Image Set-based Hand Shape Recognition Using Camera Selection Driven by Multi-class AdaBoosting

Yasuhiro Ohkawa, Chendra Hadi Suryanto, Kazuhiro Fukui,
University of Tsukuba, Japan.   ohkawa@cvlab.cs.tsukuba.ac.jp

筑波大学
University of Tsukuba

Goal
To construct a multi-camera system for recognizing Japanese Fingerspelling with high speed and precision.

1 : Basic Approach

Image-set based method

Recognition method based on similarity between two image-sets.
e.g. multi-viewpoint images, sequential images

Mutual Subspace Method: MSM

- **Subspace representation**
  Each image-set is represented by a linear subspace, which is generated by PCA.
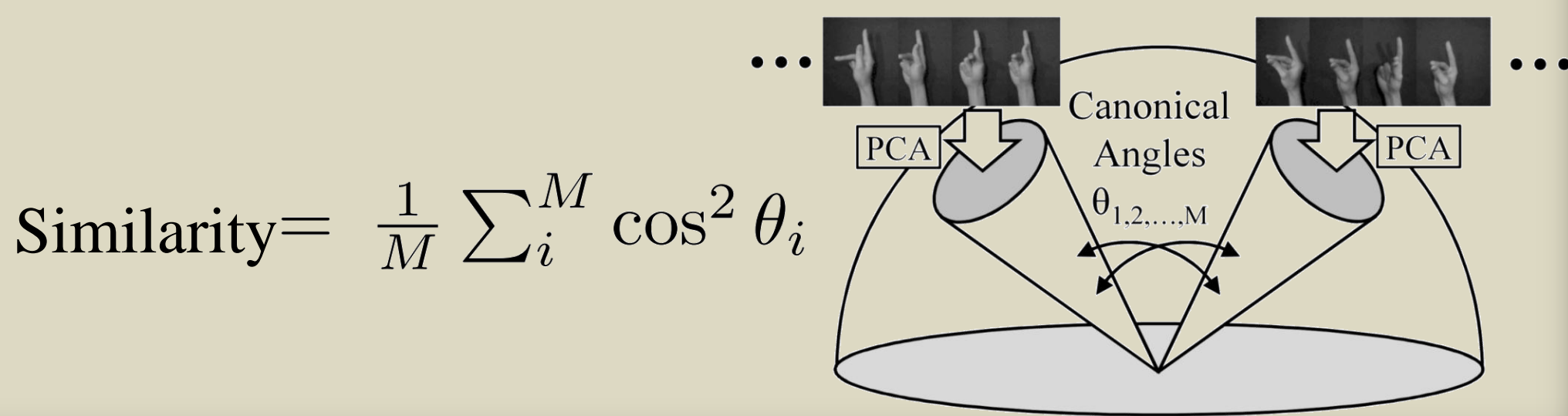
- **Canonical Angles**
  Similarity between two subspaces is measured by the canonical angles θ between them.
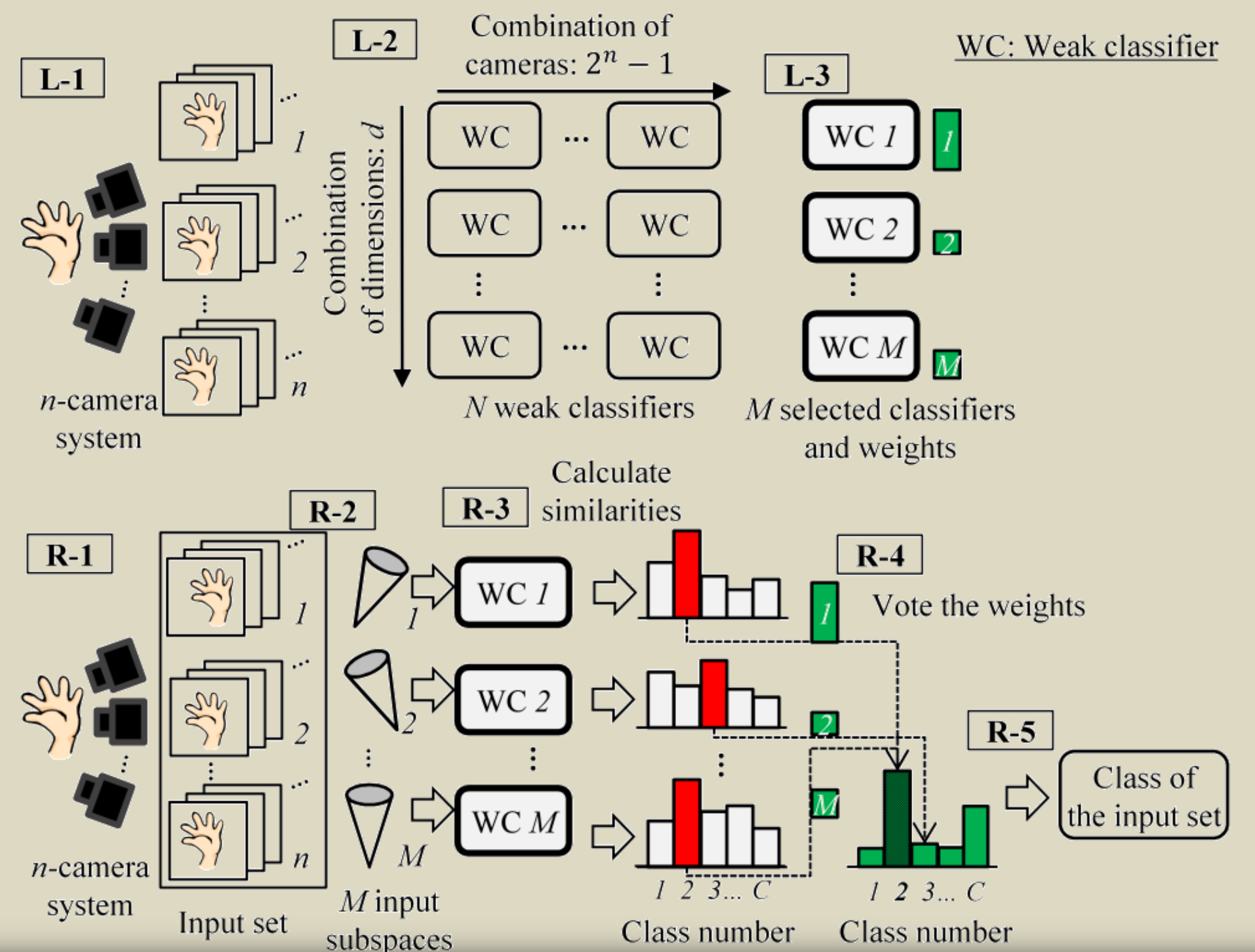
- **Nonlinear Extensions**
  MSM
    Kernel MSM
      Kernel Orthogonal MSM[1]

