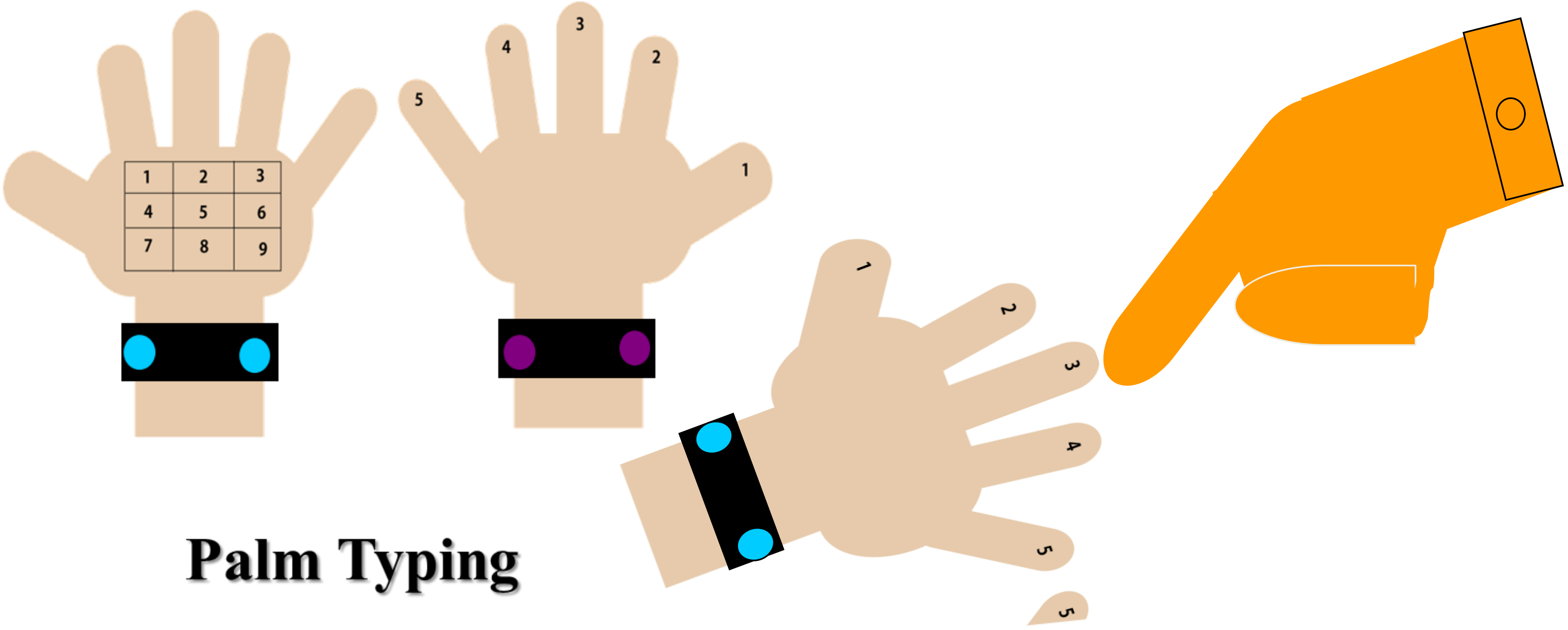
Vital Sensing
人体情報センシング

掌描画方式

Palm Typing, Writing Scheme



Palm Typing

Using the palm of the hand as a keyboard or
Writing letters instead of notebooks

Palm Writing

Non-contact Blood Pressure Acquisition Using Wireless Signals

- Non-invasive blood pressure measurement with optical sensors
- Non-contact blood pressure measurement by image

→The effects of light outdoors, skin color, etc. are not taken into account.

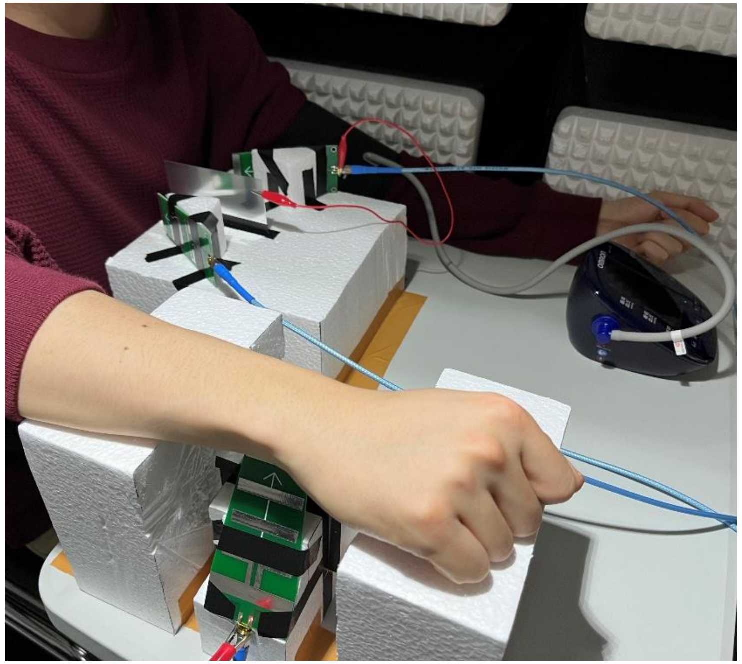
＊Realization of blood pressure measurement using radio waves

