Comparative study of path normalization for path prediction

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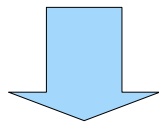[†] HIROSHIMA UNIVERSITY

[‡] NAIST

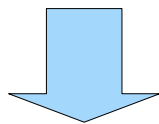[††] KYUSHU UNIVERSITY
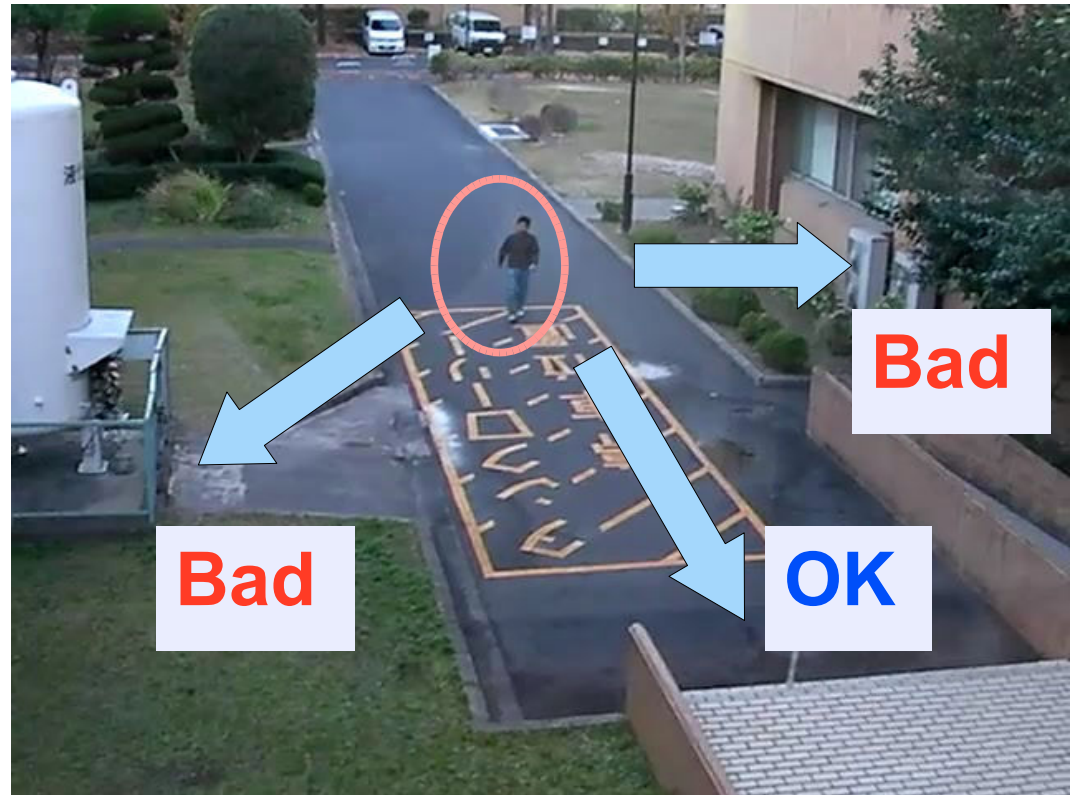
Background

Surveillance camera system

Current : Tracking

⬇

Next step ...
Judgment of
suspicious person

⬇

Future...
Walking path prediction
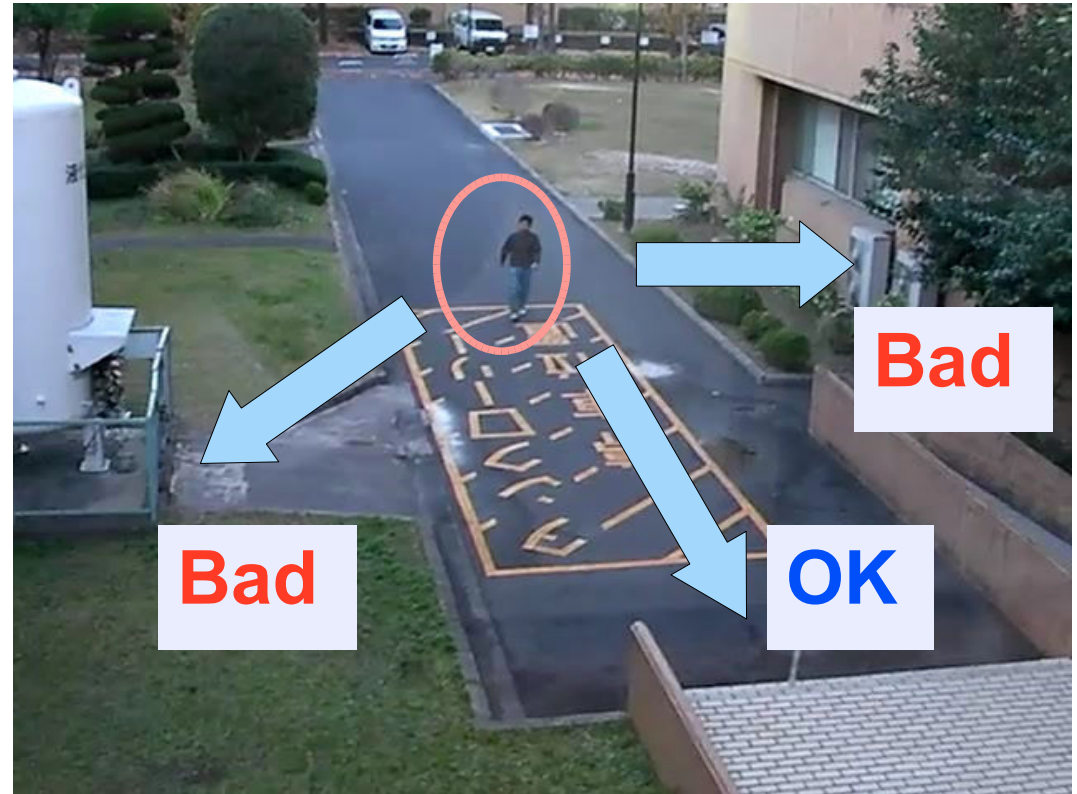
Literature review

Path prediction methods

- Kalman Filter

- Autoregressive(AR) model

- Eigenspace-based prediction (Yamamoto, 2004)

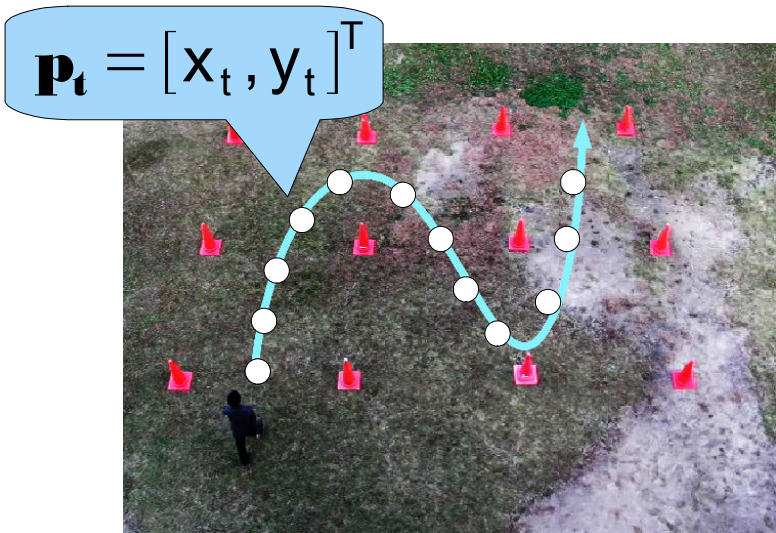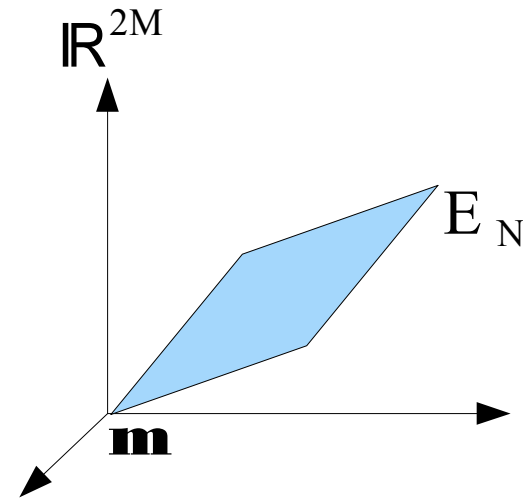**Bad**