$$\text{Similarity} = \frac{1}{M} \sum_i^M \cos^2 \theta_i$$
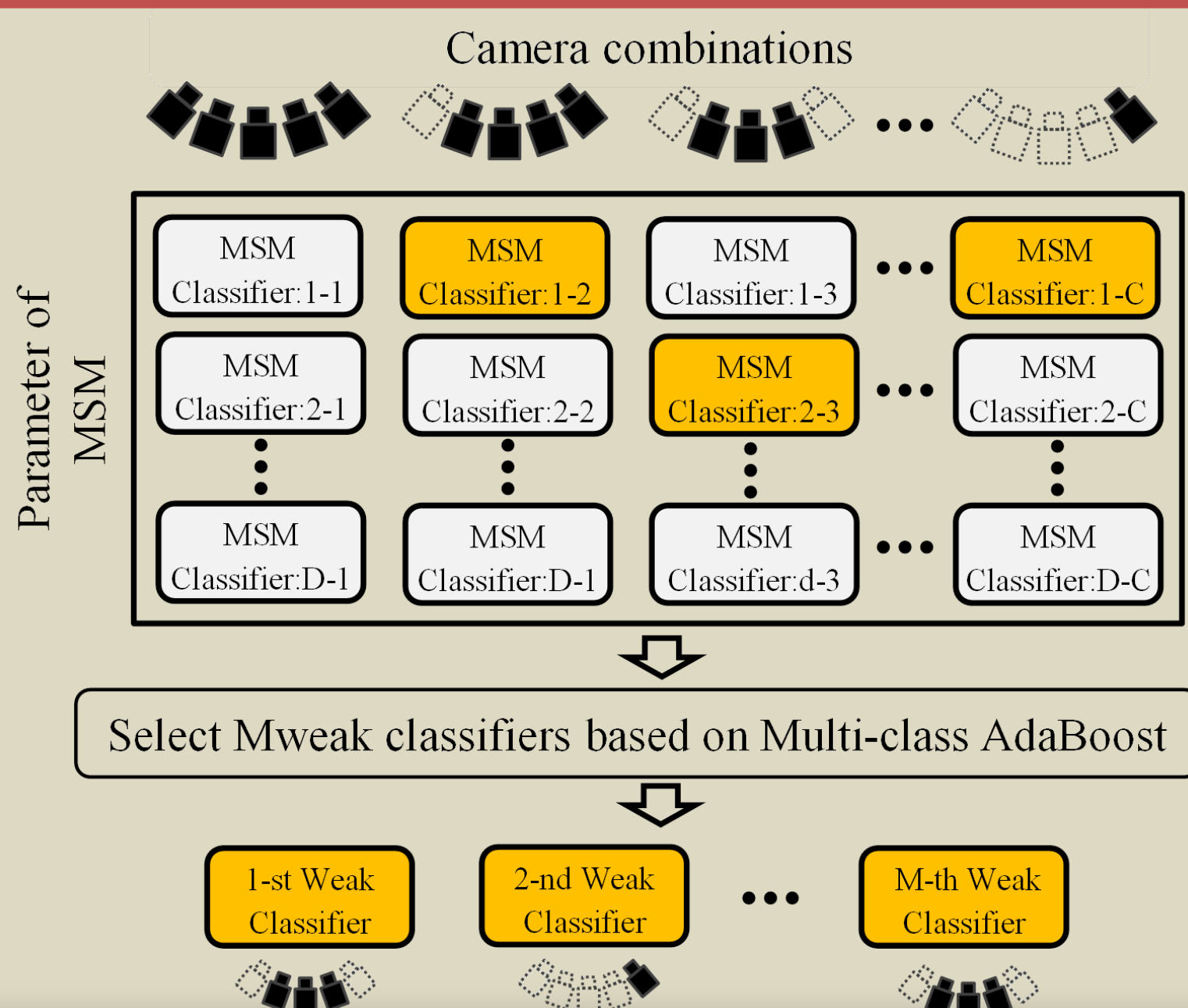
2 : Problems and Our solution

