Gait-based Person Authentication by Wearable Cameras

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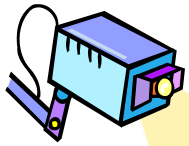
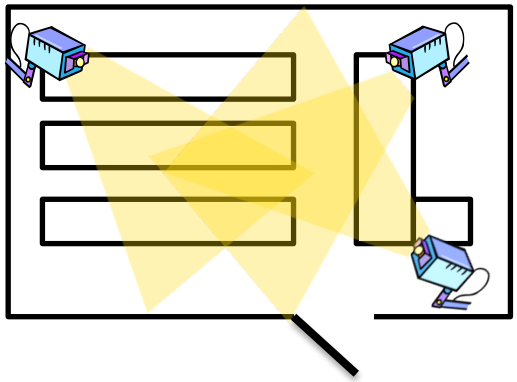
Presenter: Kohei Shiraga
Coauthors: Ngo Thanh Trung
Ikuhisa Mitsugami
Yasuhiro Mukaigawa
Yasushi Yagi

The Institute of Scientific and Industrial Research, Osaka Univ.



Background

- Surveillance Cameras
  - Stores, banks and stations, etc.
  - Useful for crime-prevention
- Problem: **blind spots**

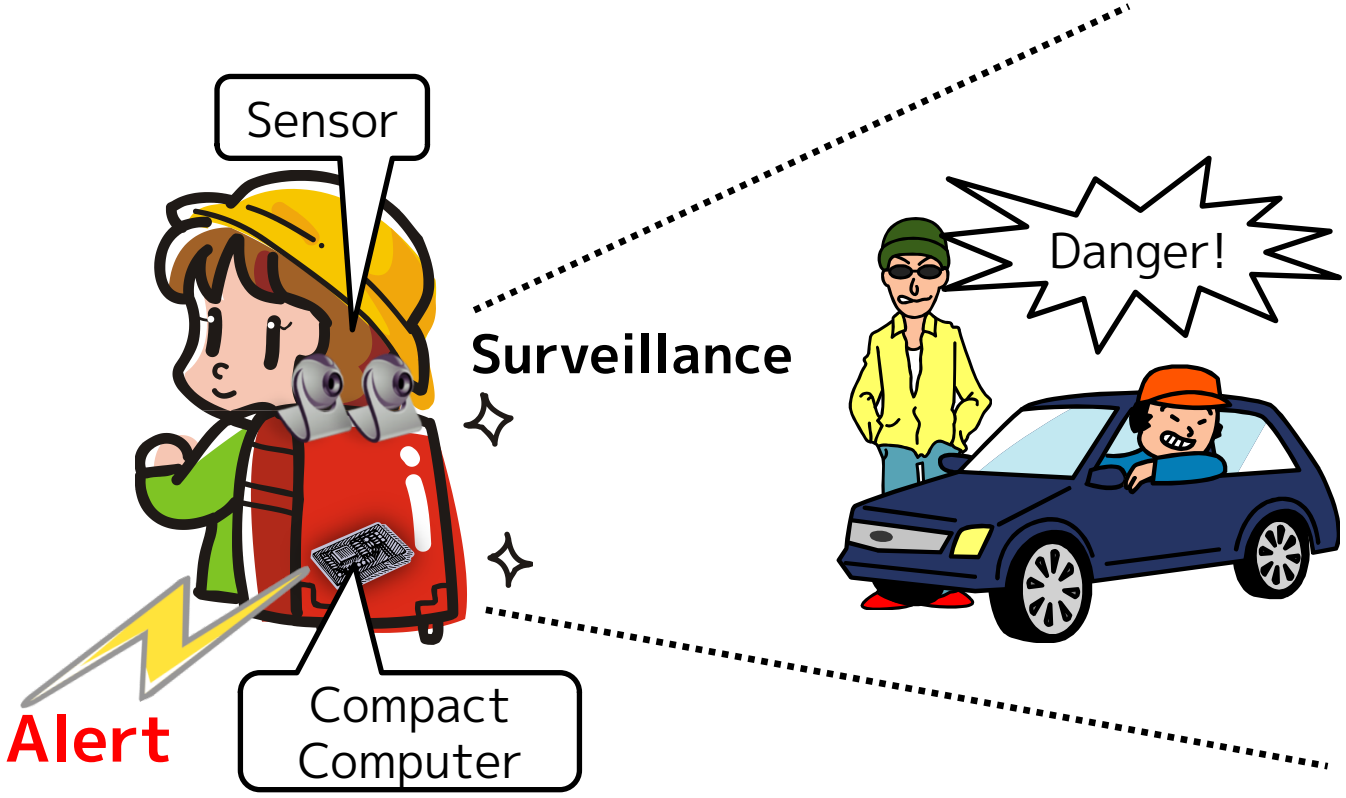


back alley

- **A new technique for crime-prevention is required**

Wearable surveillance (WS)

