Person Tracking and Identification based on Features from Depth sensors

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Background

- It is getting popular to use camera to identify and track people
  - The information can be used as big data.
- In case of Osaka station city in 2014.
  - take photograph people's face
  - It was criticized very much.

朝日新聞　２０１４年１月６日　朝刊　１ページ　大阪本

大阪駅ビル 顔で追跡

4月から実験

カメラ90台 行動把握

JR大阪駅の駅ビル「大阪ステーションシティ」（大阪市北区）で通行人の顔をカメラ約90台で撮影し、その特徴を登録して同一人物を自動的に追跡する実験が4月から始まる。顔認証技術＝📷＝の精度を確かめるのが狙いで、データは個人が識別できない処理をしたうえで、JR西日本に提供されるという。不特定多数の人を撮影しデータを収集する行為に、専門家はプライバシー侵害への懸念を示している。▼31面＝こっそり収集

大阪ステーションシティの地下通路にはすでに顔認証用カメラが設置されている

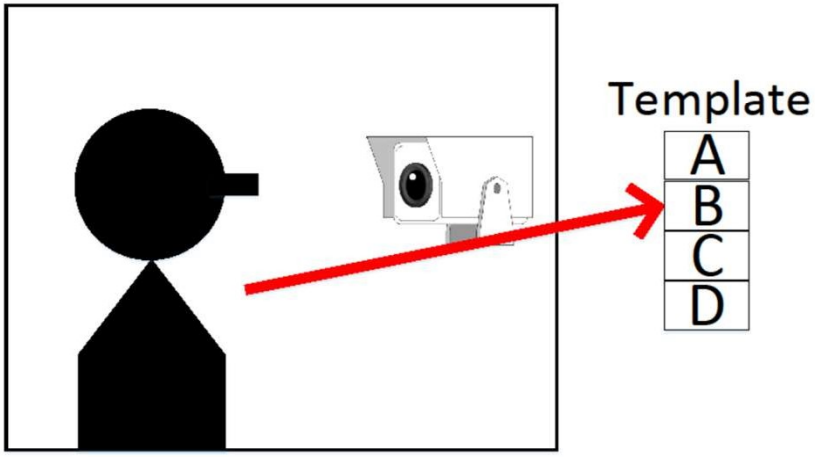
総務省所管の独立行政法人「情報通信研究機構」（東京都小金井市）がJR西日本とステーションシティを運営する「大阪ターミナルビル」の協力を得て、2年間実施する。実験では、各カメラで3㍍四方にいる数十人の顔を瞬時に撮影する。両目の幅など100カ所程度の特徴を抽出し、人の顔の特徴を抽出定のIDを与えて登別のカメラが同じ特つ顔を識別すると、物と判断して追跡。内での約1週間の行握できる仕組みだ。

JR大阪駅ビルでの顔認証実験の流れ

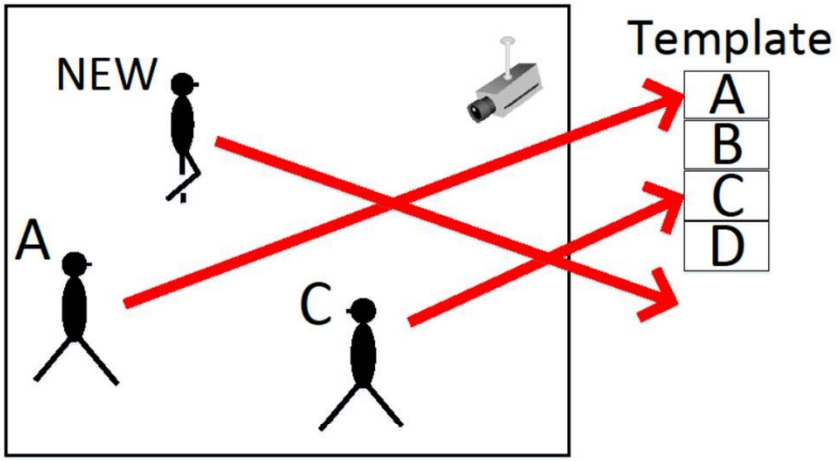
Asahi Newspaper 6/Jan/2014

Difference between Authentication and Tracking

Authentication



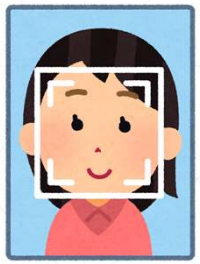
Tracking

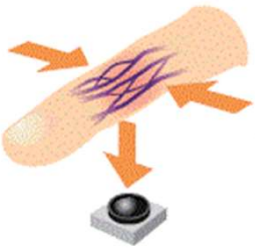


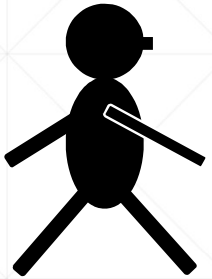
	Authentication	Tracking
application	prove that I am proper user	analyse movement
target	**cooperative**	**noncooperative**
desired accuracy	high	low
matching	$1:n$	$m:n$
privacy care	**unnecessary**	**necessary**
threat	pretend to be proper user	recognized to other person

Various biometrics

	suitable for authentication	suitable for identification
face	✓	✓
vein	✓	—
fingerprint	✓	—
gait	**—**	**✓**







- gait
  1. Very long range.
  2. Accuracy is not so high → It has high privacy.
  3. Less sensitive information than others.

Objective

We aim to develop a privacy-friendly person tracking system based on gait.