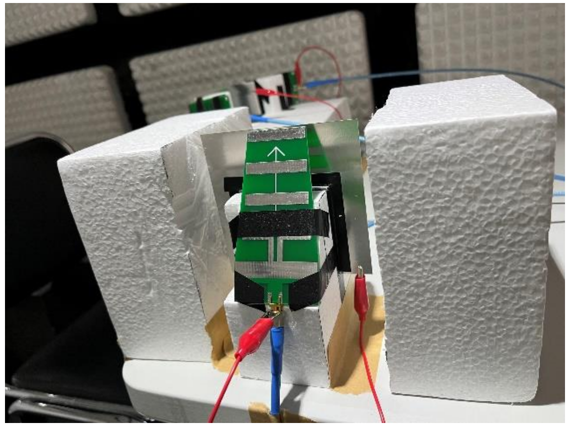
→Non-contact measurement

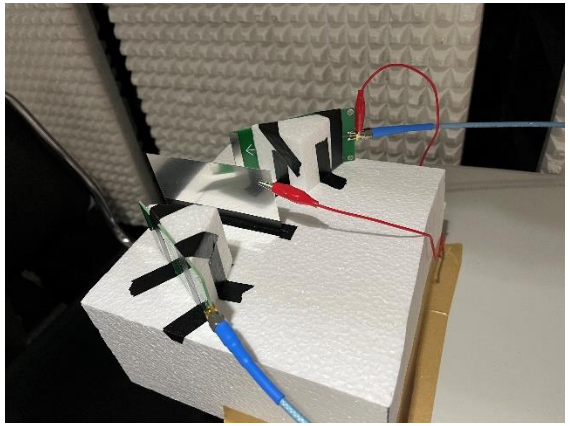
Not affected by light and skin

Measurements can be taken with a smartphone

Experiment setup for wrist and chest





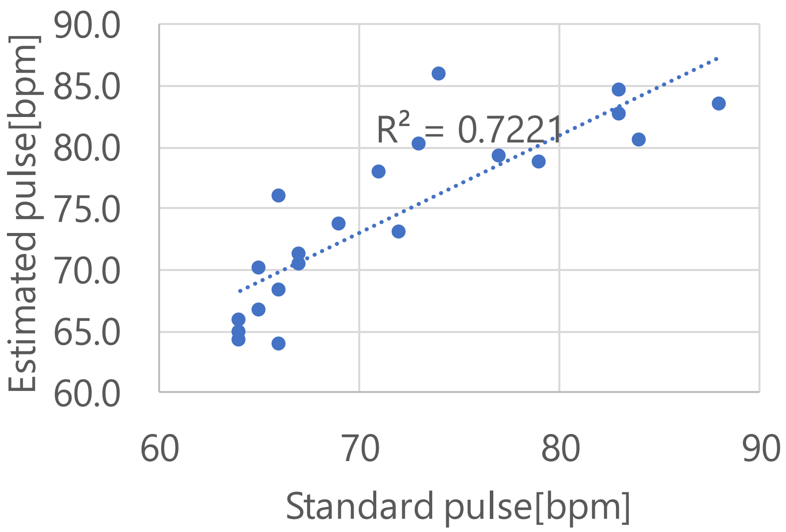


・Collect 10 data per subject (5 resting data, 5 post-exercise data)
・Reflect the microwave signals to right wrist and left chest
・Measure blood pressure on left arm as the reference value
・The reflex onset time is when the cuff pressure begins to decrease.
・The aluminum plate was grounded by an earth wire
・The NA was calibrated before measurement.

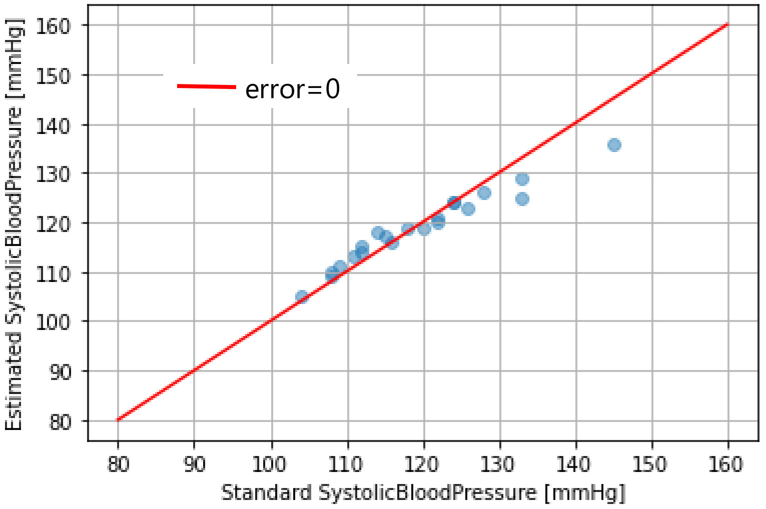
⇒新しい実験セットアップで100データほど取得した。

Estimated pulse and systolic blood pressure

Mean Absolute Percentage Error: 5.2[%]
Root Mean Square Error: 3.7[bpm]
Mean Absolute Error: 4.8[bpm]



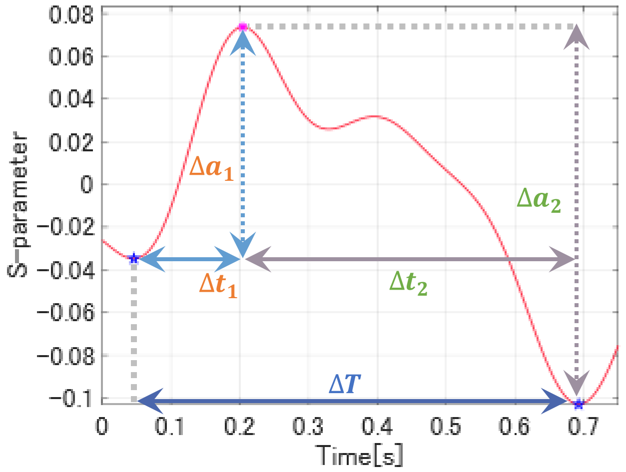
Root Mean Square Error： 3.2[mmHg]
Mean Absolute Error： 2.4[mmHg]
決定係数： 0.89



学習されたデータの最高血圧推定結果

<u>**Data is sparse and there are no data for people with high blood pressure (people of different ages) => Need for collection in the future.**</u>

呼吸波形	脈波波形	加速度脈波波形
	脈拍数	
	立ち上がりの勾配	b/a
	立ち下がりの勾配	c/a
呼吸数	**勾配の総和**	d/a
呼吸の深さ	**立ち上がりの時間**	e/a
	立ち下がりの時間	b-dの勾配
	振幅	SDMPGAI
	AIx	



脈波波形からの特徴量導出

Δt_1: 立ち上がりの時間
Δt_2: 立ち下がりの時間

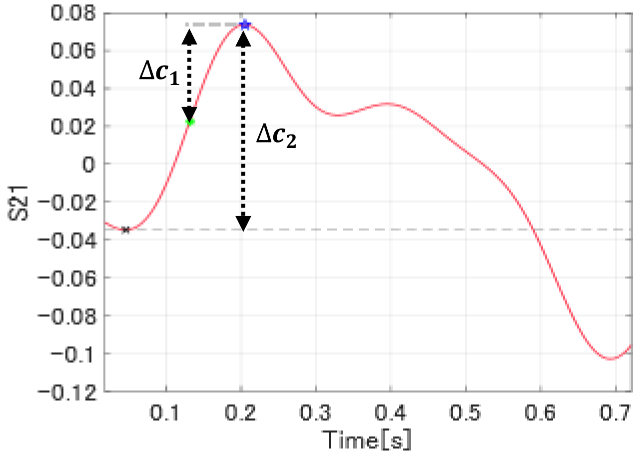
脈拍数[bpm] $= \frac{60}{\Delta T}$

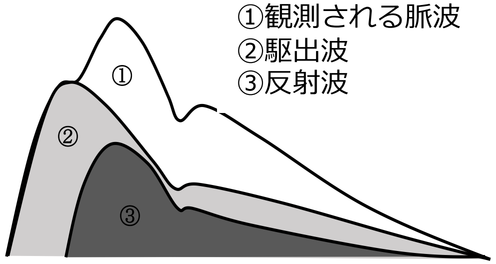
振幅 $= \frac{\Delta a_1 + \Delta a_2}{2}$