Bad

OK

Walking path condition

- Not simple

- Depend on walking environment

Learning

$$\mathbf{p_t} = [x_t, y_t]^T$$

Walking path $[\mathbf{p}_1^T, \mathbf{p}_2^T, \dots]^T$

Learning N paths

$\mathbb{R}^{2M}$

E_N

$\mathbf{m}$

Making Eigenspace E_N
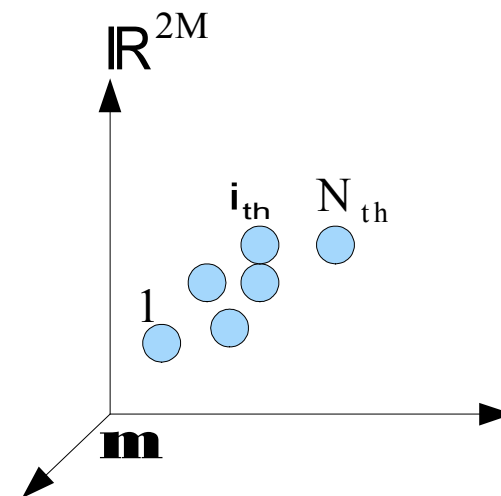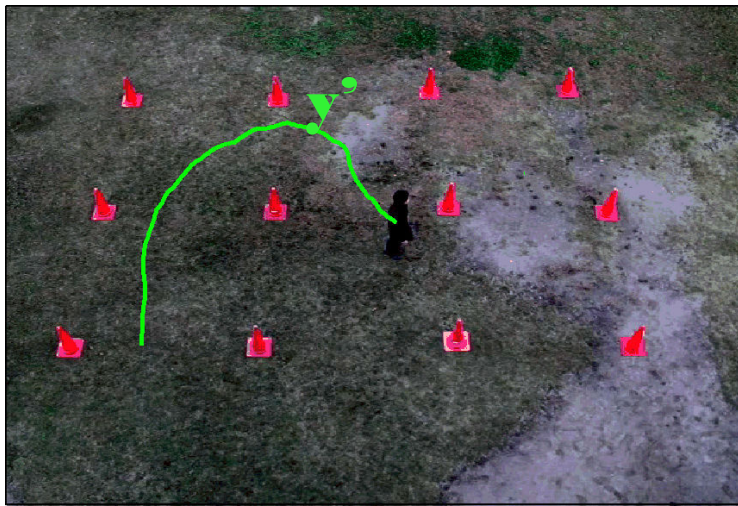
Normalization
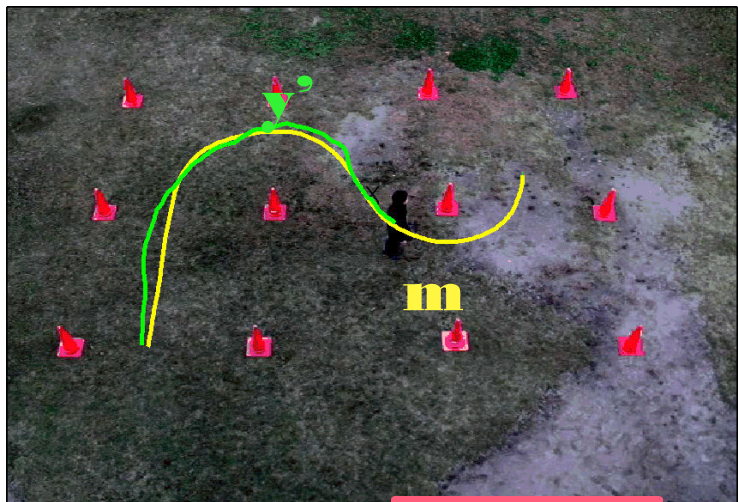
$$\mathbf{y} = [\mathbf{p}_1^T, \mathbf{p}_2^T, \dots, \mathbf{p}_M^T]^T$$

$\mathbb{R}^{2M}$

$\mathbf{i}_{th}$ N_{th}

1

$\mathbf{m}$
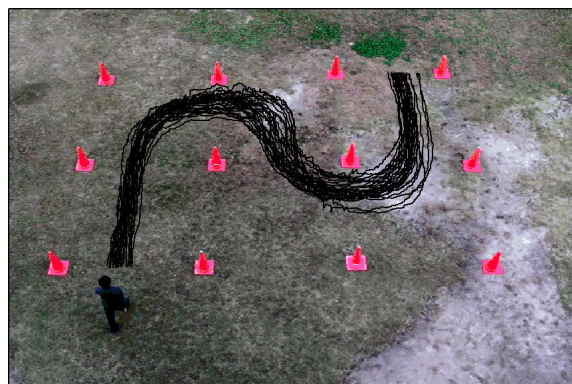
Prediction

$$\mathbf{y'} = [\mathbf{p}_{1,}^T \mathbf{p}_{2,}^T \ldots, \mathbf{p}_s^T]^T \subseteq \mathbb{R}^{2s}$$

$$\mathbf{y''} = [\mathbf{p}_{1,}^T \mathbf{p}_{2,}^T \ldots, \mathbf{p}_s^T, \boxed{\mathbf{m}_{s+1}, \ldots, \mathbf{m}_M}]^T \subseteq \mathbb{R}^{2M}$$

Projection

Inverse Projection

Problem & Objective
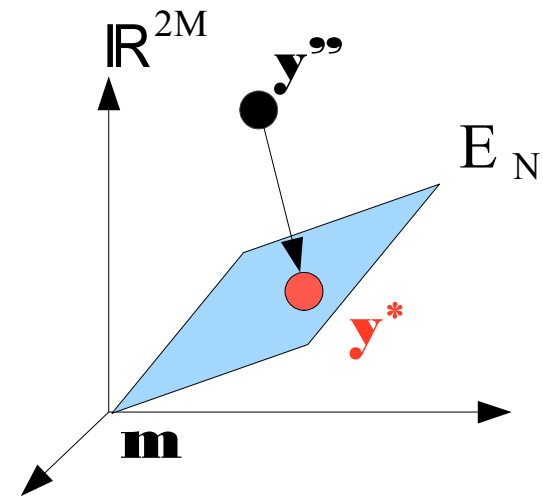
Problem

– Prediction path does not correspond to actual path

Reason

– Normalization of paths

Objective

– Investigation of

the effect of Normalization

- Resampling (Yamamoto, 2004)

- DP (Proposed)