Problems of Kernel Orthogonal MSM
- High Computational Cost
- Large memory size

Depending on the number of learning patterns due to kernel trick.

Solution
- Regard a classifier based on the MSM as a weak classifier.
- Generate weak classifiers while changing both the combination of cameras used for inputting the image sequence.
- Select combinations of the multiple cameras based on Multi Class AdaBoost[2].

2: Flow of the proposed method

4: Experiments

- 27 hand shapes (selected from Japanese Fingerspells) collected from 17 subjects by using 5 cameras system.

	ER[%]	EER[%]	Recogniton time [ms]
MSM	10.54	4.91	6
KOMSM[1]	7.33	2.11	2728
Proposed method	**7.79**	**2.03**	**134**

20 times faster!

🔴 : Selected camera   ⚫ : Unselected camera

Camera Combination								
Weight	5.4	2.8	2.4	2.0	1.8	1.7	1.4	1.1
Ref. Dim	45	85	5	80	60	10	25	45
Input Dim	2	2	1	1	1	1	1	1

Top eight weak classifiers selected by multi-class AdaBoost.

4: Conclusions

- We proposed an image set-based hand shape recognition method using camera selection driven by the multi-class AdaBoost.
- Proposed method could outperform nonlinear kernel methods, KOMSM, with smaller computational cost.

[1] Zhu, J., Rosset, S., Zou, H., Hastie, T.: Multi-class adaboost. Technical report, Department of Statistics, University of Michiga, ,2006.
[2] Fukui, K., Yamaguchi, O.: The kernel orthogonal mutual subspace method and its application to 3d object recognition.ACCV, 2007.