

大阪府立大学
OSAKA PREFECTURE UNIVERSITY



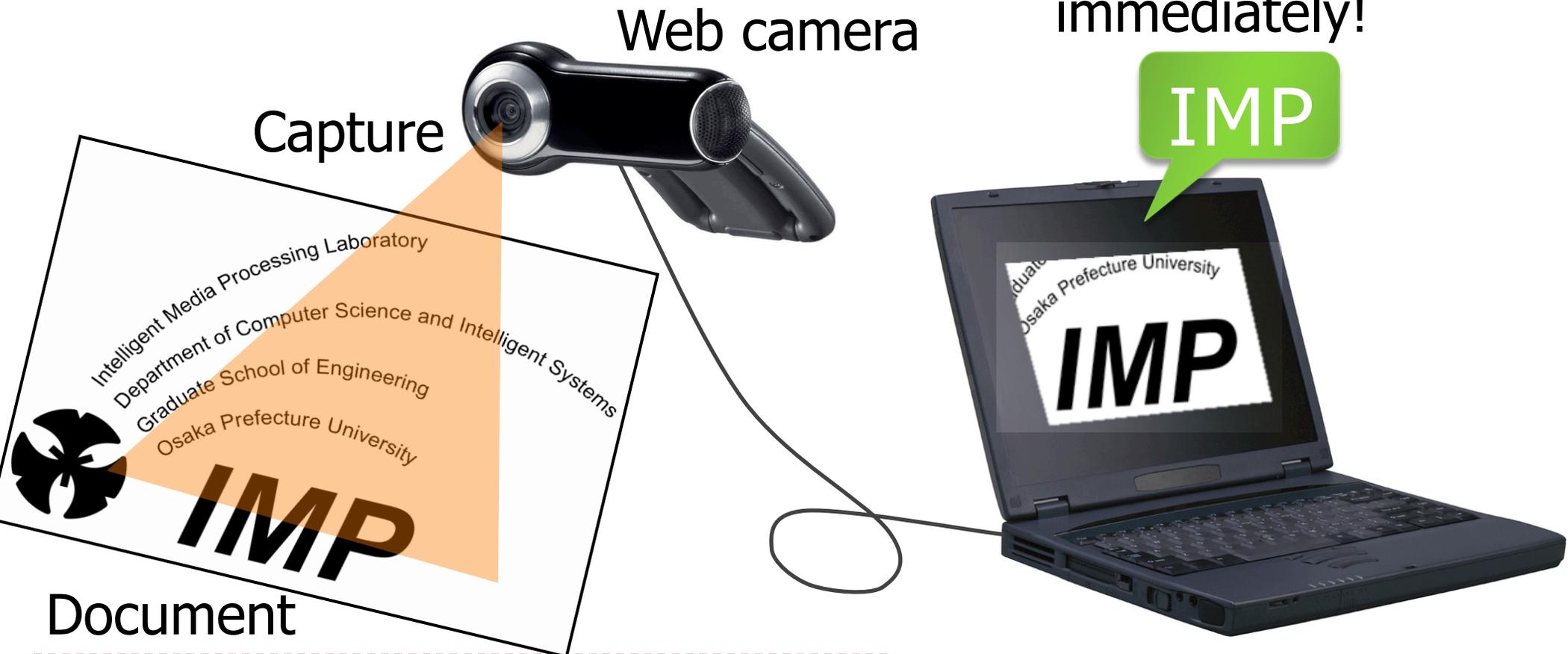
Real-Time Camera-Based Character Recognition Free from Layout Constraints