Learning

$\mathbf{p_t} = [x_t, y_t]^T$

Walking path : $[\mathbf{p}_1^T, \mathbf{p}_2^T, \cdots]^T$

$\mathbb{R}^{2M}$
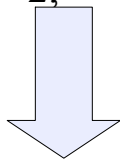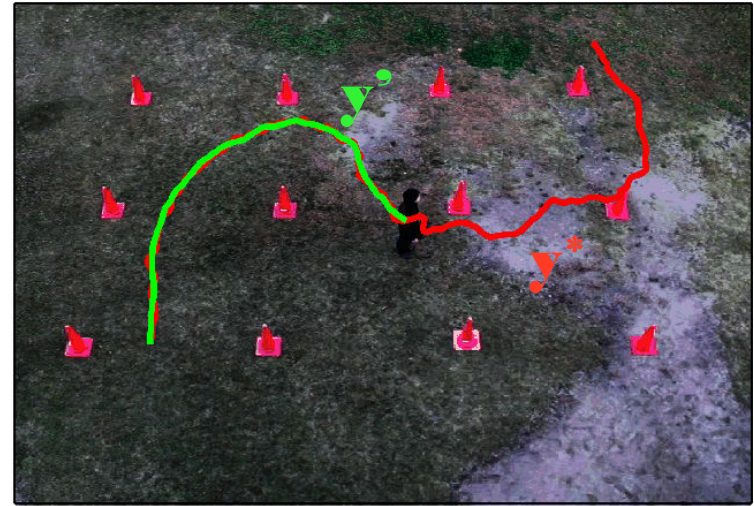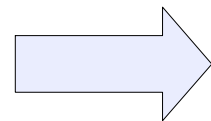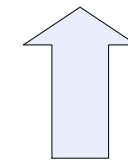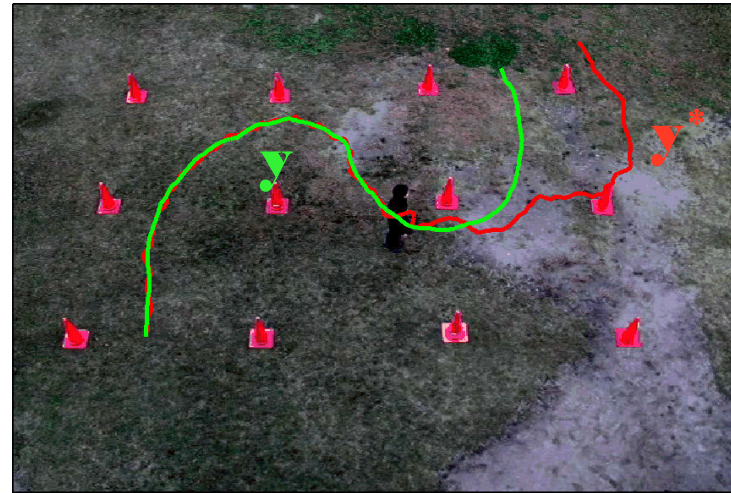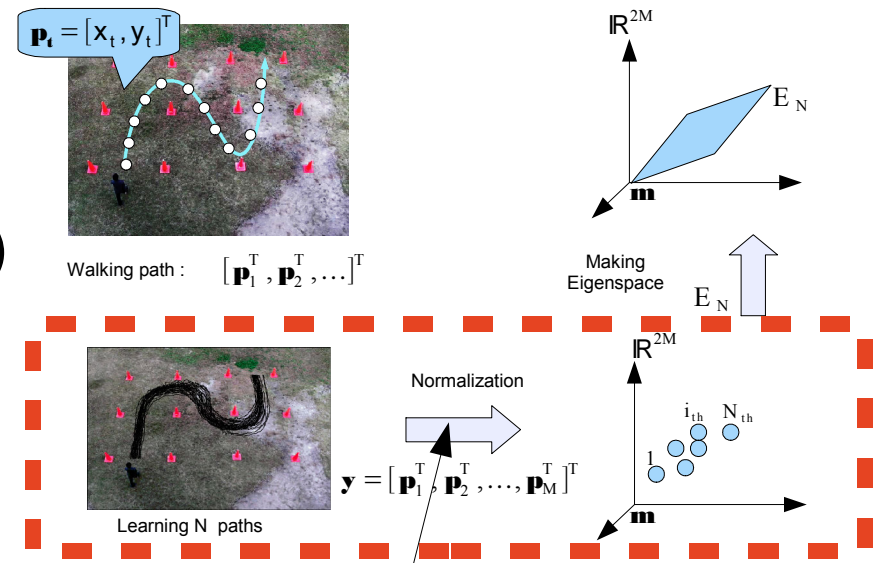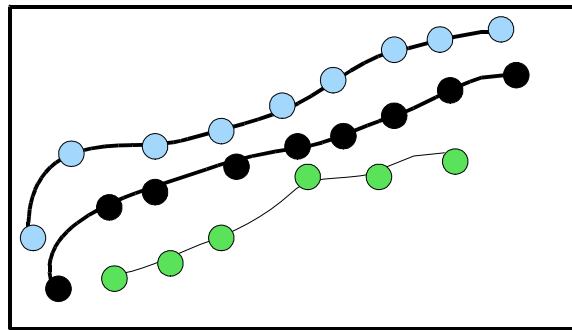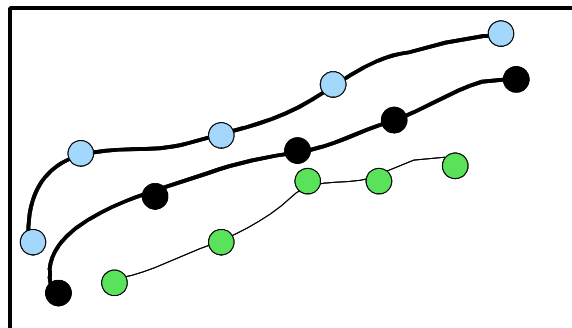
E_N

$\mathbf{m}$

Making Eigenspace

E_N

Learning N paths

Normalization

$\mathbf{y} = [\mathbf{p}_1^T, \mathbf{p}_2^T, \cdots, \mathbf{p}_M^T]^T$
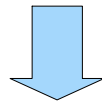
$\mathbb{R}^{2M}$
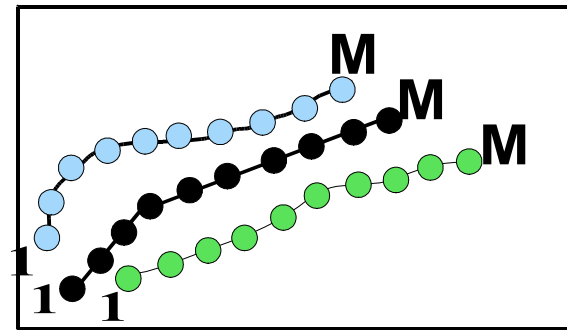
i_{th} N_{th}

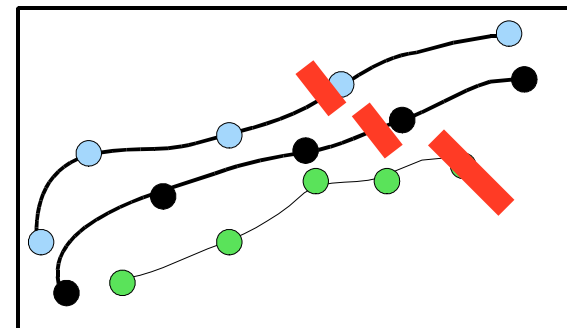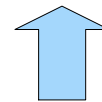$\mathbf{m}$