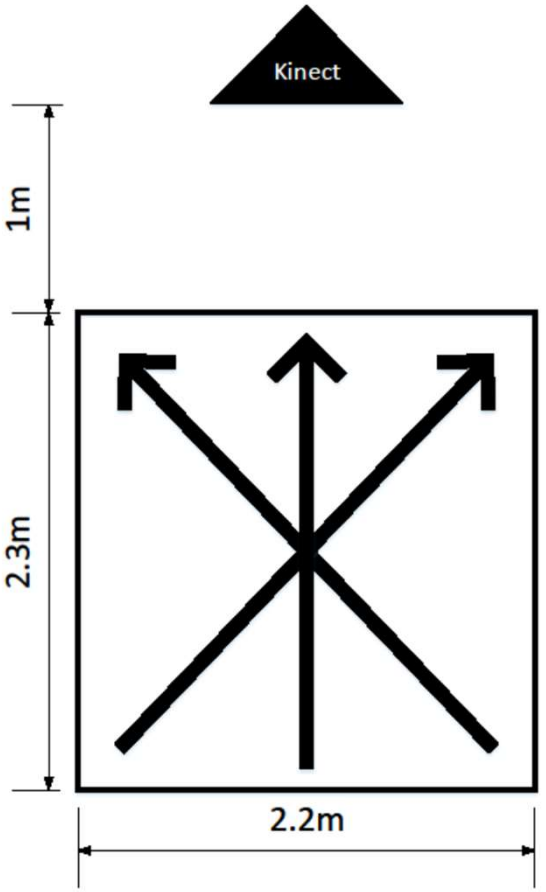
Outline of Proposed System

1. Data Capture
2. Define Features
3. Preprocessing / Postprocessing
4. Tracking

1. Data Capture

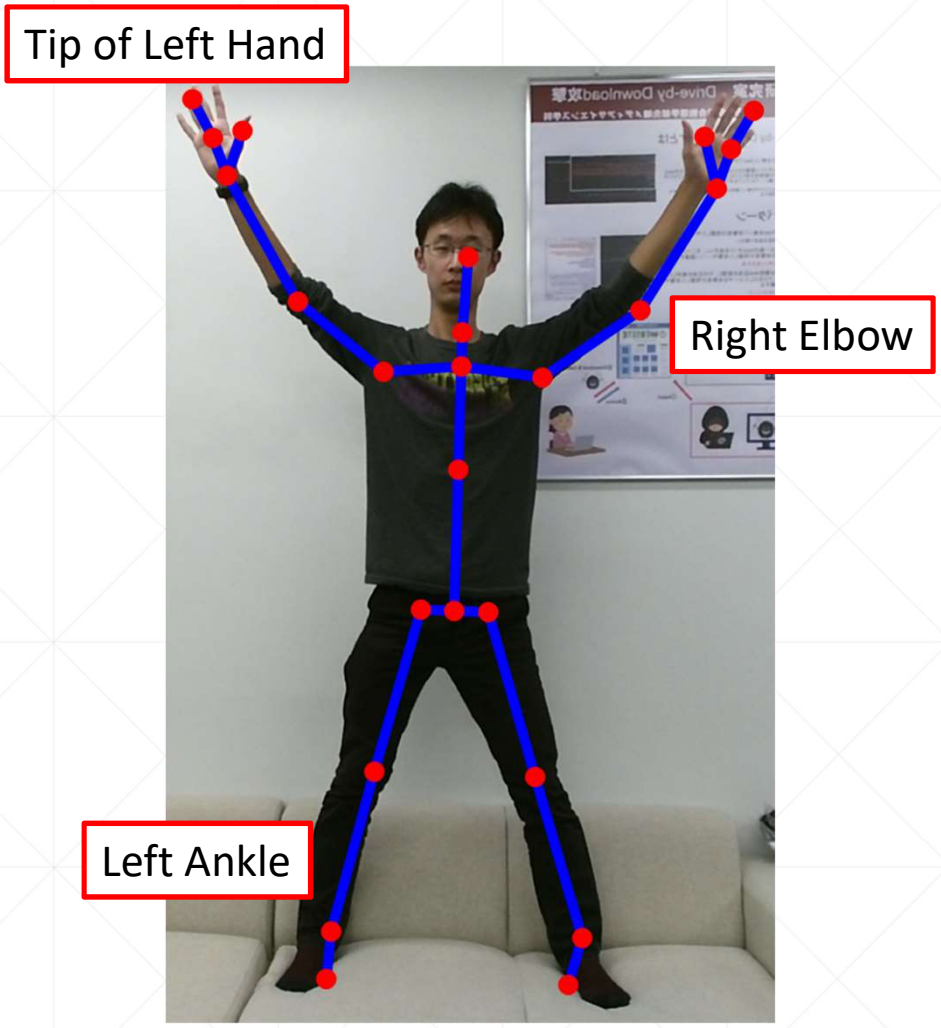
- We observed walking subjects.
- Subjects walked twice along three arrows.