M. Iwamura, T. Tsuji, A. Horimatsu, and K. Kise

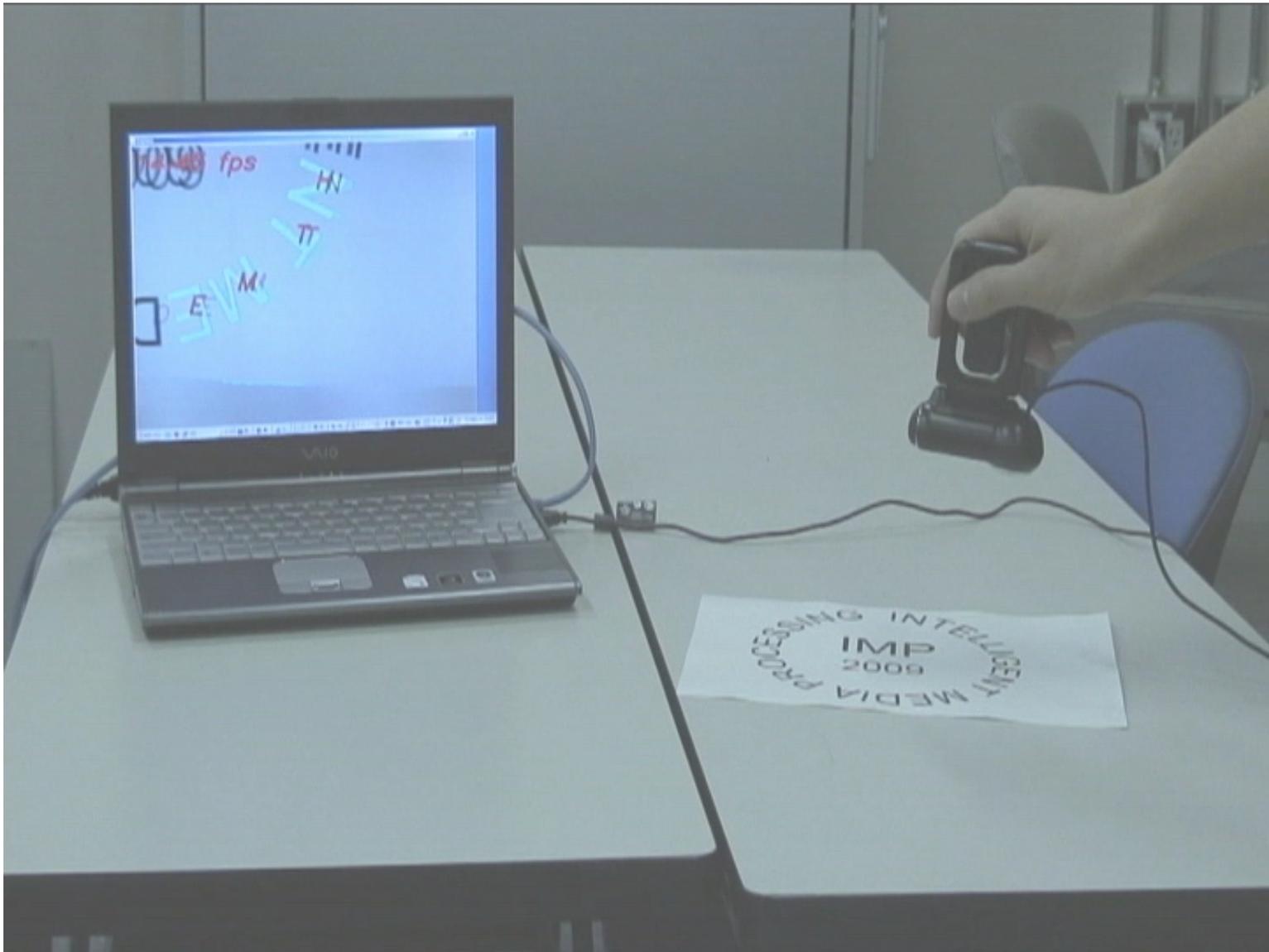
Real-Time Camera-Based Character Recognition System

Recognizes ~200 characters/sec

Recognizes character immediately!