立ち上がりの勾配 $= \frac{\Delta a_1}{\Delta t_1}$

立ち下がりの勾配 $= \frac{\Delta a_2}{\Delta t_2}$

上腕式血圧計との相対誤差
6.5%





①観測される脈波
②駆出波
③反射波

胸データからのAIx $= \frac{\Delta c_1}{\Delta c_2}$

Augmentation Index (AIx):

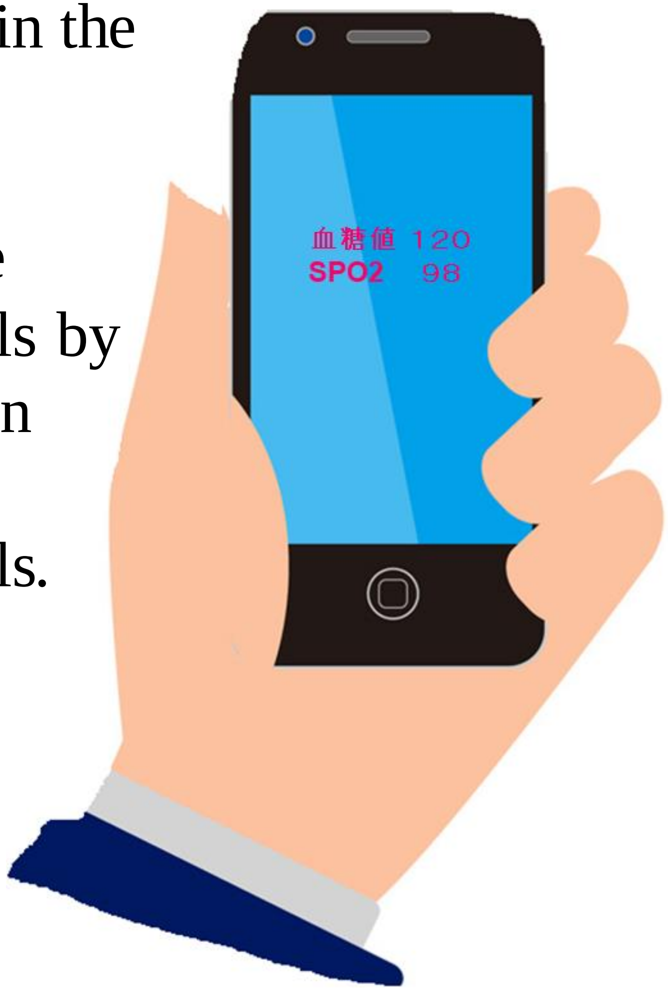
全身の動脈硬化度を定量的に評価する指標。
脈波は、心臓からの駆出波と末端血管での反射波の重ね合わせであり、
その反射波による増大程度を定量化する。
血圧とAIxは強い相関があるとされている。

最初の変曲点→駆出波のピーク
脈波波形全体のピーク（最初の極大点）→反射波のピーク

光を用いた非接触血糖値取得
Non Contact Blood Glucose Level Measurement

Blood glucose levels are very important in the prevention and treatment of diabetes.

Research is to establish a highly accurate method of measuring blood glucose levels by learning the correlation between detection using light to establish a highly accurate method of measuring blood glucose levels.



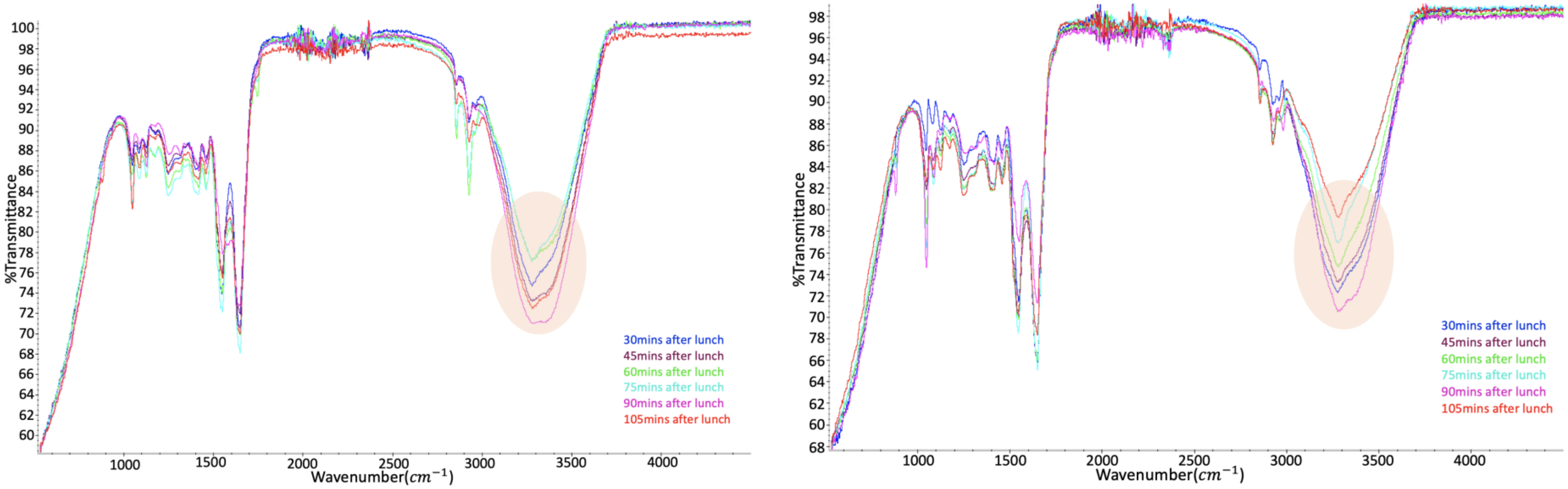
Background (3)

- These measurement methods not only bring pain to the patients but also put users at infection risks due to skin-cuts.