Normalization:Resampling or DP

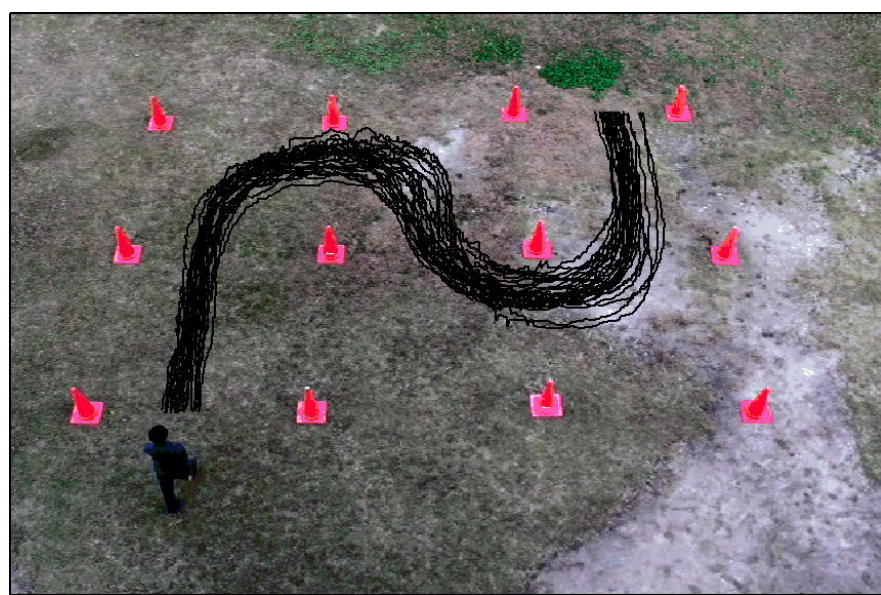# Normalization by resampling

Learning
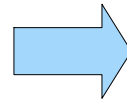
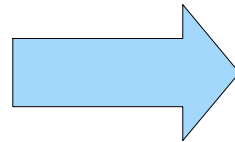Resampling

Downsampling

Cutting

Features

- Smoothing shape of paths
- Not considering the influence of nonlinear relationship of walking speed between frames
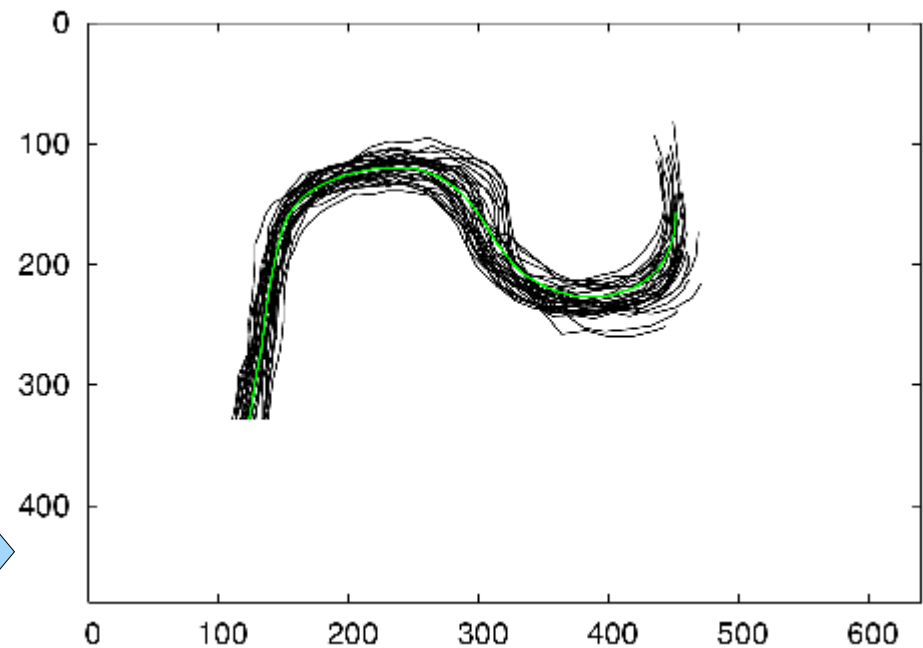
Experimental setting

- Sample path: 30
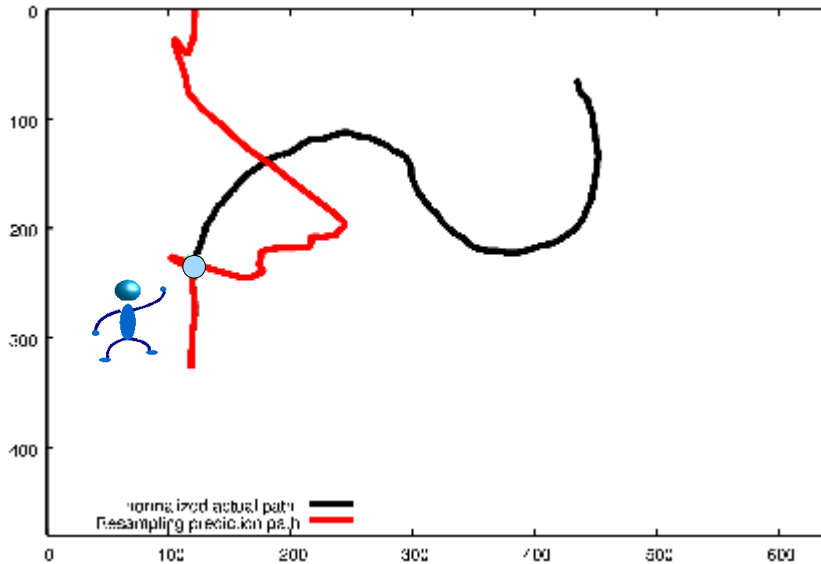
- Resampling : 300 coordinates
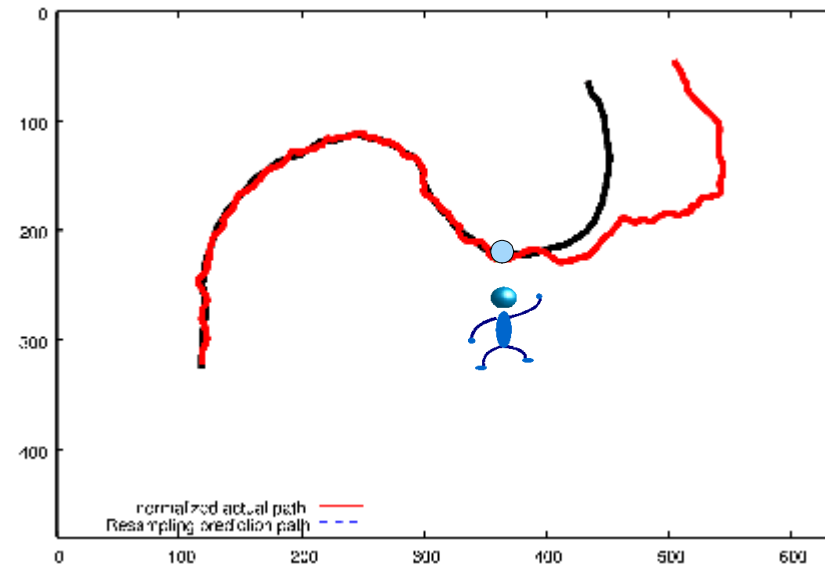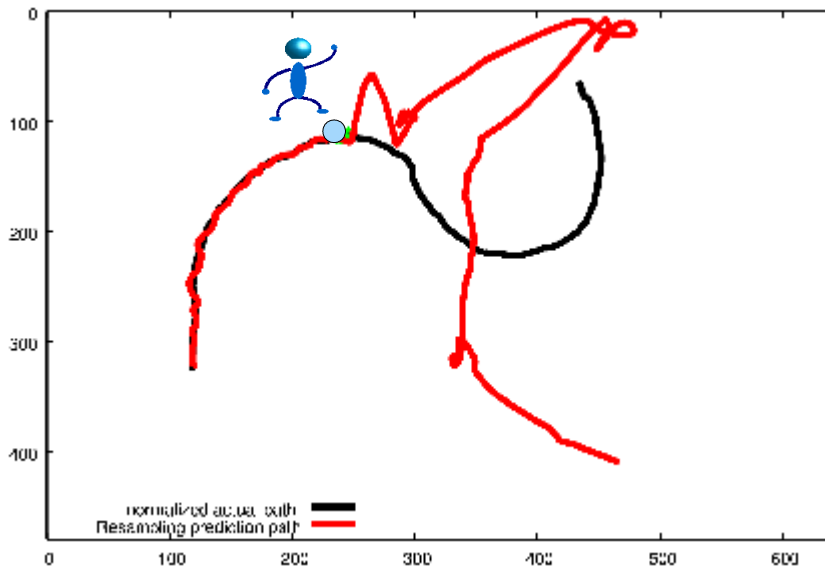