	Value
Term	August 2017
Number of Subjects	10
Number of Walking per Subjects	6

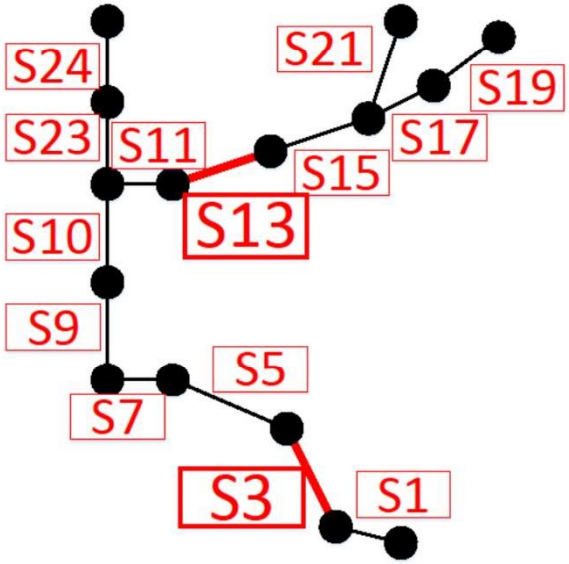


2. Skeleton Data

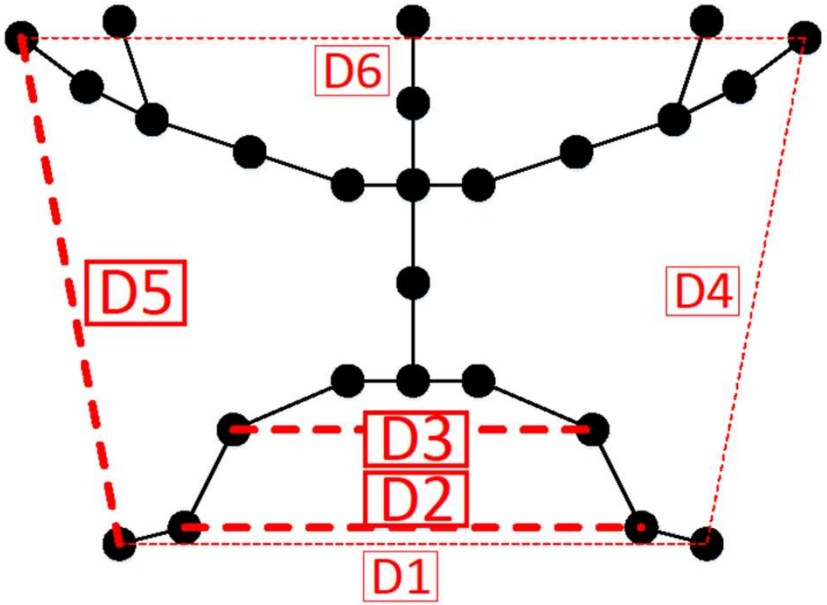
- Microsoft Kinect V2
- We capture three-dimensional coordinates of 25 joints called skeleton data