DEMO

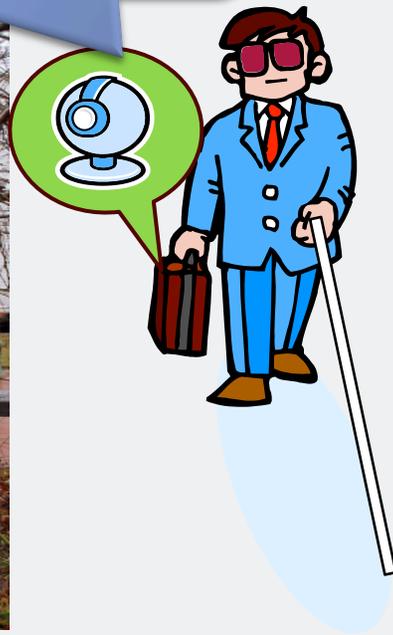


Applications

Recognizes all characters in a scene and provide useful information only

Voice navigation for visually disabled people

“Push button” is on your right side



Translation service for foreign travelers

Car-free mall



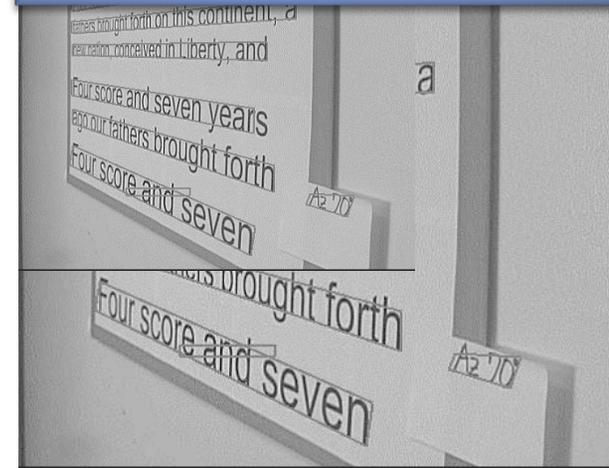
Existing Methods and Problems

1. Real-time recognition capable **only for characters in a straight text line**



Not recognizable

Recognizable



2. Can recognize each character in a complex layout **with much computational time**



Existing Methods vs Proposed Method

1: Real-time

2: Perspective distortion

3: Layout free

Myers 2004	○	○	×
Kusachi 2004	×	○	○
Li 2008	×	○	○
Proposed method	○	○	○

Recognition of Individual Characters



Real-time Processing



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1. Background
2. Overview of the Proposed Method
3. Contour Version of Geometric Hashing
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Overview of the Proposed Method 1

Handled by post processing

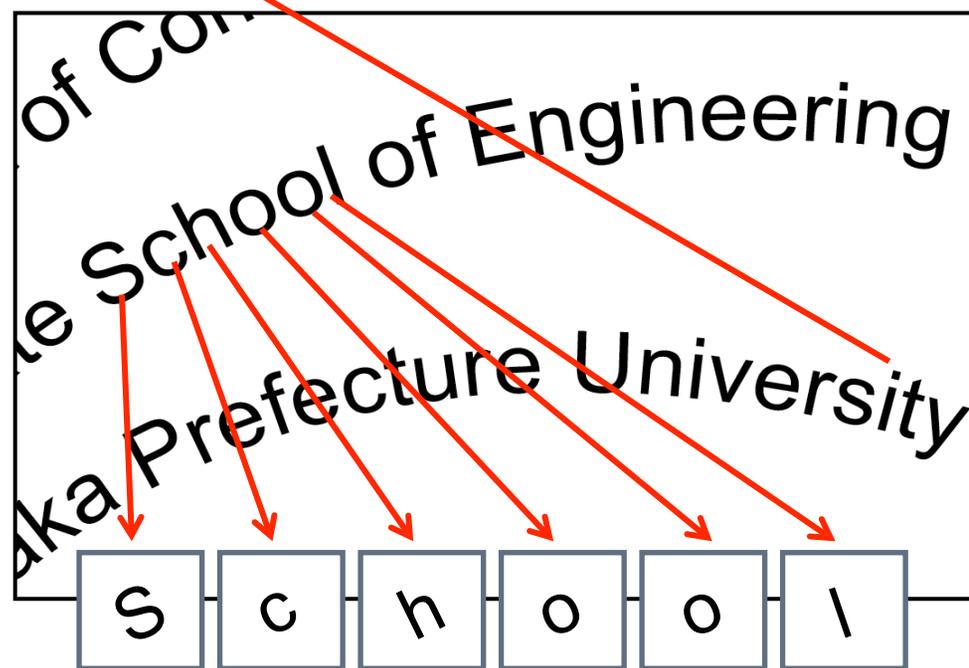
i

Recognizes individual connected components

Realizes 3: Layout free

Assumptions

- ▶ Black characters are written on a flat white paper
- ▶ All connected components are easily segmented