- A new concept for crime-prevention
  - Use WS system
  - WS system observes & analyzes environment



WS system

- WS systems must:
  - Be compact and lightweight
  - Be Stand-alone

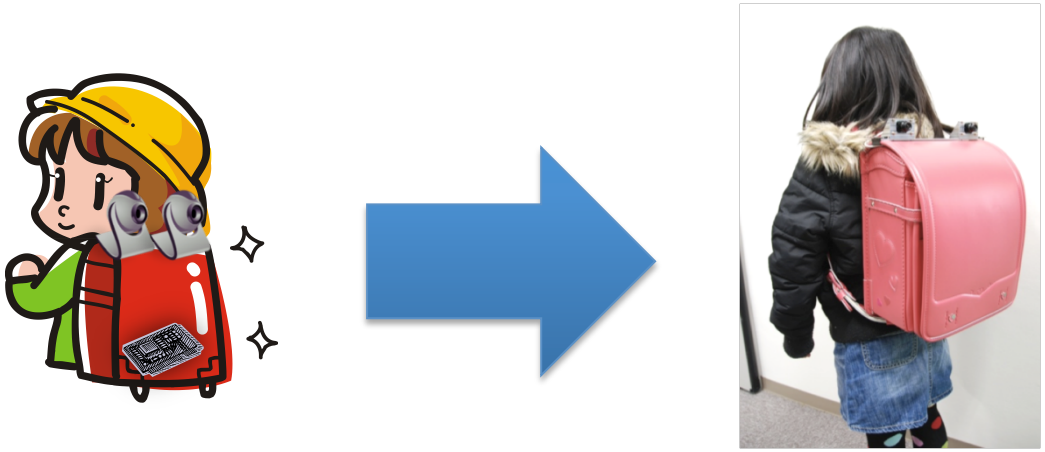
- Required functions
  - **User authentication**
  - Scene understanding
  - Notification

Stolen

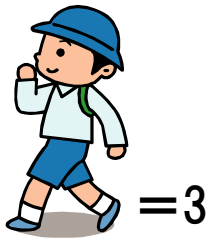
Chased by

Our contributions

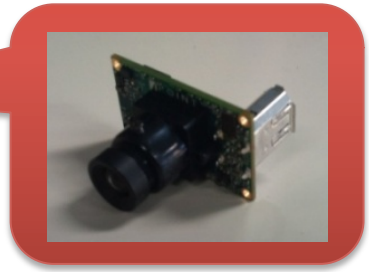
- A prototype system



- User Authentication for WS systems
  - The wearer == The owner ??
  - Gait-based method
  - Implement on the prototype



Prototype



Stereo camera pair
FFMV-03MTC x2
(Point Grey Research)

Compact computer
NXV1-1394-PCB
(Fujitsu Kyushu
Network Technologies)