Fig. Invasive glucometer available in market

Experiment---confirm optimal wavelength

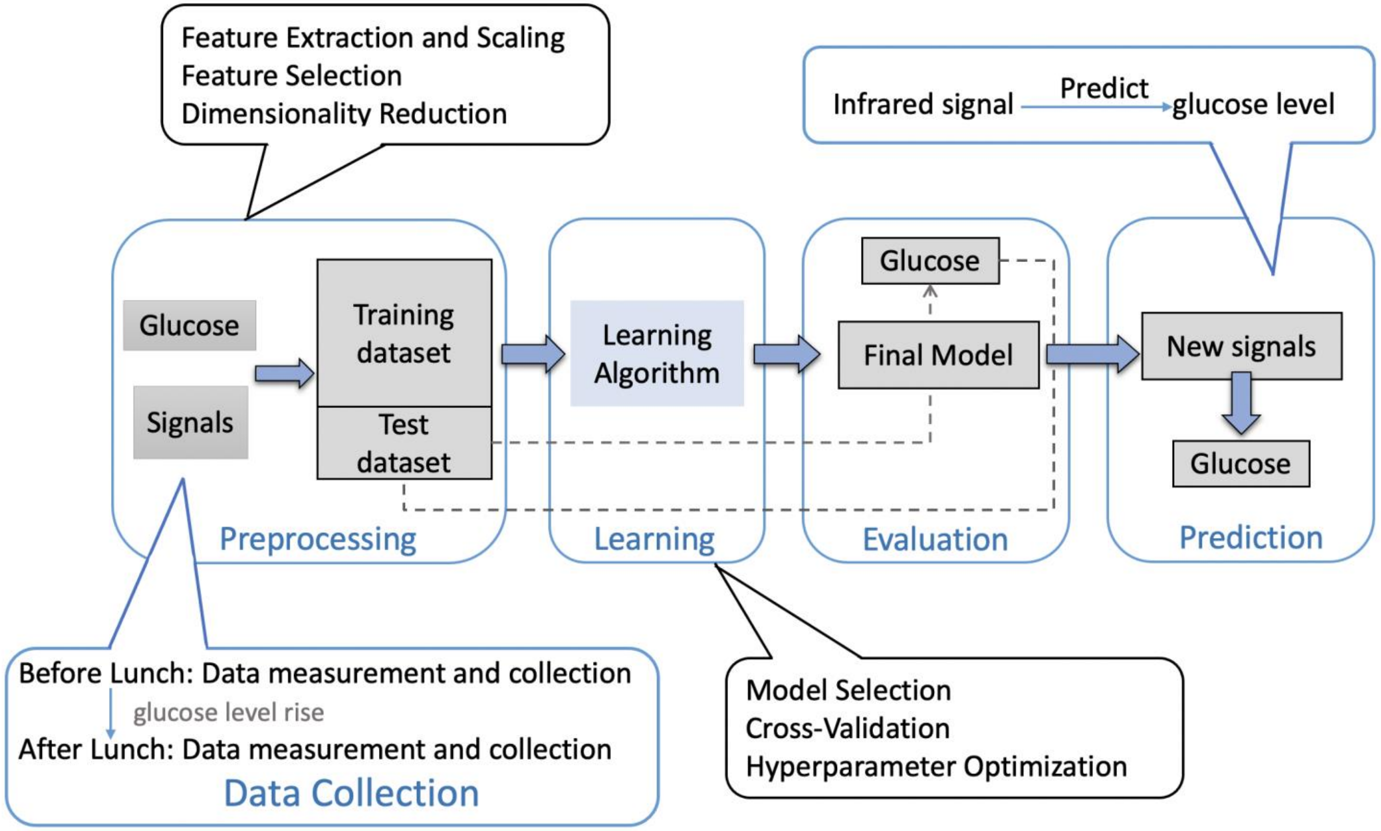
Spectroscopy result of the index finger on the left hand



(a) (b)

Fig. Mid-infrared spectrum of male subject (a) and female subject (b)

Step 2: Data Preprocess



Research scheme

Proposed evaluation method

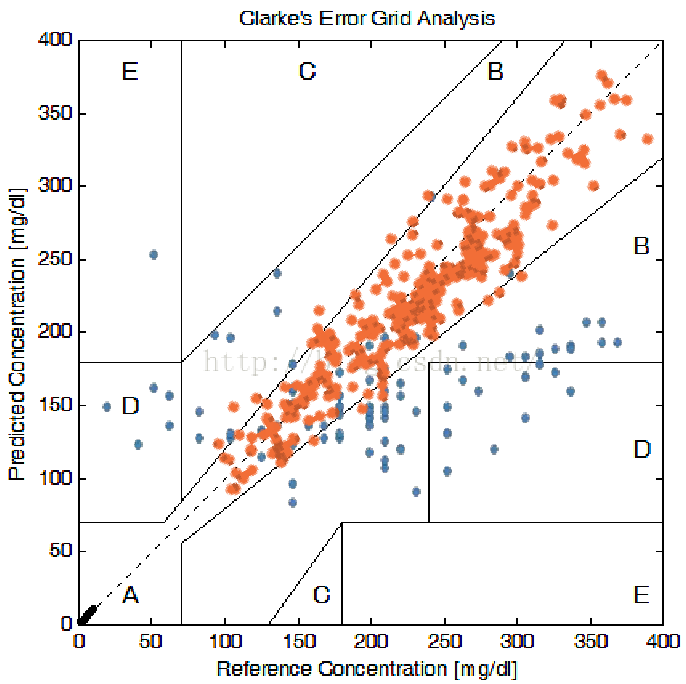
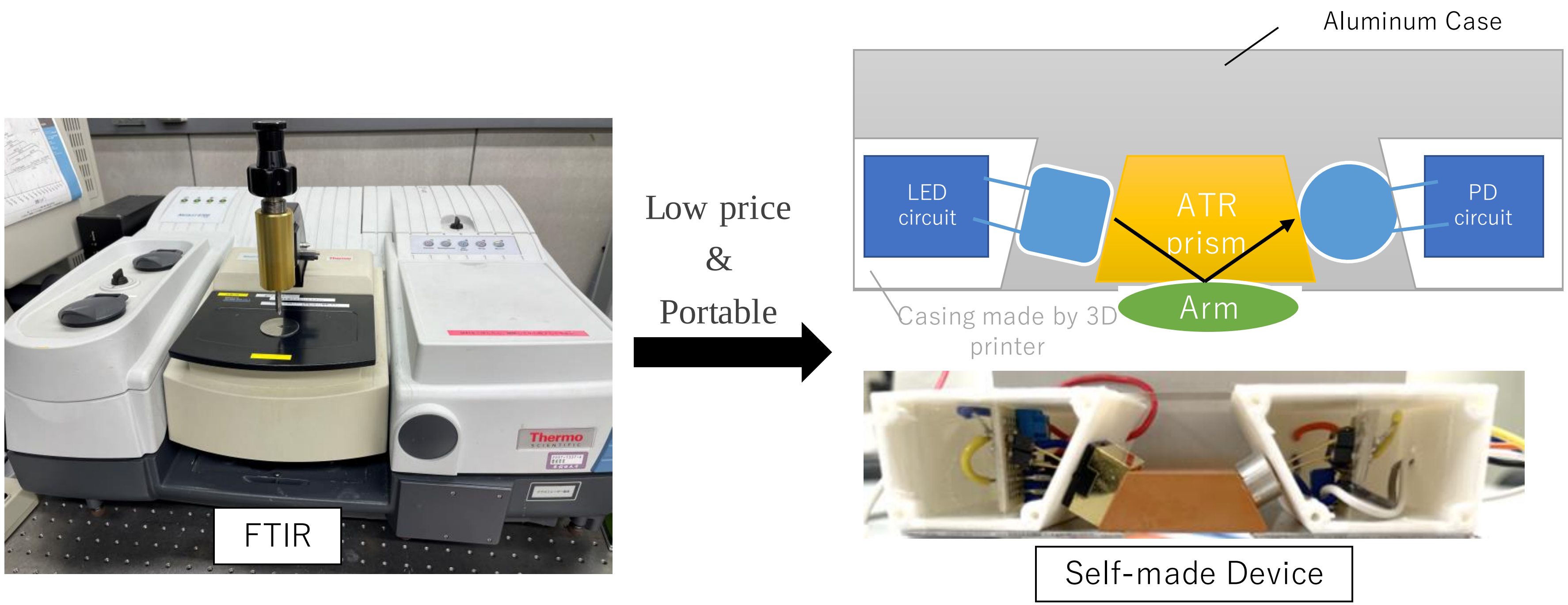