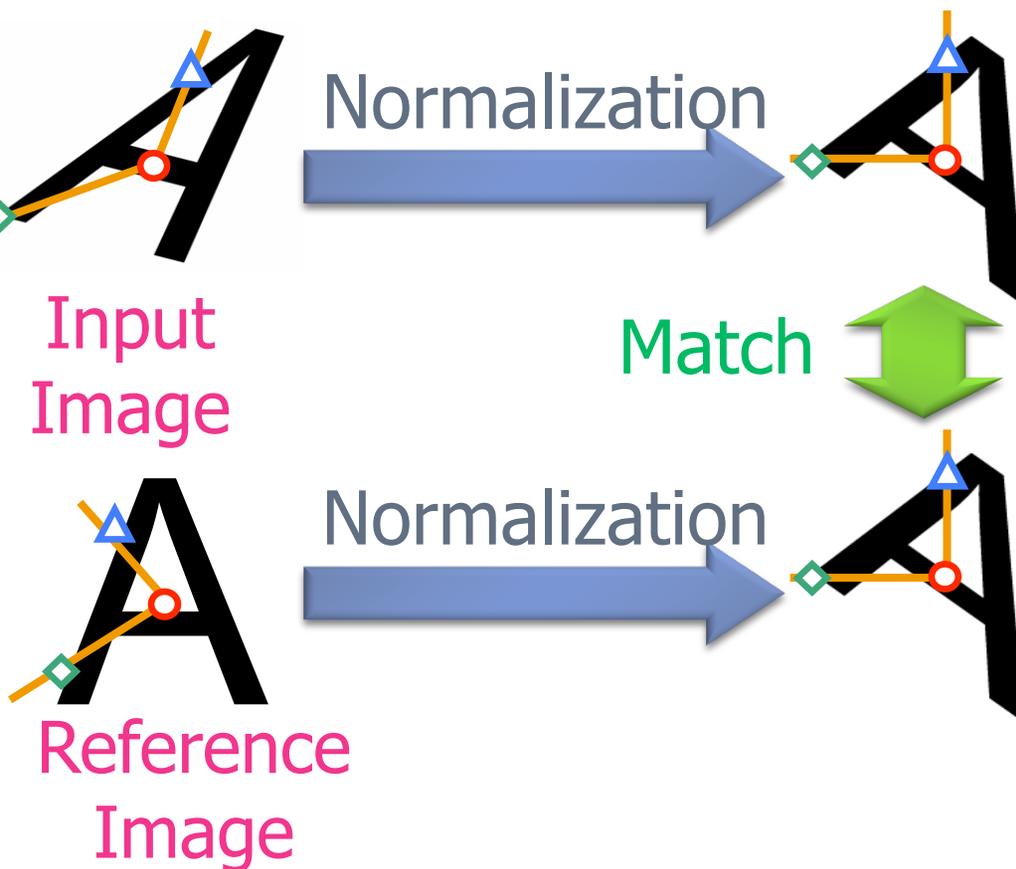
How to quickly match segmented connected components

Overview of the Proposed Method 2

- ▶ Affine invariant recognition
 - ▶ Three corresponding points help matching

Realizes robust recognition to

2: Perspective distortion



Overview of the Proposed Method 2: Contour Version of Geometric Hashing

Existing method :
Geometric Hashing (GH)