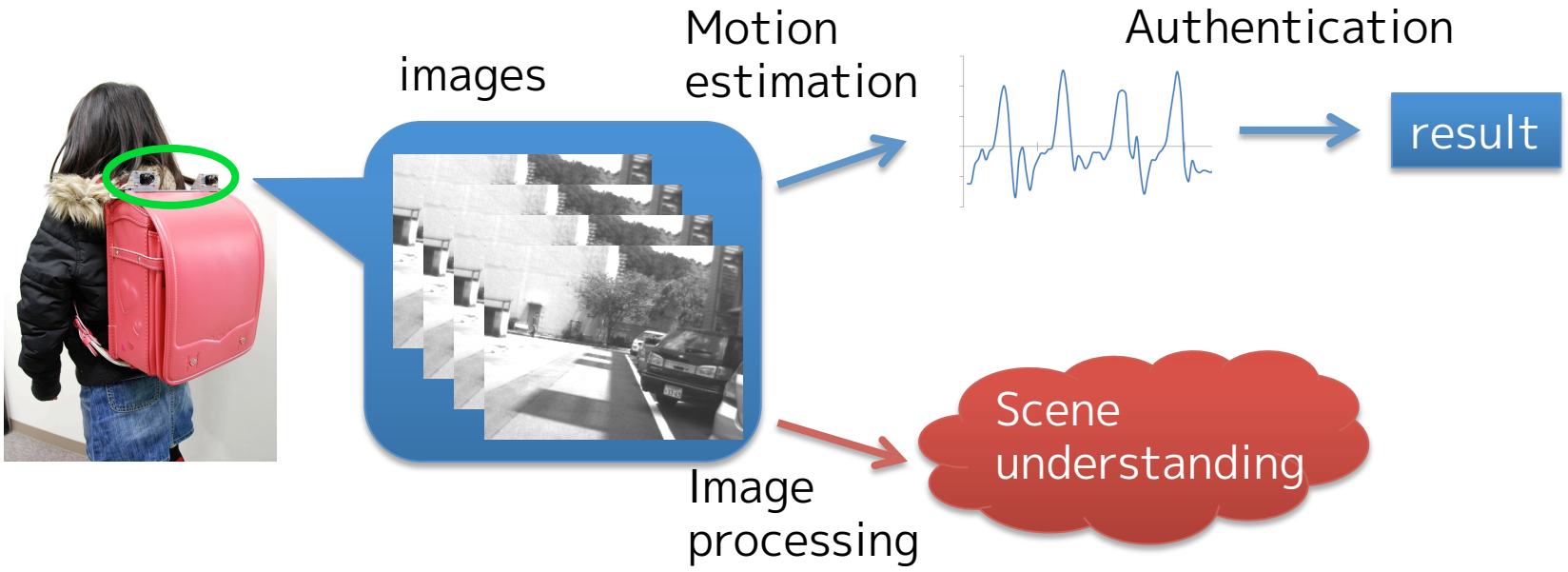
Battery
XP8000
(XPAL Power)

Has an **image processor**
Real-time image processingz

600g weight
(except for the school bag)

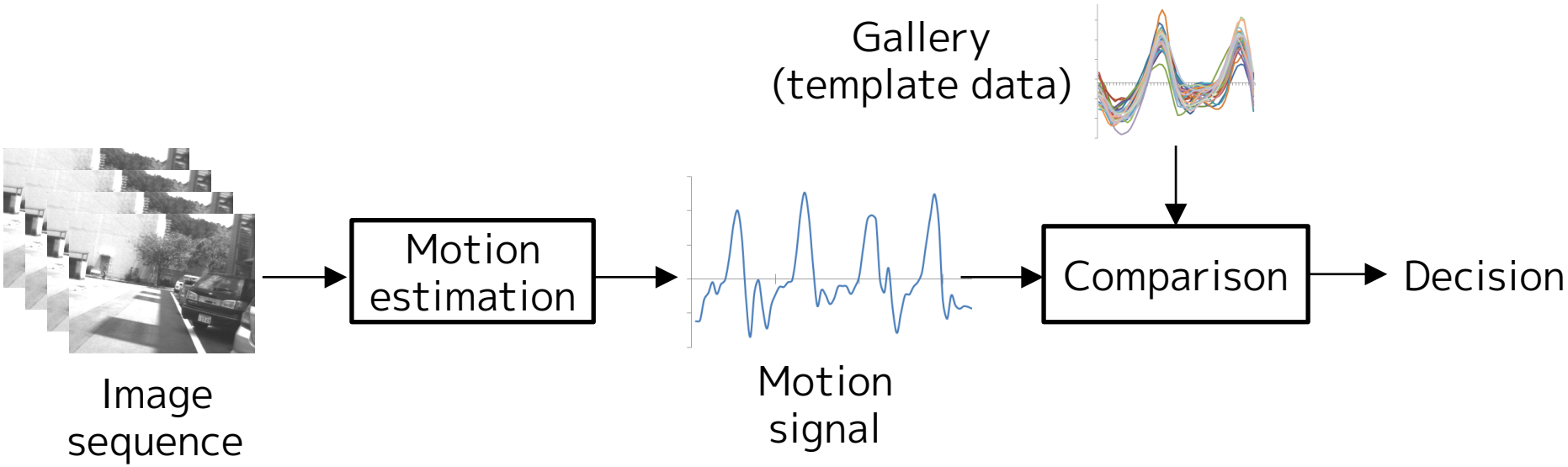
Gait-based user authentication for WS systems