Fig. Clarke's Error Grid Analysis.[1]

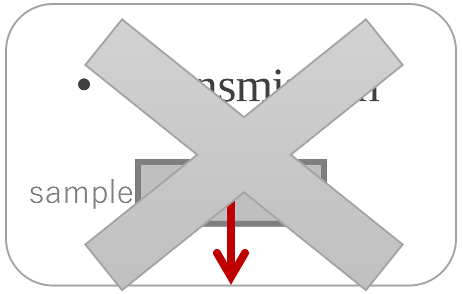
- The widely popular and comparison tool for clinical accuracy of glucose-related measurements is the error grid analysis.

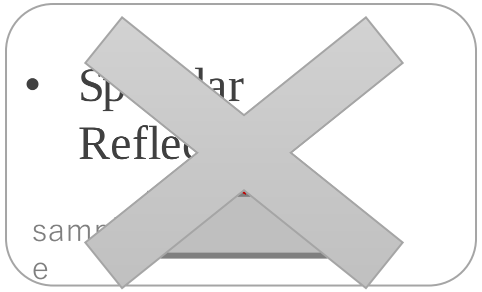
- Region A are clinically correct decisions.
- Region B are clinically uncritical decisions.
- Whereas values in C and D are potentially dangerous. In both zones the blood glucose values lead to over-corrections.
- Region E are clinically significant errors.

[1] Researchgate, https://www.researchgate.net/figure/Modified-Clarke-error-grid-classification-zones_fig1_305391007

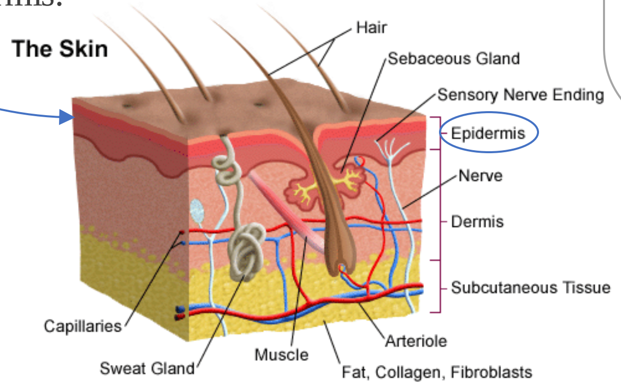

FTIR
Low price
&
Portable
Aluminum Case
LED
circuit
ATR
prism
PD
circuit
Arm
Casing made by 3D
printer
Self-made Device

Major sampling techniques in FTIR



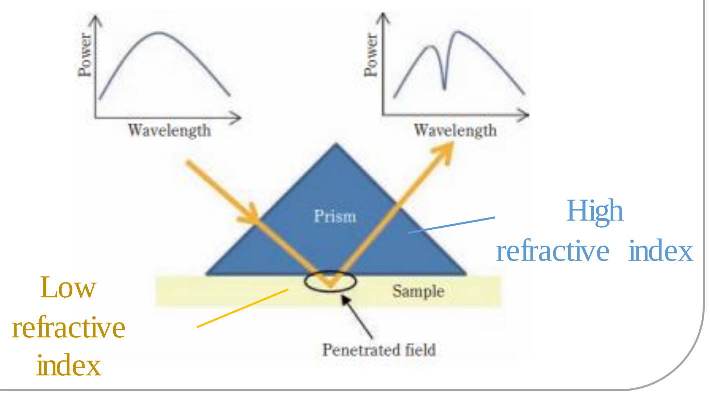


Most infrared radiation is absorbed in the upper layer of skin, the epidermis.