Contour Version of GH

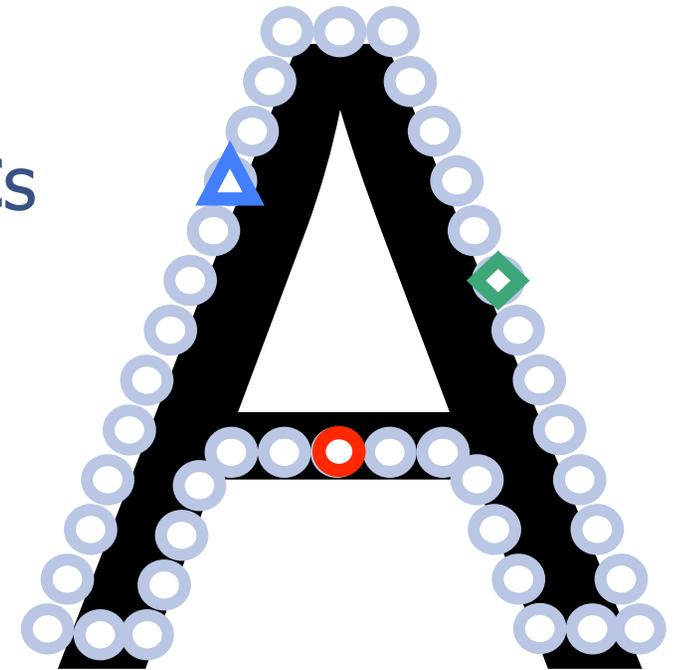
Start point of the
proposed method



Applied GH to
recognition of CCs



No. of Points : P

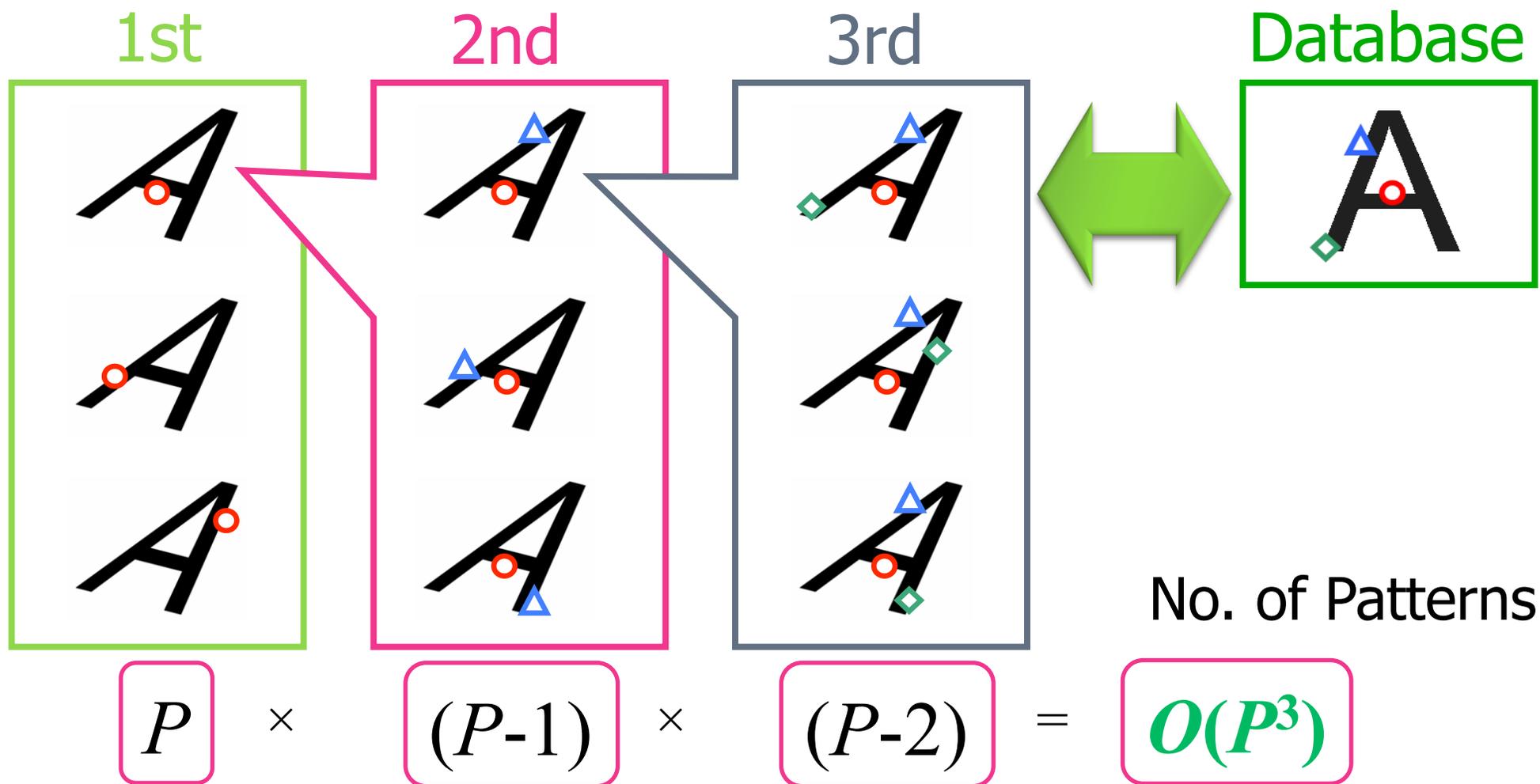


Matching of point arrangement

Matching of Shape

Overview of the Proposed Method 3: Three-Point Arrangements of CVGH

- ▶ CVGH examines all three points out of P points



Overview of the Proposed Method 3: Three-Point Arrangements of Prop. Method

- ▶ Proposed method snips useless three-point arrangements

In case of $P=100$

CVGH

970,200

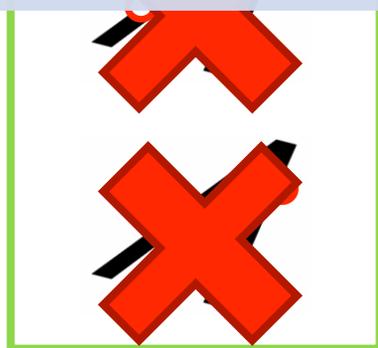
