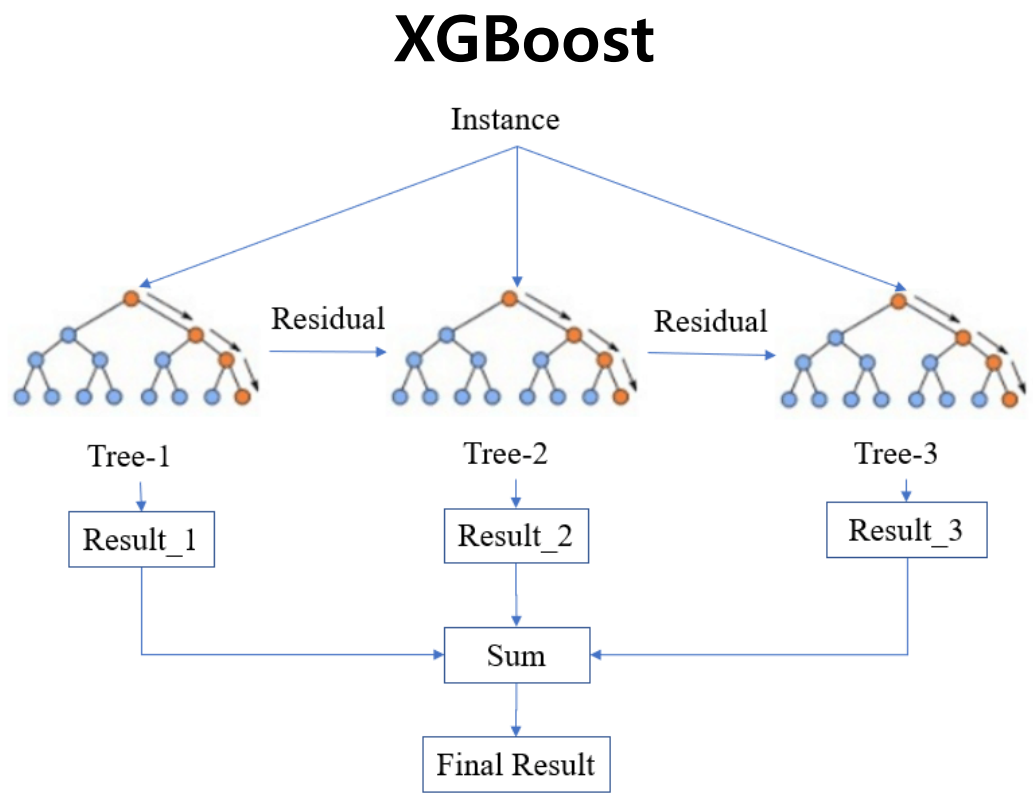
Extract Statistical Feature

- Min
- Max
- Quantile
- Median
- Skewness
- Kurtosis

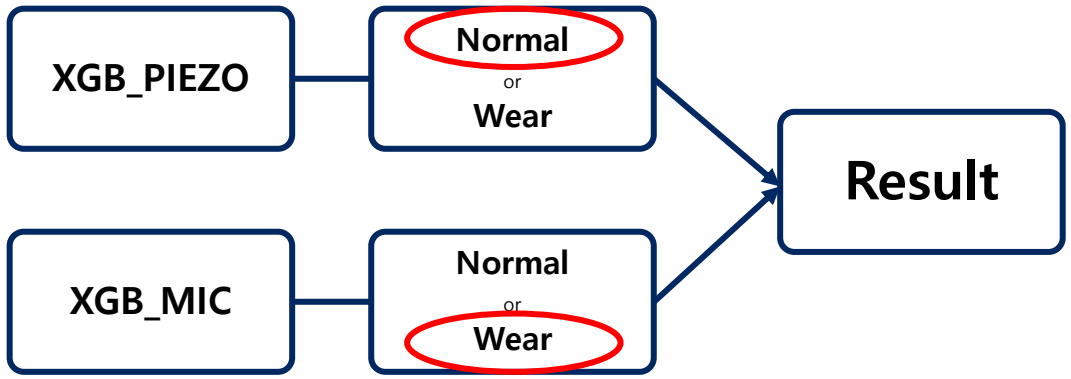
PCA

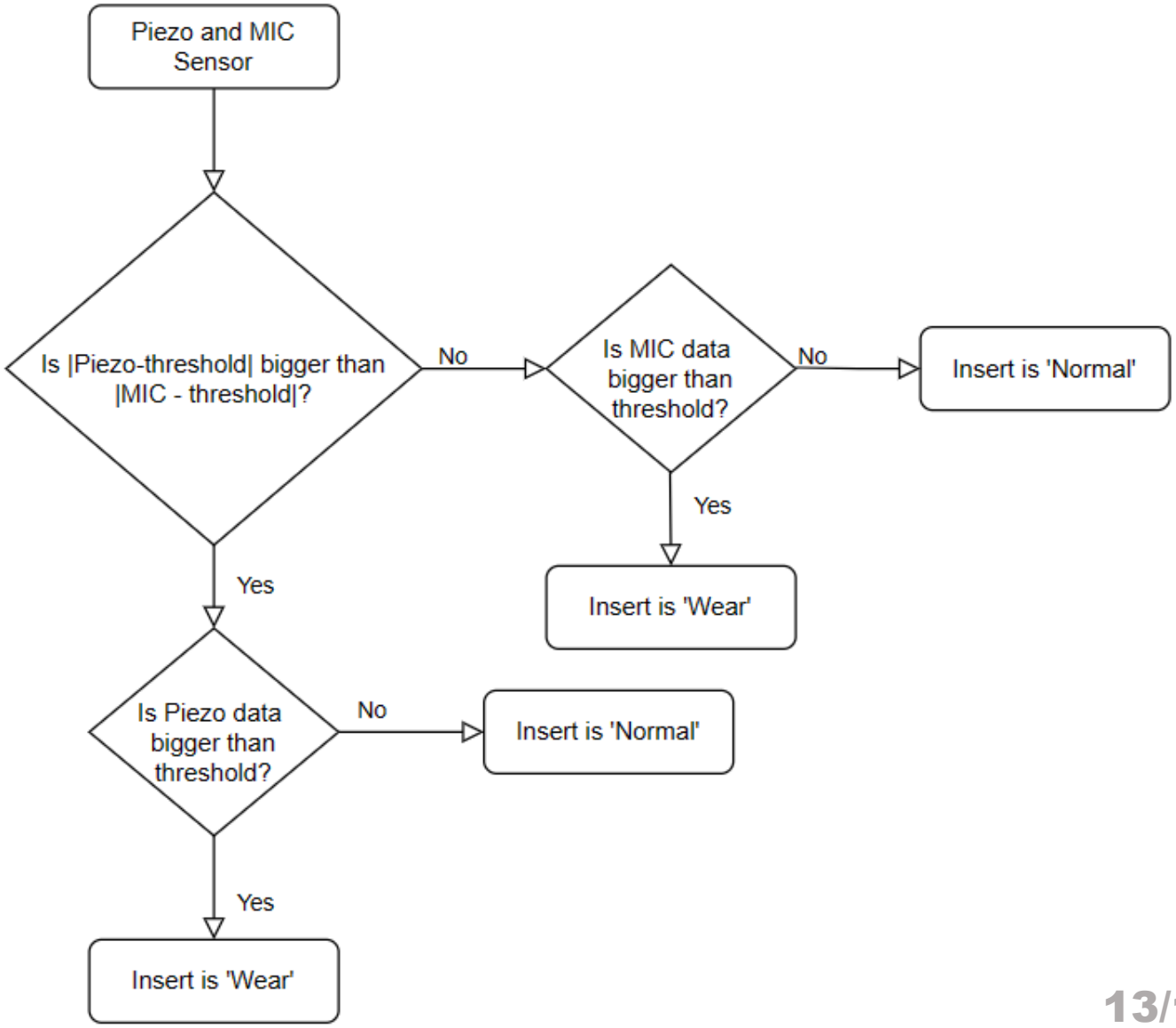


4. 데이터 분석 및 학습 모델 성능 평가 about different Machine Learning Algorithm

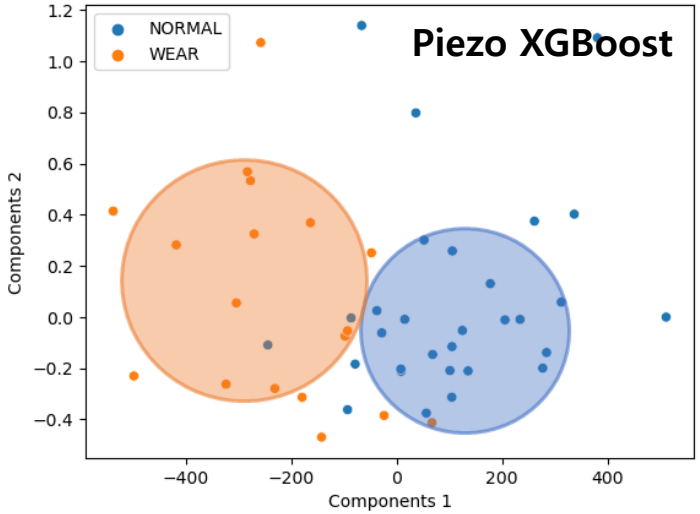


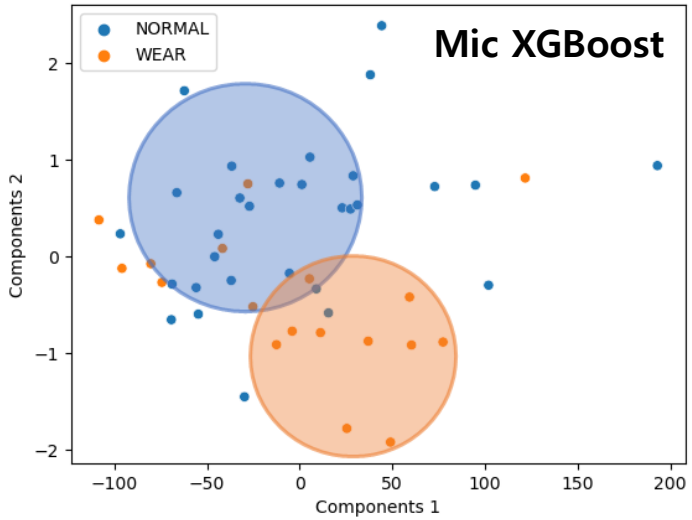
4. 데이터 분석 및 학습 진단 기준





4. 데이터 분석 및 학습 성능 평가





	PIEZO_XGB	MIC_XGB	piezo_xgb_prob	mic_xgb_prob	RESULT	ANSWER