Sample paths

Normalization
(Resampling)

Resampling result

Prediction Results by Resampling

50th frame(39 coordinates are known)

250th frame(199 coordinates are known)

Black line: actual path
Red line: prediction path

150th frame(120 coordinates are known)

Features
- Prediction paths do not correspond
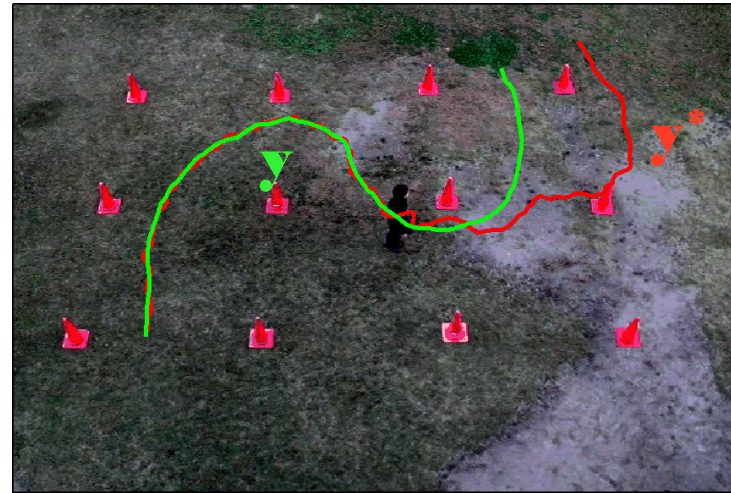
Problem & Objective

Problem

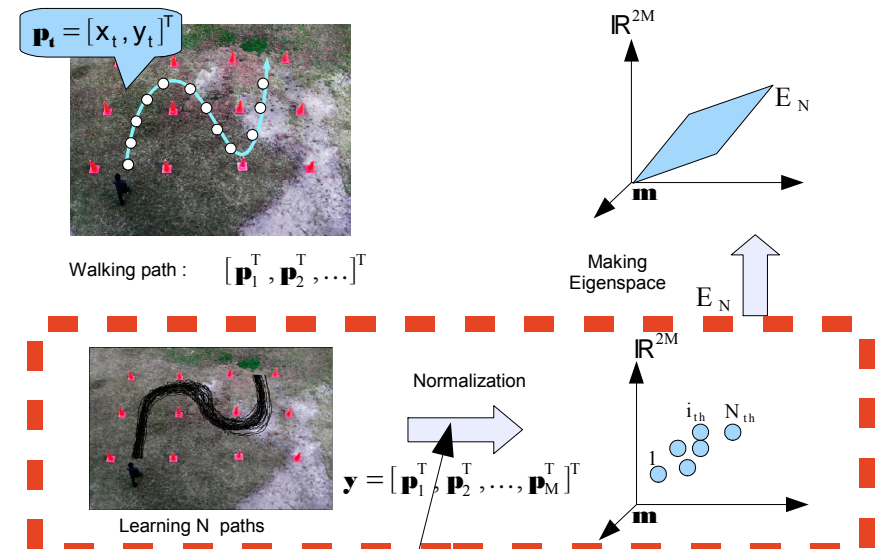- Prediction path does not correspond to actual path

Reason

- Normalization of paths

Objective

- Investigation of

  the effect of Normalization

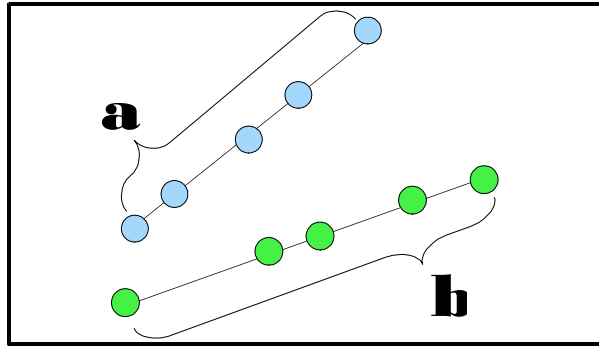 - Resampling (Yamamoto, 2004)
  - DP (Proposed)

Learning

$\mathbf{p_t} = [x_t, y_t]^T$

Walking path : $[\mathbf{p}_1^T, \mathbf{p}_2^T, \dots]^T$

$\mathbb{R}^{2M}$

E_N

$\mathbf{m}$

Making Eigenspace

E_N

Normalization

$\mathbb{R}^{2M}$

i_{th} N_{th}

$\mathbf{y} = [\mathbf{p}_1^T, \mathbf{p}_2^T, \dots, \mathbf{p}_M^T]^T$
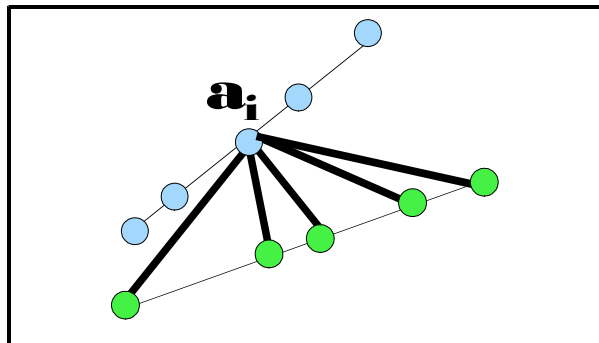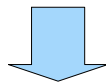
$\mathbf{m}$

Learning N paths

Normalization:Resampling or DP

Normalization by DP

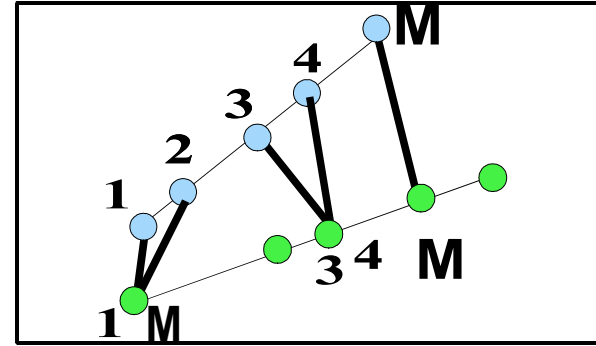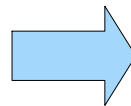- DP (Dynamic programming)

Refference pattern **a**
and input pattern **b**

Matched patterns **a**
and **b**

Calculate the Euclidean
distance between a_i
and input pattern
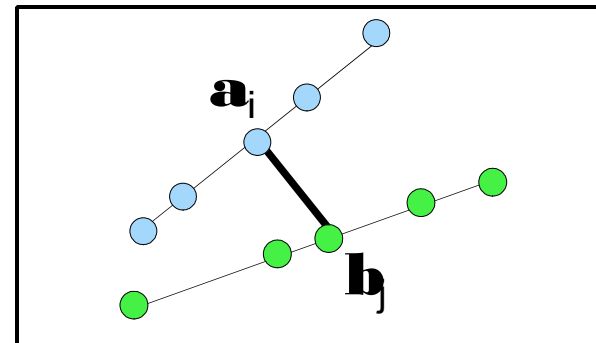
Choose the minimum
Euclidean distance
between a_i and b_j