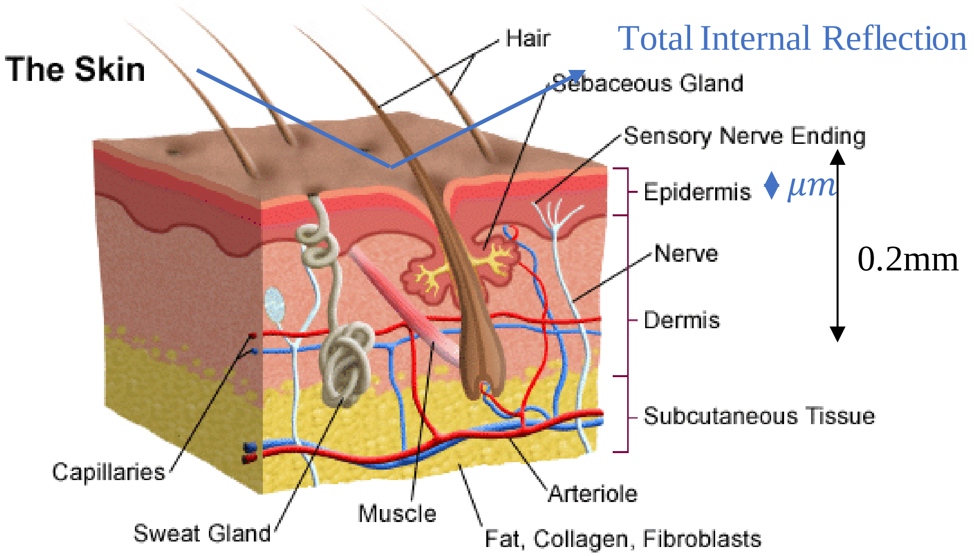


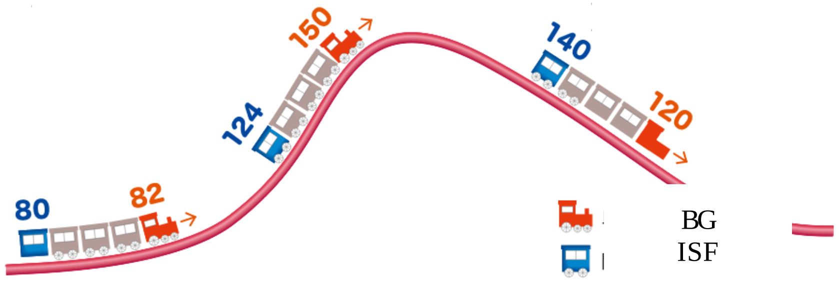
The Structure of skin.
From *Anatomy of Skin* by Stanford Medicine Children's Health.

- Attenuated Total Reflection (ATR)



血糖値　vs　間質液中の糖濃度





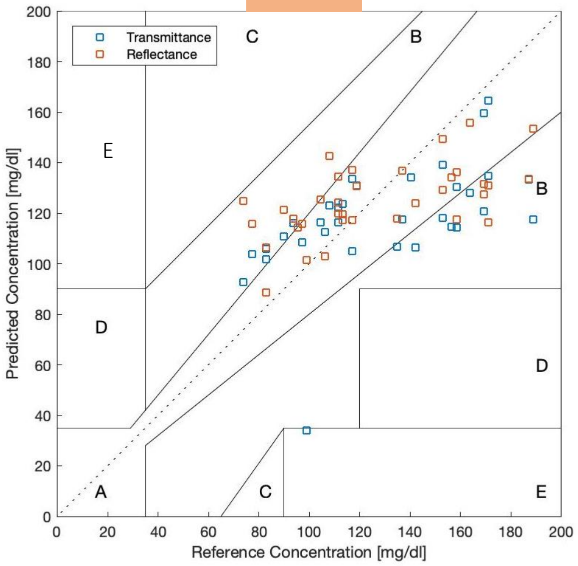
- High correlation
- Time lag of 5-10min

Prediction Model

- Partial least squares regression
- Support Vector Regression
- Random Forest
- Adaboost
- Artificial neural network
- Xgboost
- Decision Tree Regression

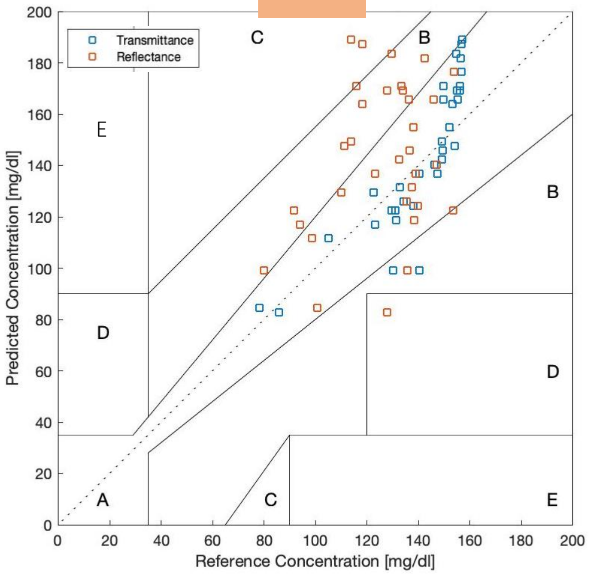
Accuracy (1/2)

PLSR



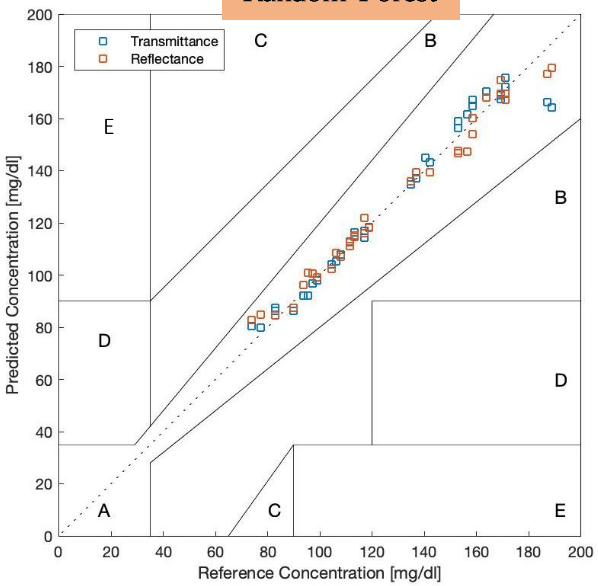
Transmittance: 0.199
Reflectance: 0.319

ANN



Transmittance: 0.838
Reflectance: 0.893

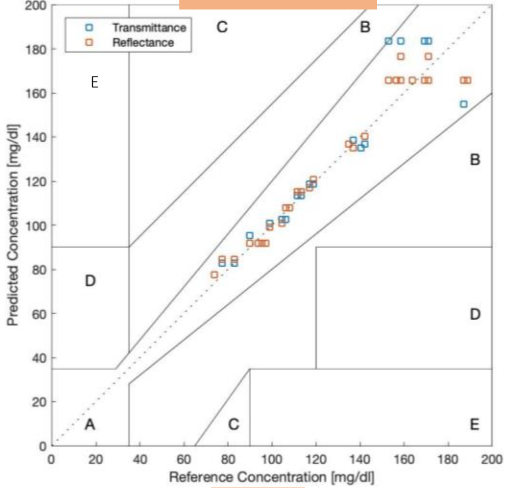
Random Forest



Transmittance: 0.981
Reflectance: 0.993

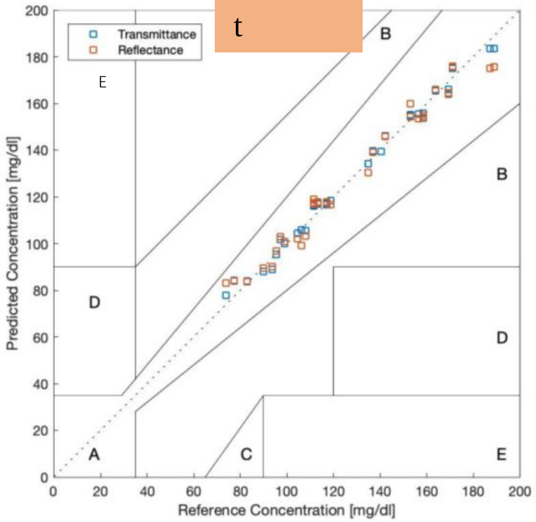
Accuracy (2/2)