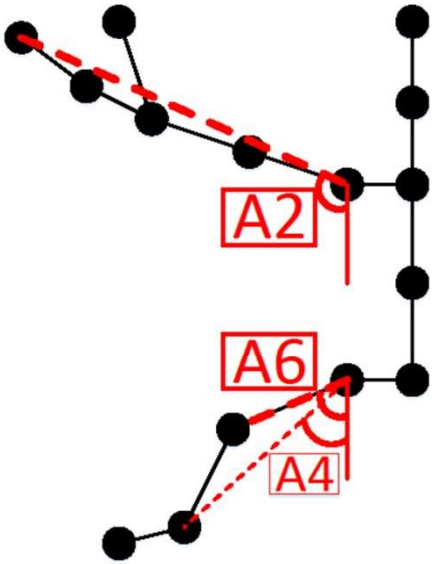
2. Define Features



Static Distances
S1～S24



Dynamic Distances
D1～D6



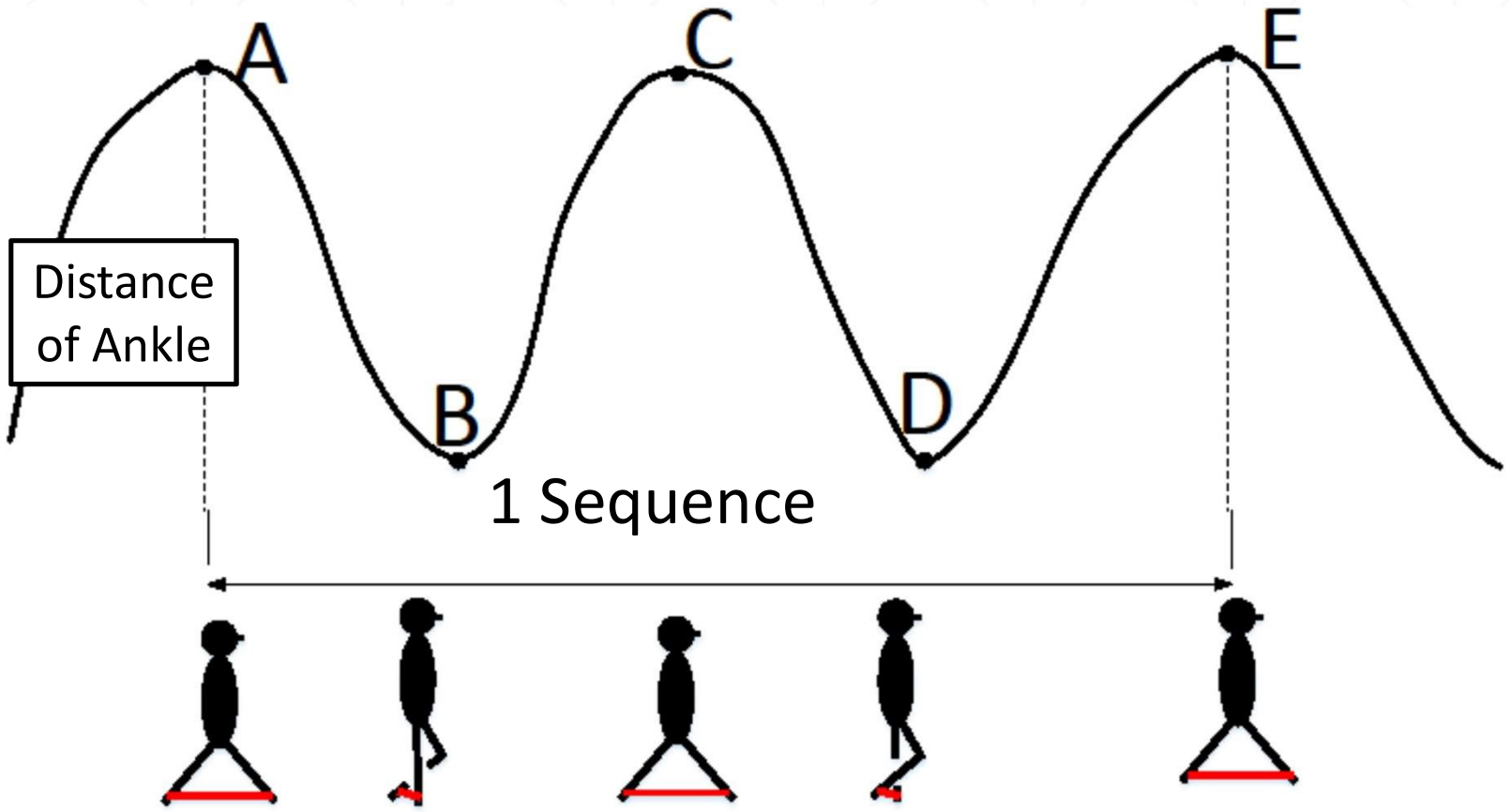
Dynamic Angles
A1～A6

- There are too many candidates (total: 36)

Research Question

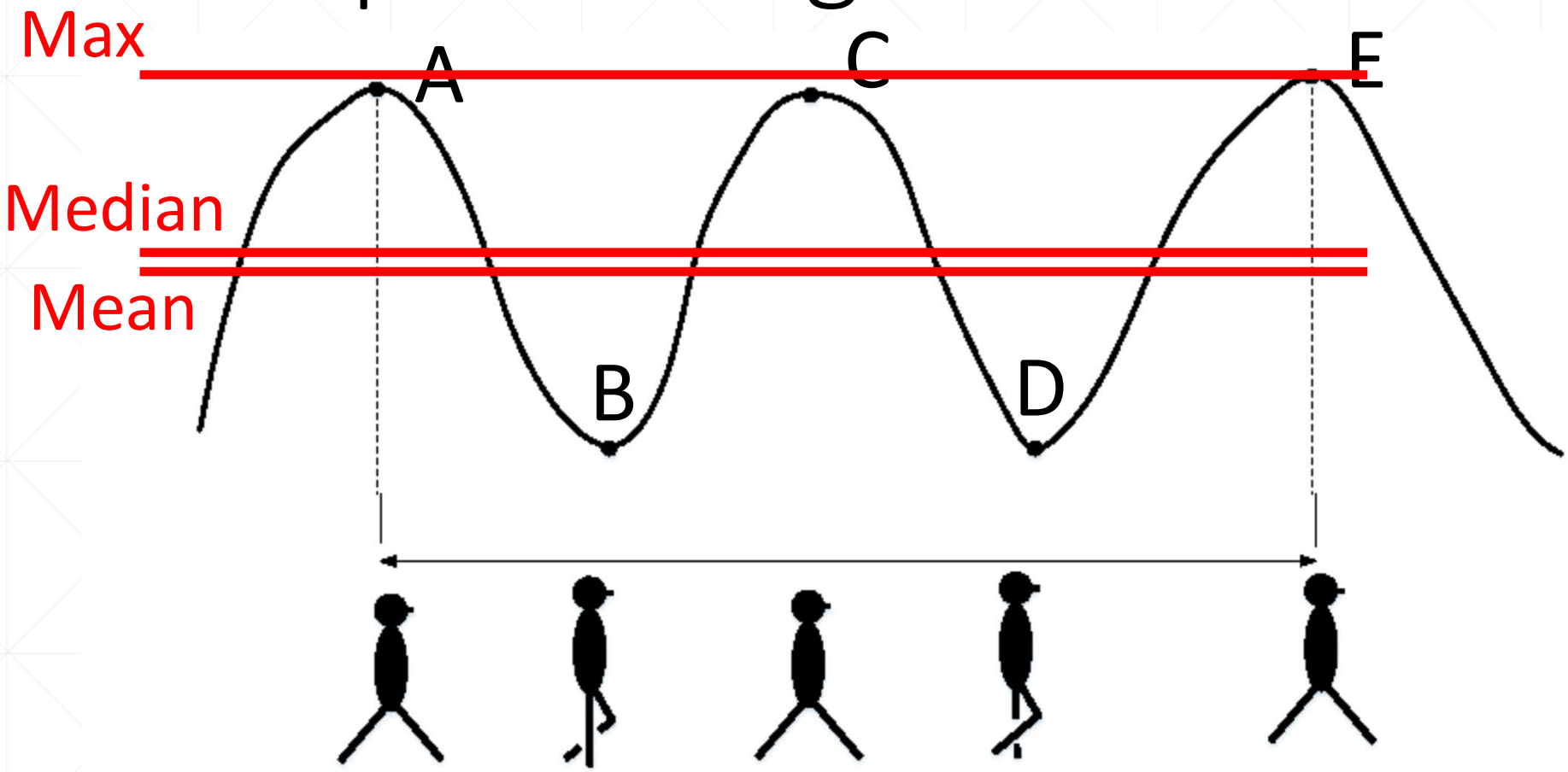
1. How much does a feature **differ** from person to person?
2. How **stable** a feature is in same person?
3. How much accuracy is improved by combining several features.