Normalization by DP

Reference pattern

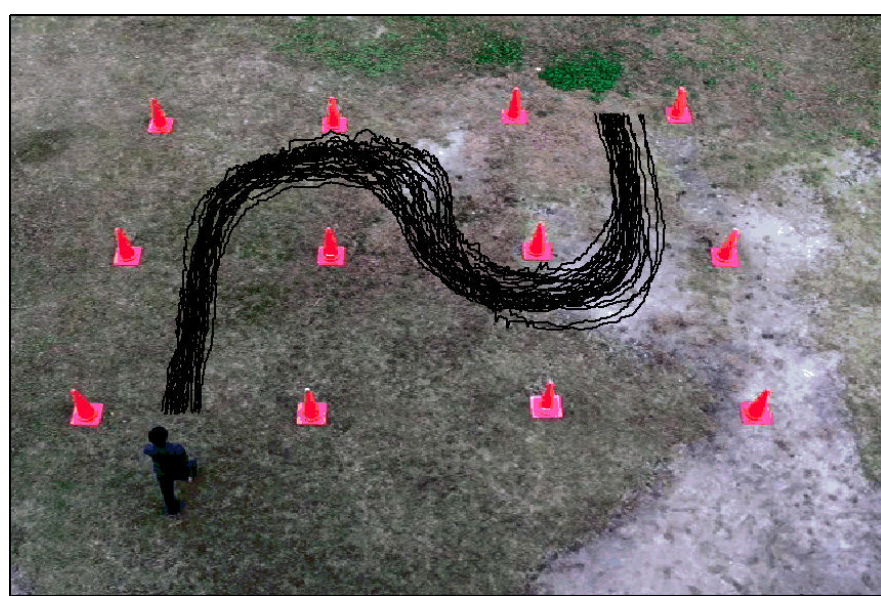Input pattern
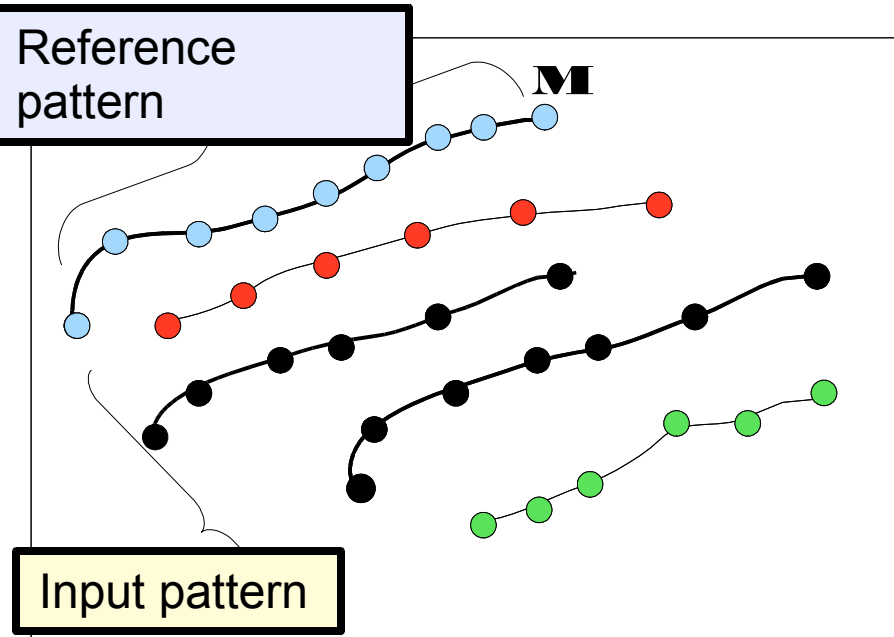
Learn N paths and choose reference pattern

DP
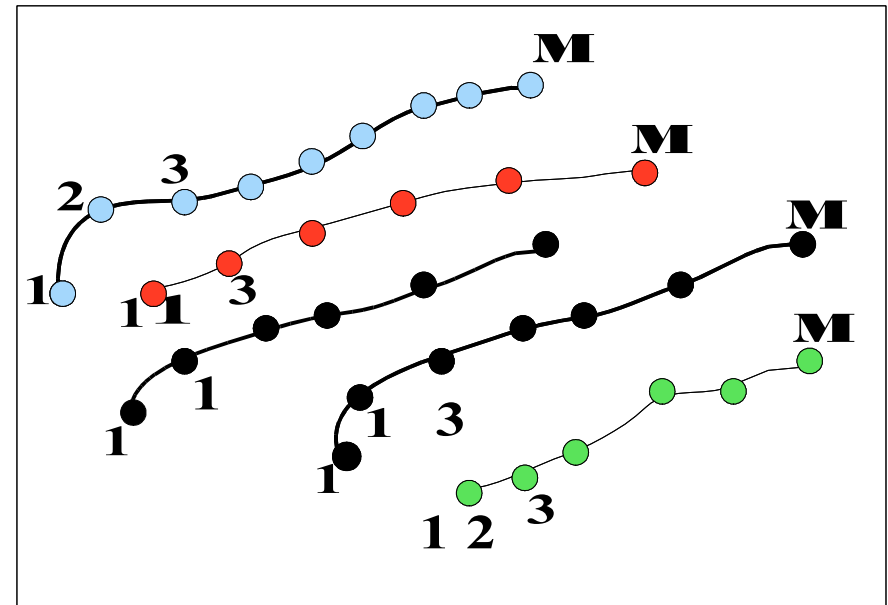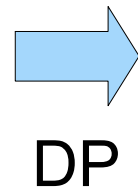
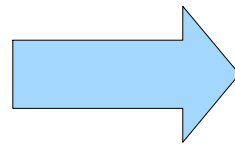Correspond to reference pattern

Features

- Make correspondence among paths
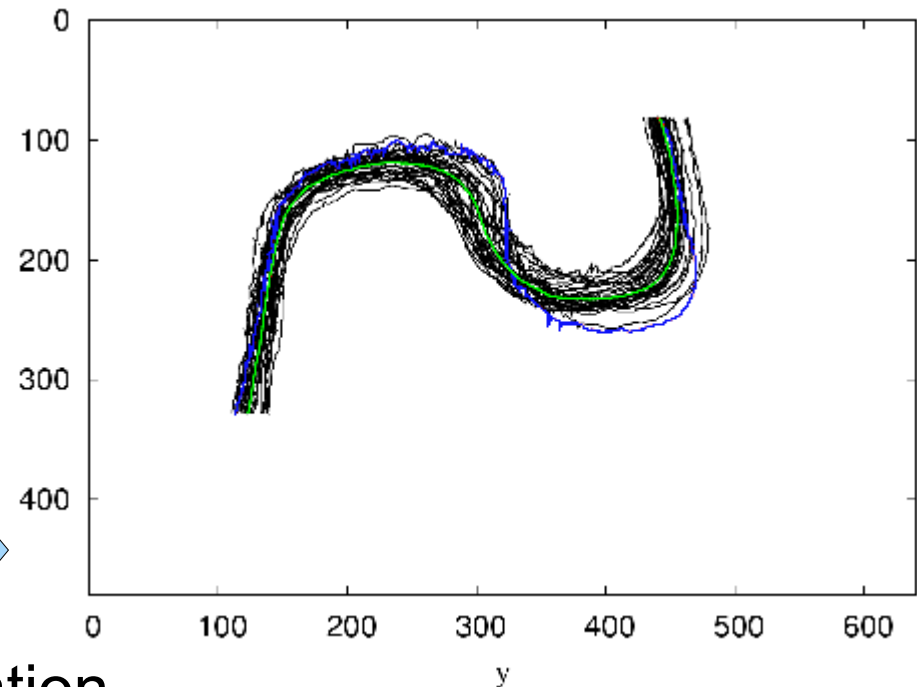- Choose actual coordinates