Decision Tree



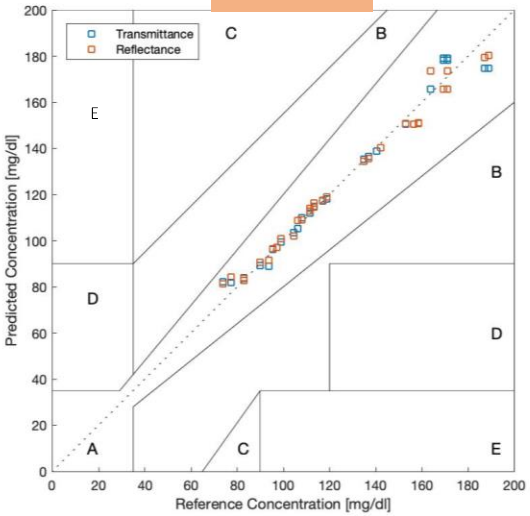
Transmittance: 0.949
Reflectance: 0.972

XGboost



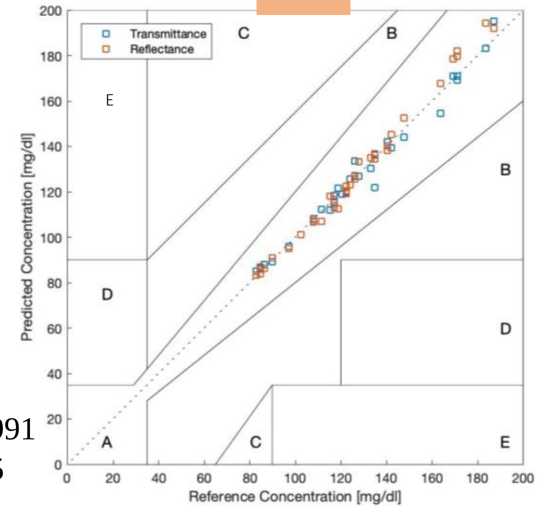
Transmittance: 0.995
Reflectance: 0.988

Adaboost



Transmittance: 0.987
Reflectance: 0.994

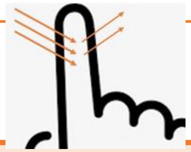
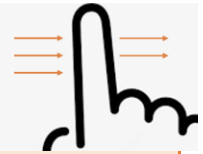
SVR



Transmittance: 0.991
Reflectance: 0.995

Performance

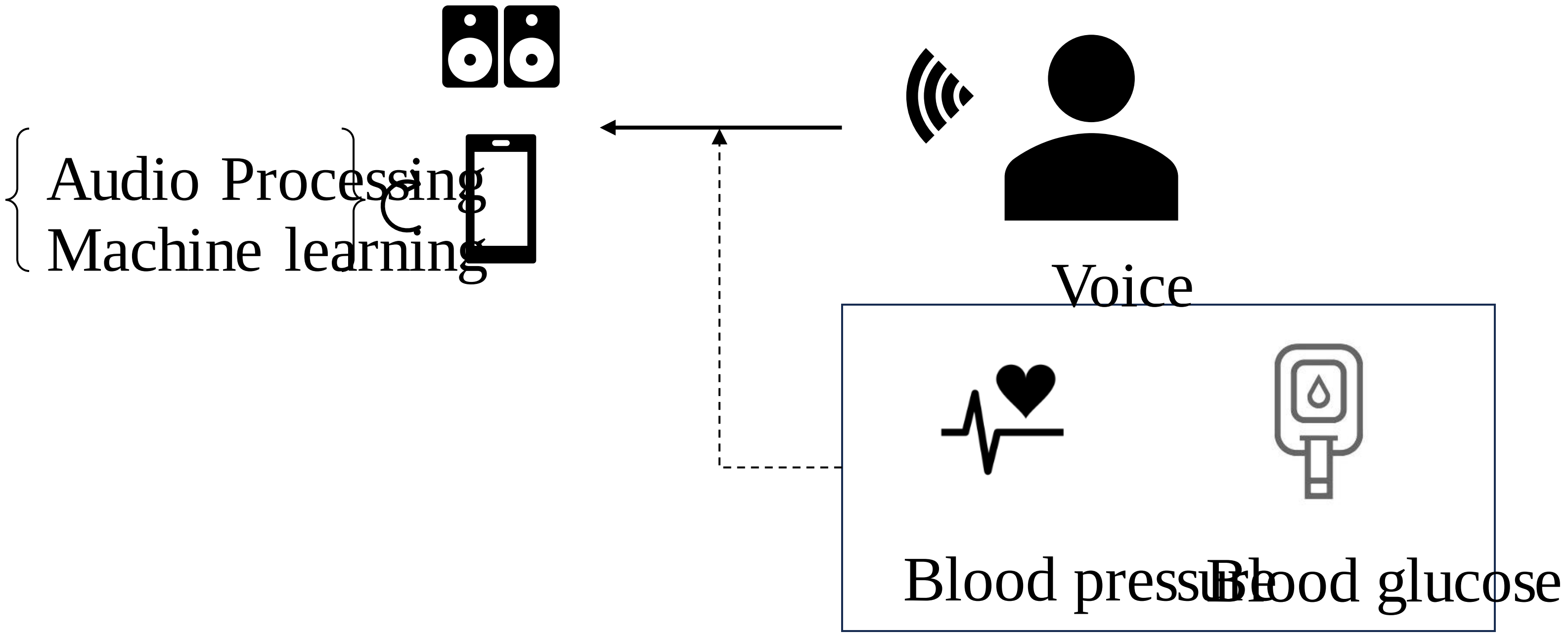
Table. Performance comparison of different prediction models (Target on finger)