3. Preprocessing



Distance of Ankles

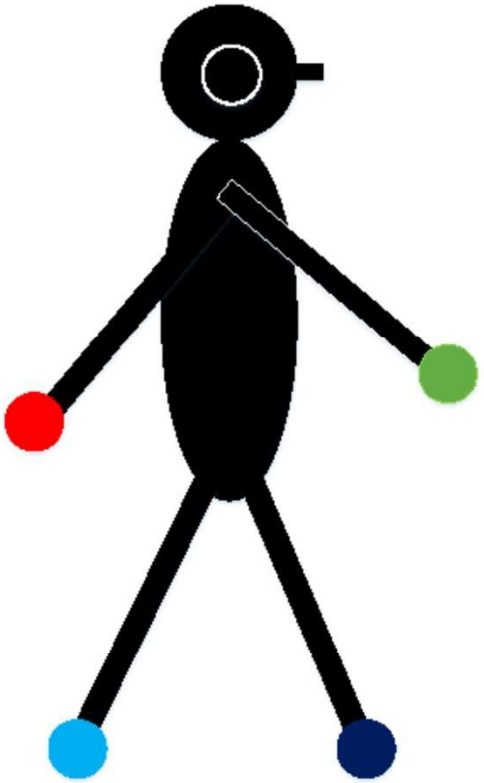
3. Postprocessing

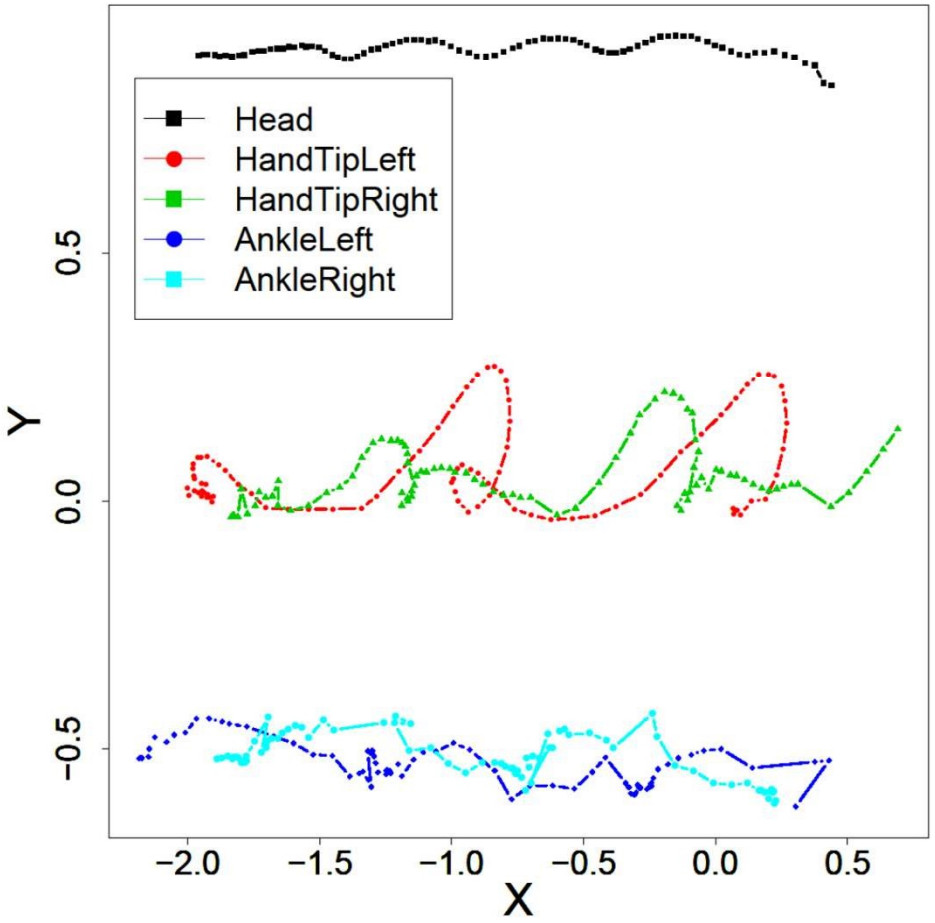


4. Tracking

- $f_{i,k}$ is a user i's kth feature.
  - θ is threshold. If compare $f_{i,k}$ and $f_{j,k'}$,
  - $same(i,j) = \begin{cases} \mathrm{T} & if\ |f_{i,k} - f_{j,k'}| \leq \theta \\ F & otherwise \end{cases}$