...	...	...	...	...	...	...
28	NORMAL	NORMAL	0.828666	0.993690	NORMAL	NORMAL
29	WEAR	WEAR	0.604870	0.886052	WEAR	NORMAL
30	WEAR	WEAR	0.979966	0.975366	WEAR	WEAR
31	WEAR	NORMAL	0.978605	0.955920	WEAR	WEAR
...	...	...	...	...	...	...
34	WEAR	WEAR	0.987139	0.991400	WEAR	WEAR
35	WEAR	NORMAL	0.982993	0.990422	NORMAL	WEAR
36	WEAR	WEAR	0.864204	0.773314	WEAR	WEAR
37	WEAR	WEAR	0.979966	0.961857	WEAR	WEAR

Accuracy : 95.8%

5. 평가 결과

▶ 목적 : 기존 선반에 사용 가능한 저비용의 공구 마모 진단 장치 개발 ◀

HW

저비용의 장비

✓ 센서 선정
✓ 기기 설계

+

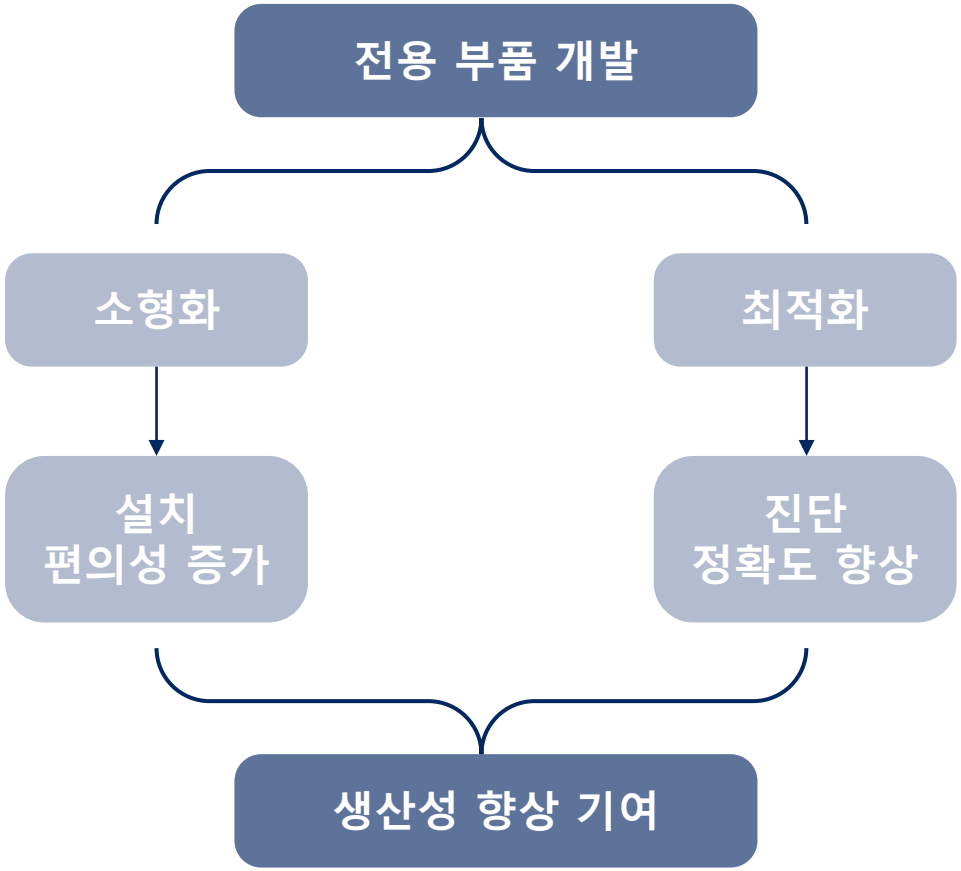
SW

머신러닝 알고리즘 학습, 탑재

✓ 데이터 수집, 전처리
✓ 알고리즘 학습

95.8% 정확성

5. 평가 활용 방안 및 기대 효과



	Model	Price (KRW)
Accelerometer	AC214-1D	938,000
Microphone	CRY333-T1	930,000
DAQ	NI 9775	6,178,680
Total Price		8,046,680

	Model	Price (KRW)
Piezo Sensor	DFR0052	5,390
Microphone	GY-MAX9814	3,700
Board	Raspberry Pi 4B	68,000
ADC	MCP3008	2,870
Magnet	Neodymium magnet	15,100
3D Printing	Case	94,710
Total Price		189,770

97.6%

Thank you!