- Utilize wearable cameras
  - Gait signal estimated from continuous images
  - Authenticate the user based on such signal
- Authentication as well as observation



Proposed authentication method

- Outline

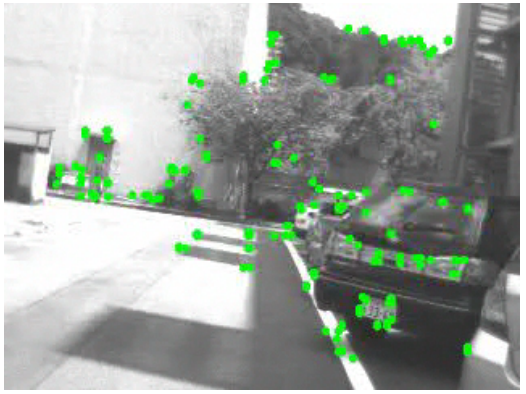


Motion estimation

- Real-time robust motion estimation[Trung et al.]

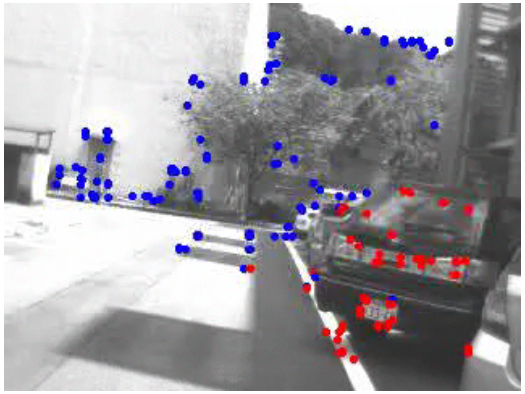
Raw image

Feature point detection



Classifying into far/near

far
near



Motion Signal (Rotation)

RANSAC-based estimation
Using **only far points**

Motion estimation on prototype

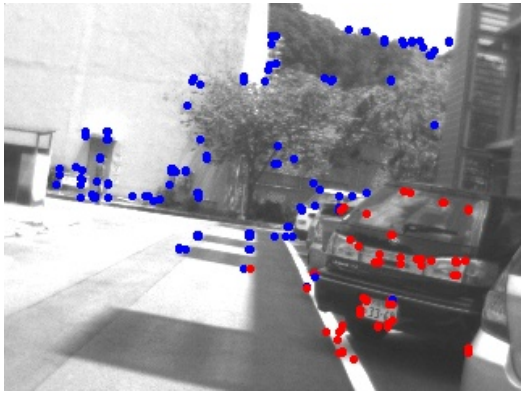
- Apply hardware acceleration

Raw image

Feature point detection

Classifying into far/near

far
near



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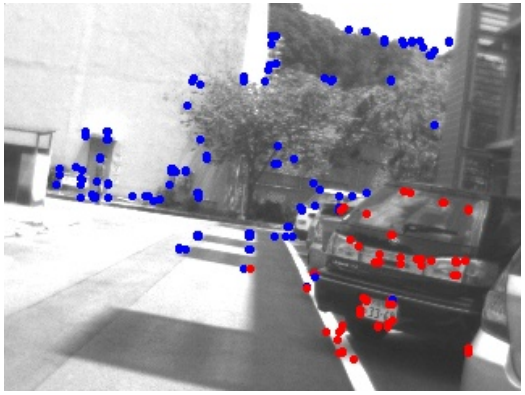


far
near

RANSAC
Using **or**

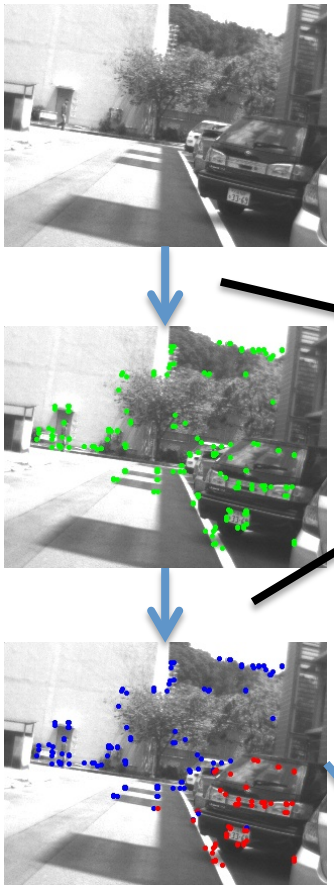
Utilize the image processor

n

tion)