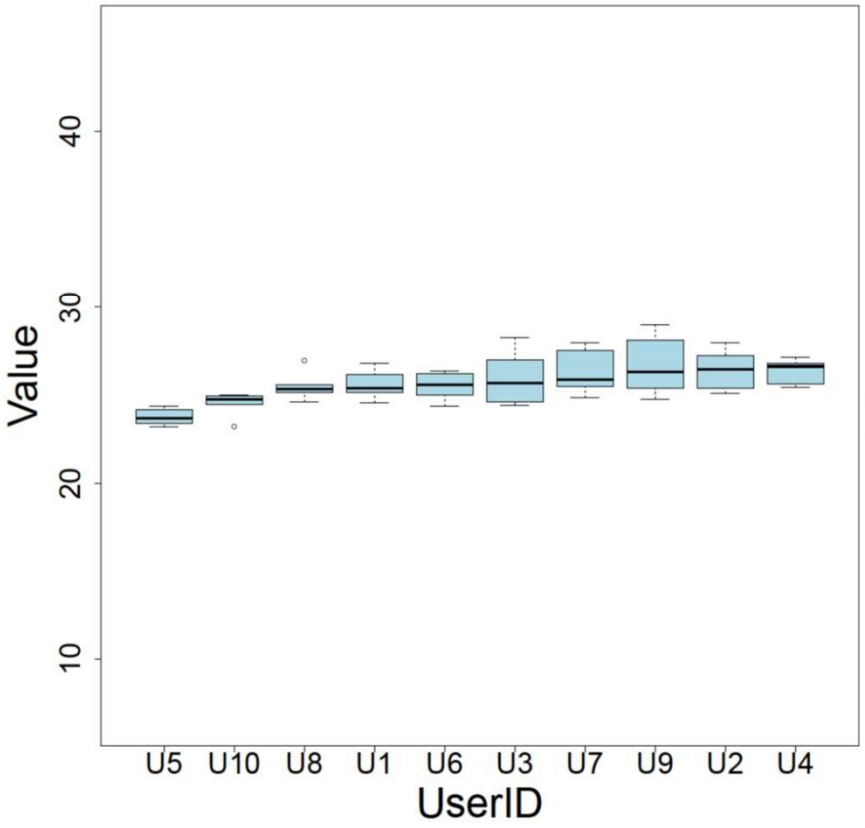
Sample of Captured Data



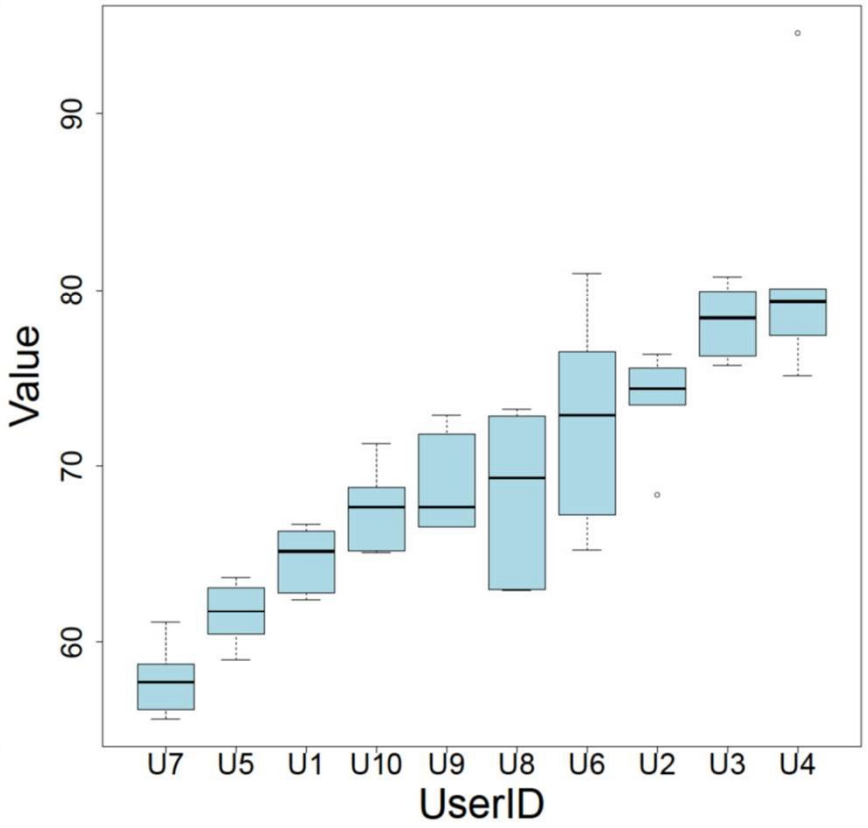


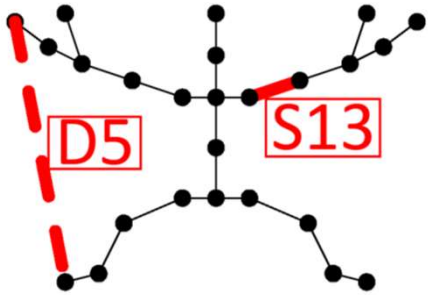
Distribution of $\mu(S_{13}), \mu(D_5)$ of all users