Experimental setting

- Sample path: 30
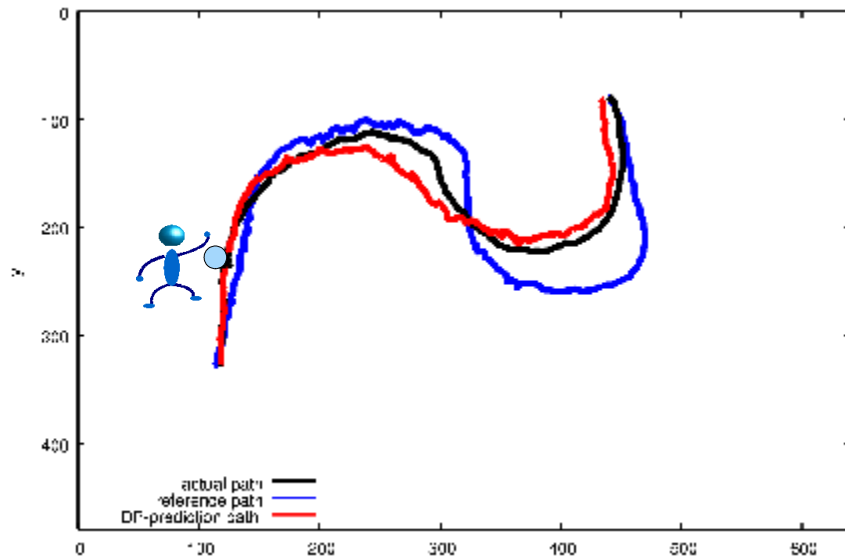- DP: 548 coordinates

Sample paths
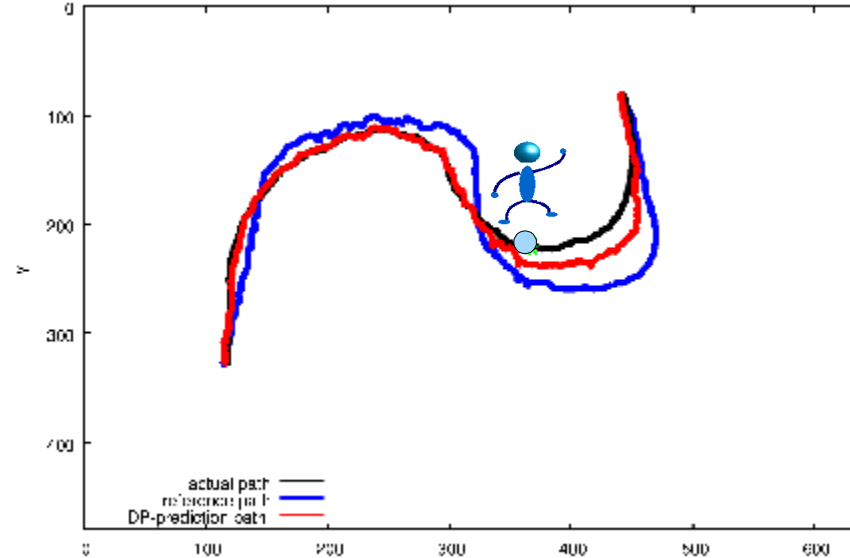
Normalization (DP)

DP matching result

Blue line: reference path
Green line: average path

Prediction results by DP
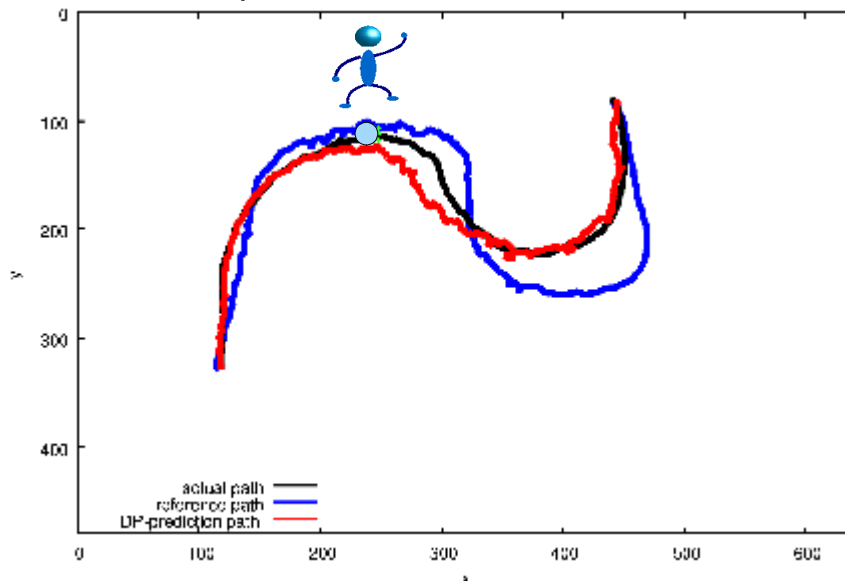

50th frame(50 coordinates are known)

250th frame(250 coordinates are known)

150th frame(150 coordinates are known)