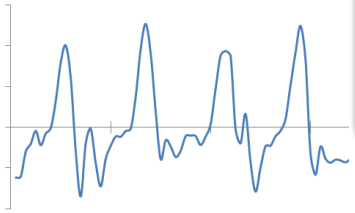
Motion estimation on prototype

- Processing time



Time required for estimation between f_{t-1} and f_t

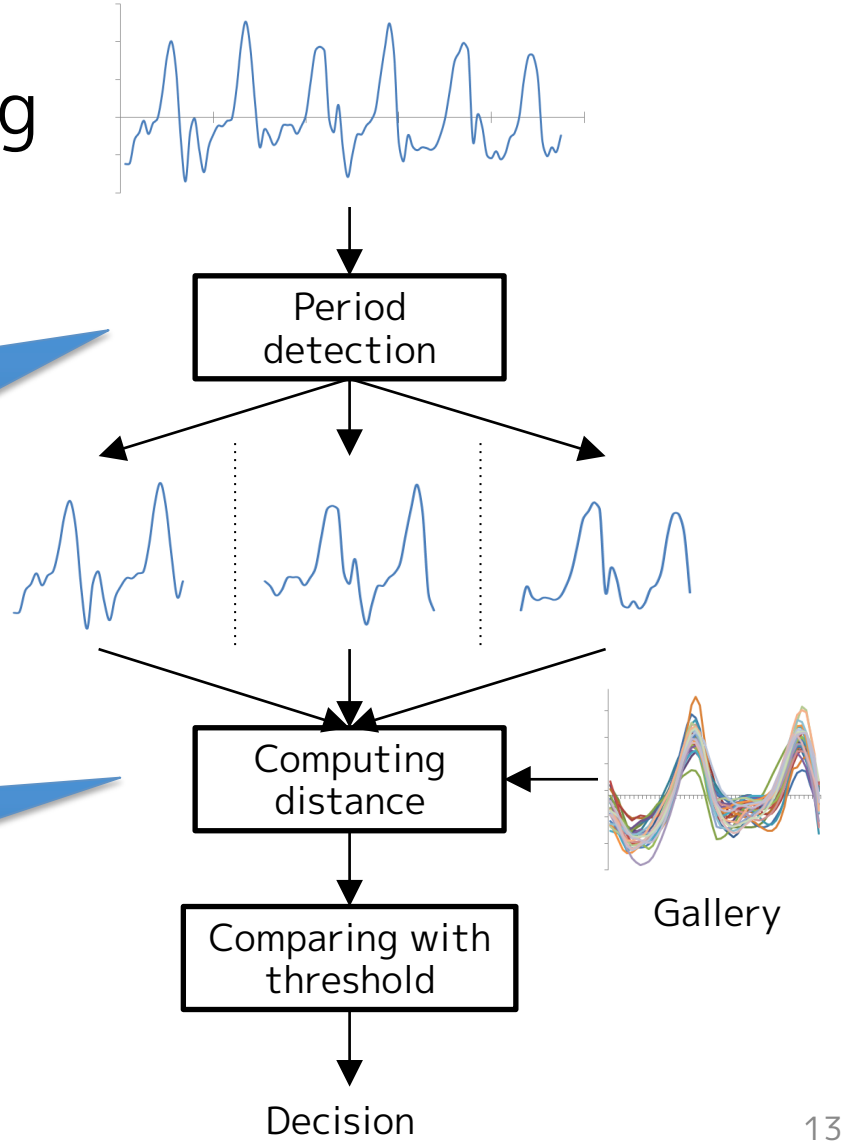
	Duration [ms]
Feature point detection	**3.8**
Far/near classification	**3.7**
RANSAC-based estimation	22.5
Total	**30.0**



Achieved **real-time** estimation for 30fps input stream

Comparison with gallery

- Period-based matching



Self-DTW
(Self Dynamic Time Warping)
[Makihara et al.]