$\mu(S_{13})$

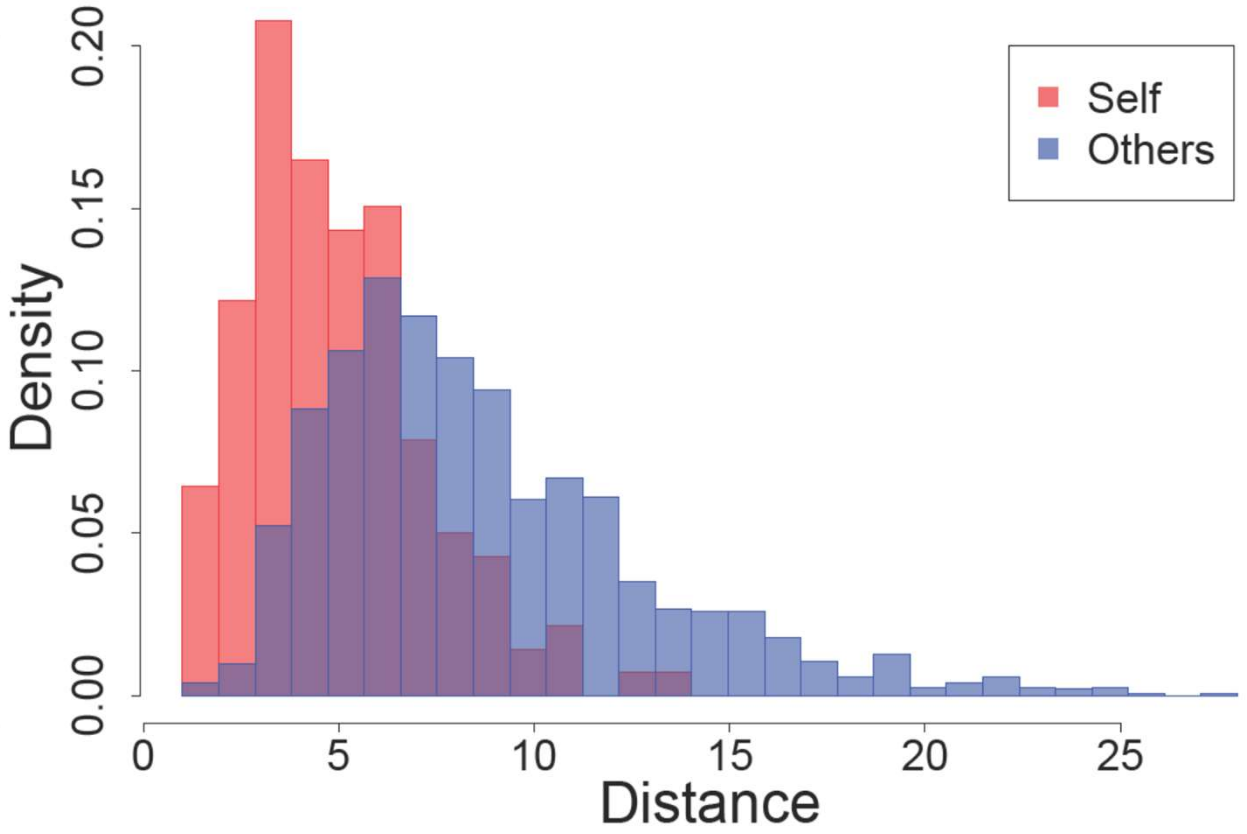


$\mu(D_5)$

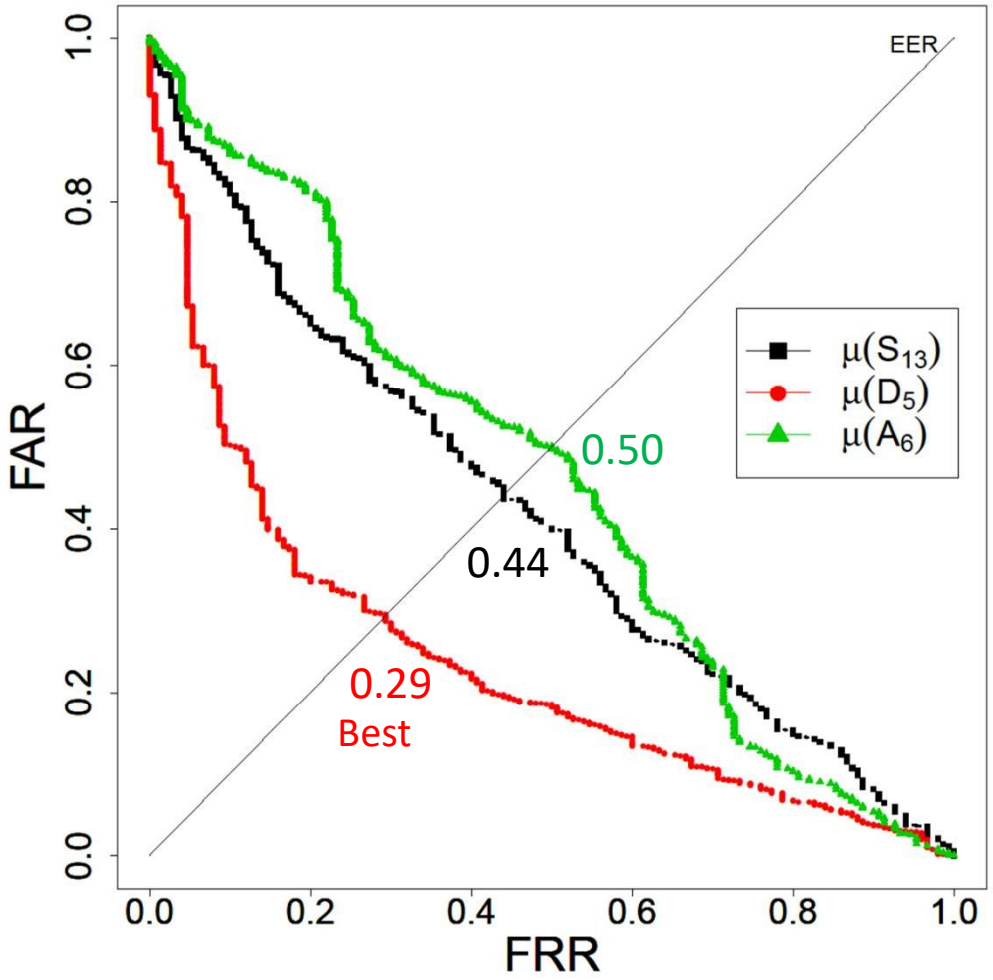


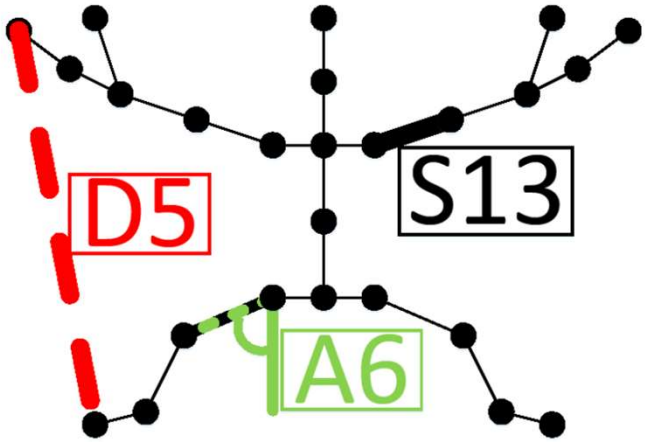


Distance between myself and with others when combine features



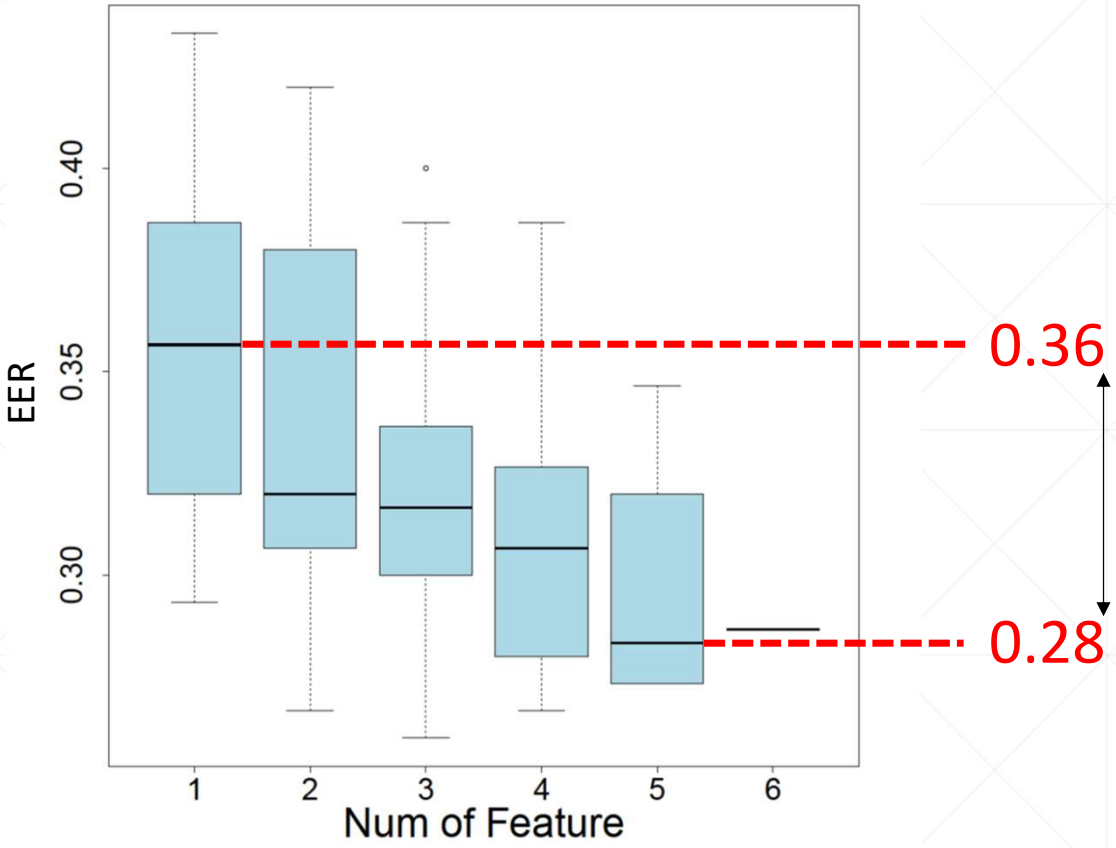
Sample of Features





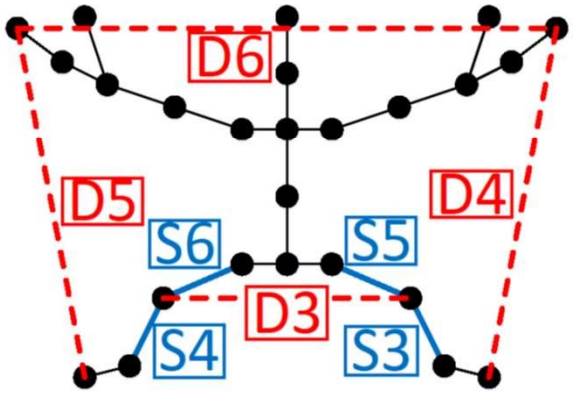
EER when combine features

(Max of dynamic distance)



Combine 5 features
improve EER 0.08 reduction

Top5 & Worst5 in EER



Top5

Features	EER
$\mu(S_3), \mu(S_4), \mu(S_5), \mu(S_6)$	0.23
$\mu(S_2), \mu(S_3), \mu(S_4), \mu(S_6)$	0.24
$\mu(D_4), \mu(D_6)$	0.25
$\mu(D_3), \mu(D_5)$	0.25
$\mu(S_3), \mu(S_6)$	0.26

Worst5

Features	EER
$max(S_7)$	0.55
$median(S_7)$	0.52
$\mu(S_2), \mu(S_7)$	0.51
$\mu(A_6)$	0.50
$\mu(S_2)$	0.49

Summary and Future Work

- Summary
  - In this work, We proposed a new gait tracking method and evaluated it.
    1. In single feature, D_5(RightHand-LeftHand) is best.(EER=0.29)
    2. In case of combined, $S_{3,4,5,6}$(leg length) is best.(EER=0.23)
    3. In case of combined, EER can be improved with 5 features, as 0.08.
- Future Work
  - To find more efficient identification method.