	 **Reflectance**			**Transmittance** 		
	R square	RMSE	MAE	R square	RMSE	MAE
Random Forest	0.982	4.454	3.425	0.962	6.439	3.780
PLSR	0.320	27.124	22.250	0.199	29.428	24.128
SVR	0.976	4.305	3.055	0.982	3.750	2.540
Adaboost	**0.984**	**4.151**	3.072	0.975	5.220	3.485
Decision Tree	0.945	7.691	5.091	0.892	10.830	6.737
XGBoost	0.974	5.281	4.355	**0.990**	**3.300**	2.713
ANN	0.716	36.367		0.825	16.732	

Research topic

Disease diagnosis from speech

- getting audio from smart devices (ex. phone, watch, speaker)

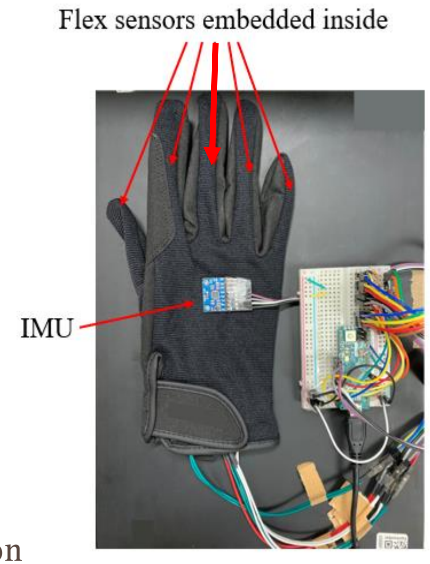


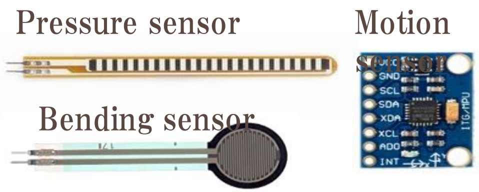
Sign Language Recognition Using ML

Sign language data acquisition → Pre-processing and learning → Recognition

❑ Sensor gloves

- Bending sensor: each finger ⟶ Detect finger band
- Motion sensor：back of hand ⟶ Detect hand movement
- Pressure sensor：Wrist ⟶ Detects pressure changes around the wrist due to muscle and tendon movement





Proposed scheme (4/9)

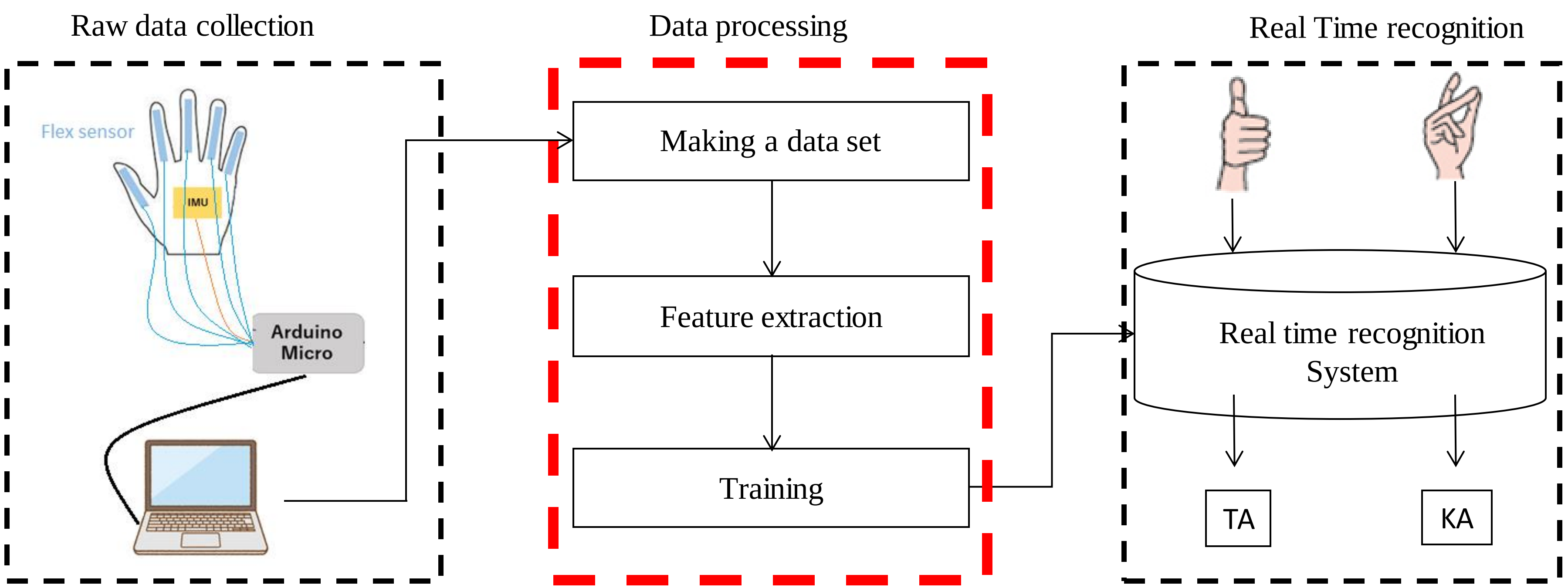
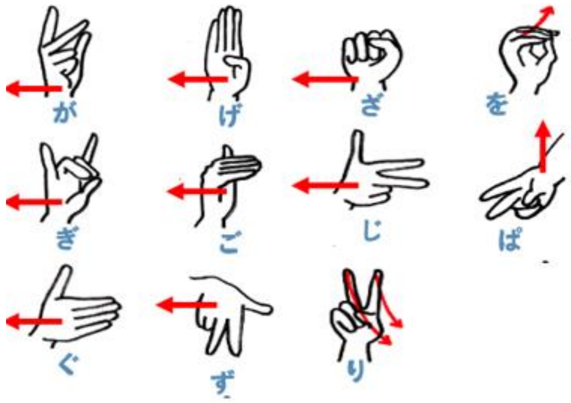


Fig.3 Proposed system

Sign Language Recognition Rate by ML

Accuracy (%)	Algorithm			
	SVM	*KNN*	*DT*	*RF*
LINE "A"	97.00	100.00	80.00	100.00
LINE "KA"	100.00	100.00	100.00	100.00
LINE "SA"	100.00	100.00	98.00	100.00
LINE "TA"	99.00	99.00	99.00	99.00
Average Accuracy	**99.00**	**99.75**	**94.25**	**99.75**



View from the other party