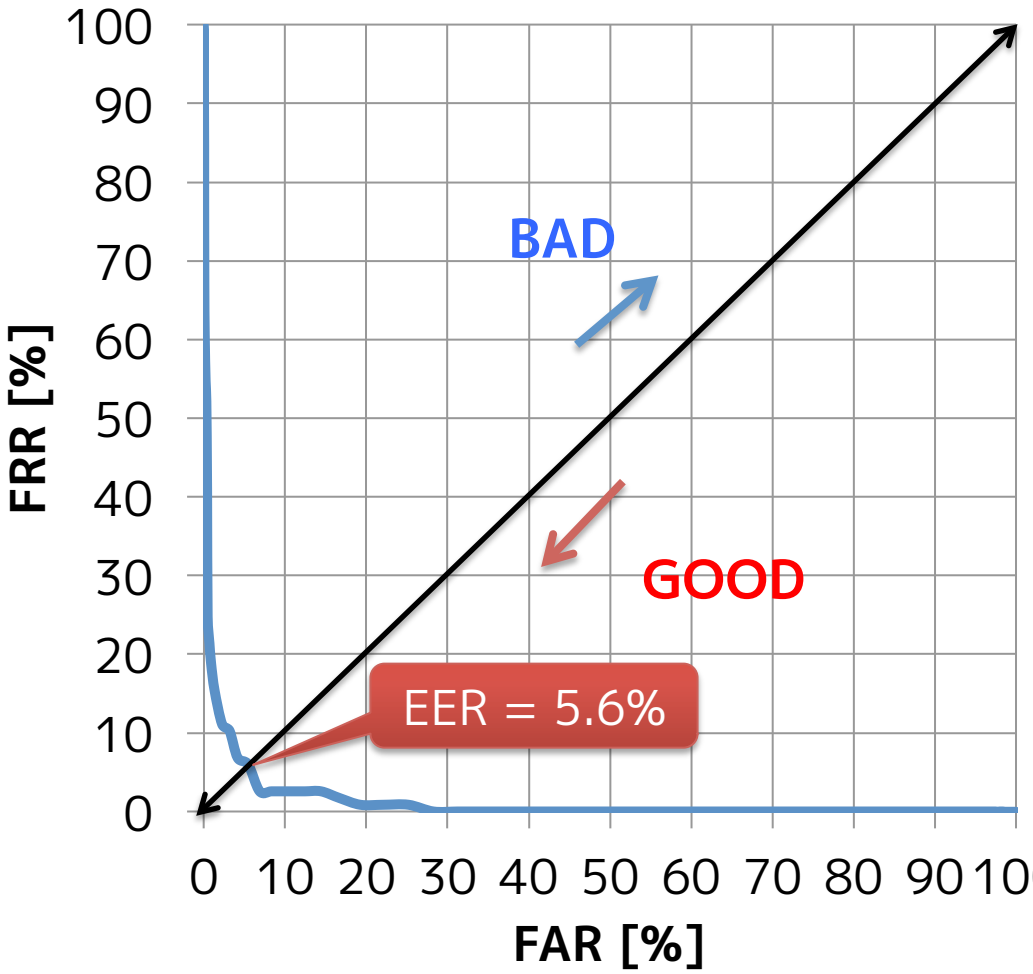
DTW-based matching
[Trung et al.]

Experiment

- Settings
  - Using our prototype system
  - 39 adult subjects
    - Outdoor
    - Natural walking speed
    - 30 seconds × 4 sequences
      - one sequence for **gallery**
      - three sequences for **input**

Results

- ROC curve



ROC curve:
describes the trade-off between FAR and FRR

		Ground Truth	
		Genuine	Imposter
Estimate	Genuine	TAR	**FAR**
	Imposter	**FRR**	TRR

FAR: False Acceptance Rate
FRR: False Rejection Rate

EER:
The error rate where FAR = FRR

Results

- EERs
  - comparable to the accuracy of existing methods using motion sensors

	# of subjects	Sensor type	EER [%]
Ailisto et al.	36	accelerometer	6.4
Gafurov et al.	21	accelerometer	5-9
Mantyjarvi et al.	36	accelerometer	7-19
Trung et al.	32	accelerometer	6.0
Our method	**39**	**camera**	**5.6**

Conclusion

- Prototype system
  - Using a hardware specialized for image processing
- A novel user authentication method for WS systems
  - Utilizing motion estimated from camera images
- Evaluated with real data from 39 subjects
  - The accuracy of our method is comparable to those of existing methods

Future work

- Further development
  - Sophisticate our authentication method
  - Other functions for the WS system