Black line: actual path
Red line: prediction path
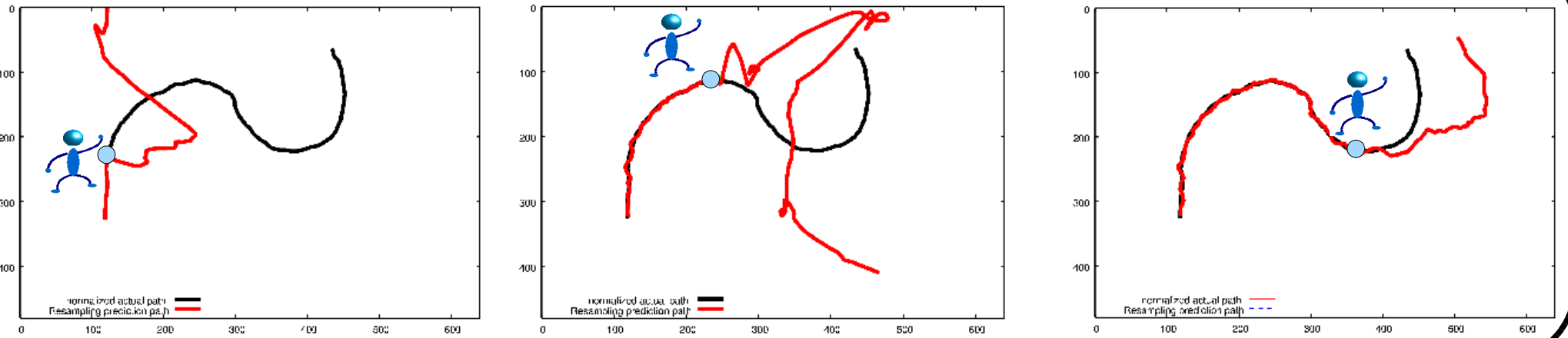Blue line: reference path
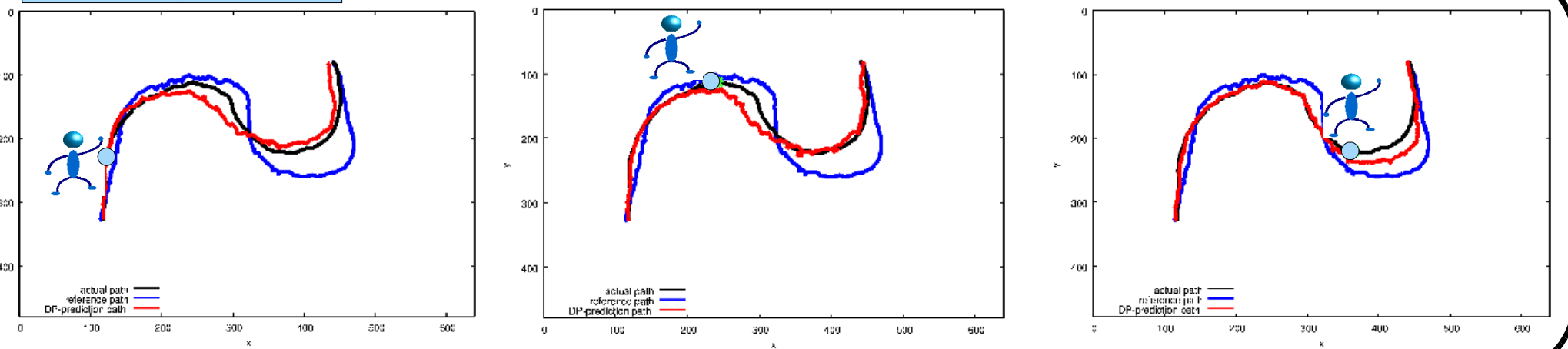
Features
- Prediction paths are similar course to actual path at each frame
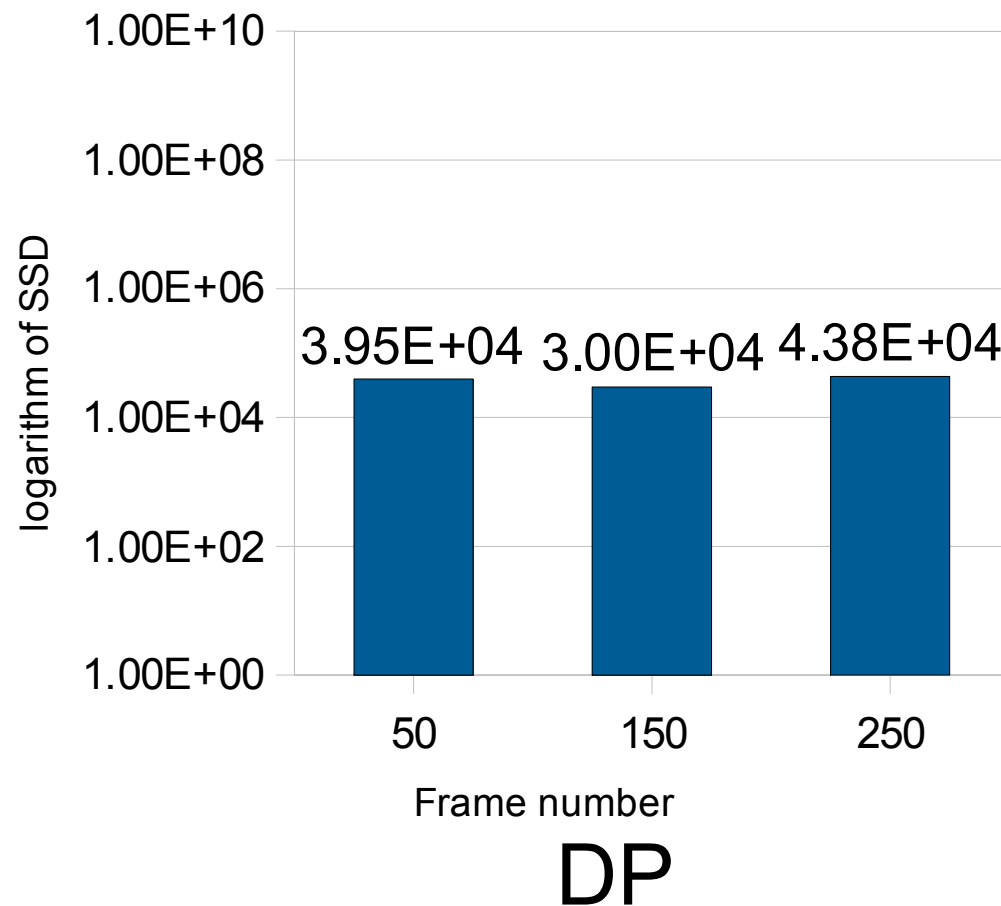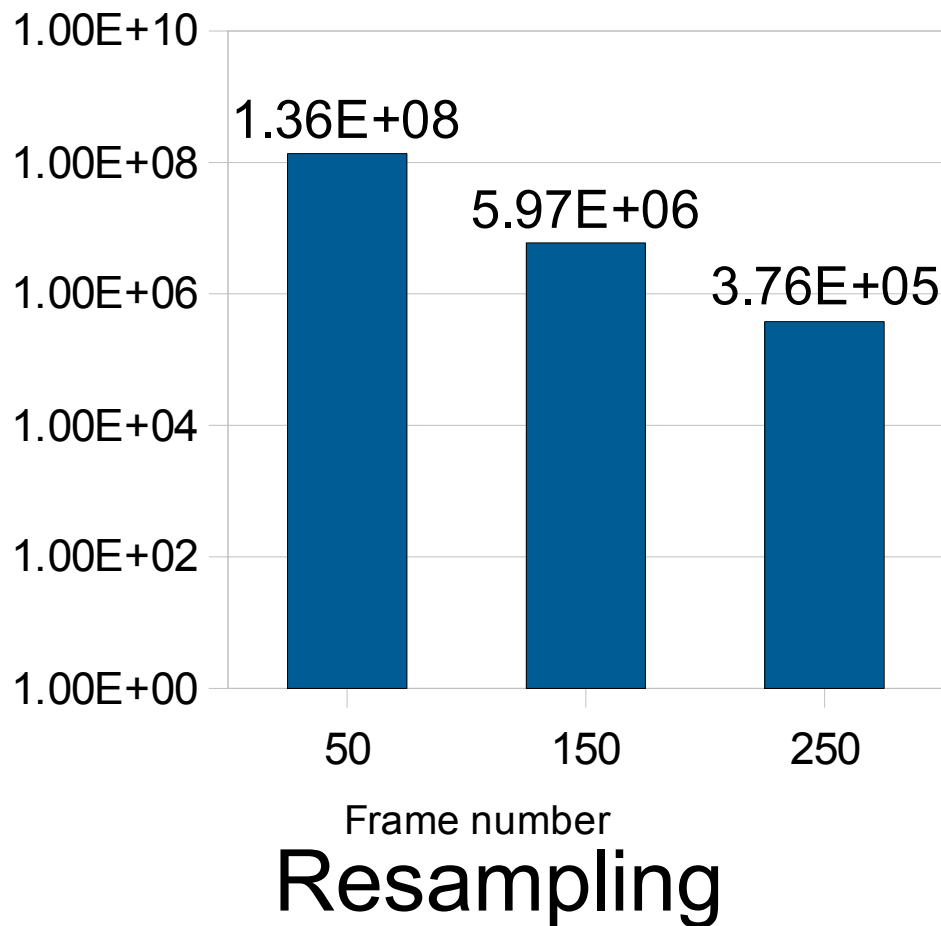- Not smooth

Prediction results

Resampling

DP

Prediction by DP is similar with actual path than by resampling

Quantitative Evaluation

- Compare resampling and DP in Logarithm of SSD

→Prediction by DP is better than by resampling

Resampling

DP

Conclusions

- Investigation of two normalization methods, resampling and DP

- the experimental results show that
  - Resampling result is smooth but does not correspond
  - DP result is close course but not smooth

Future work

- Investigation of other normalizations
- The effect of the number of eigenvector