Proposed Method

100

Realizes

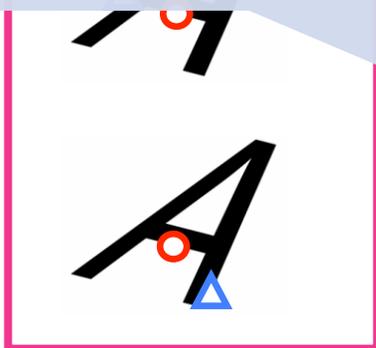
1: Real-time

Database



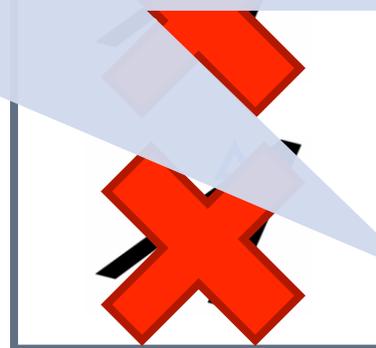
1

×



P

×



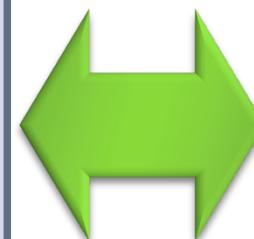
1

=

$O(P)$

No. of Patterns

$O(P^3)$



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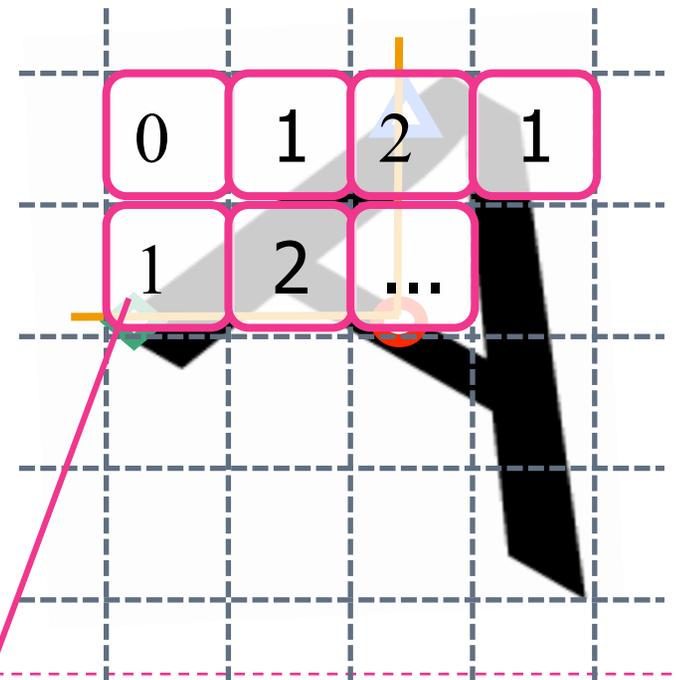
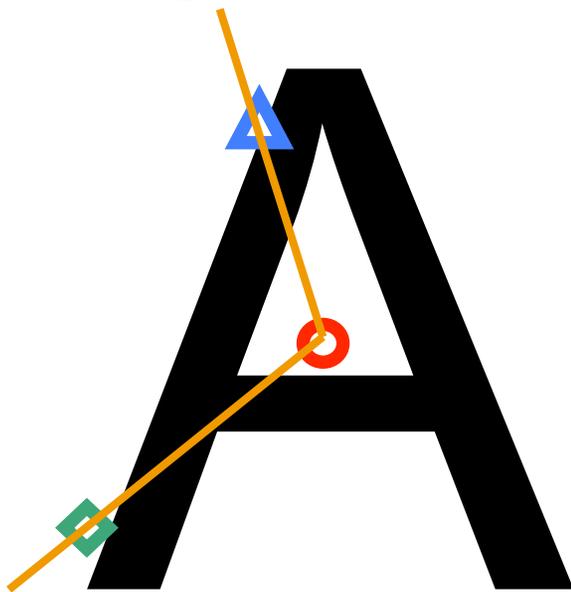


Contour Version of GH: Matching by Feature Vectors

► Calculation of feature vector

1. Normalize
2. Divide into subregions
3. Create a histogram of black pixel
4. Quantize

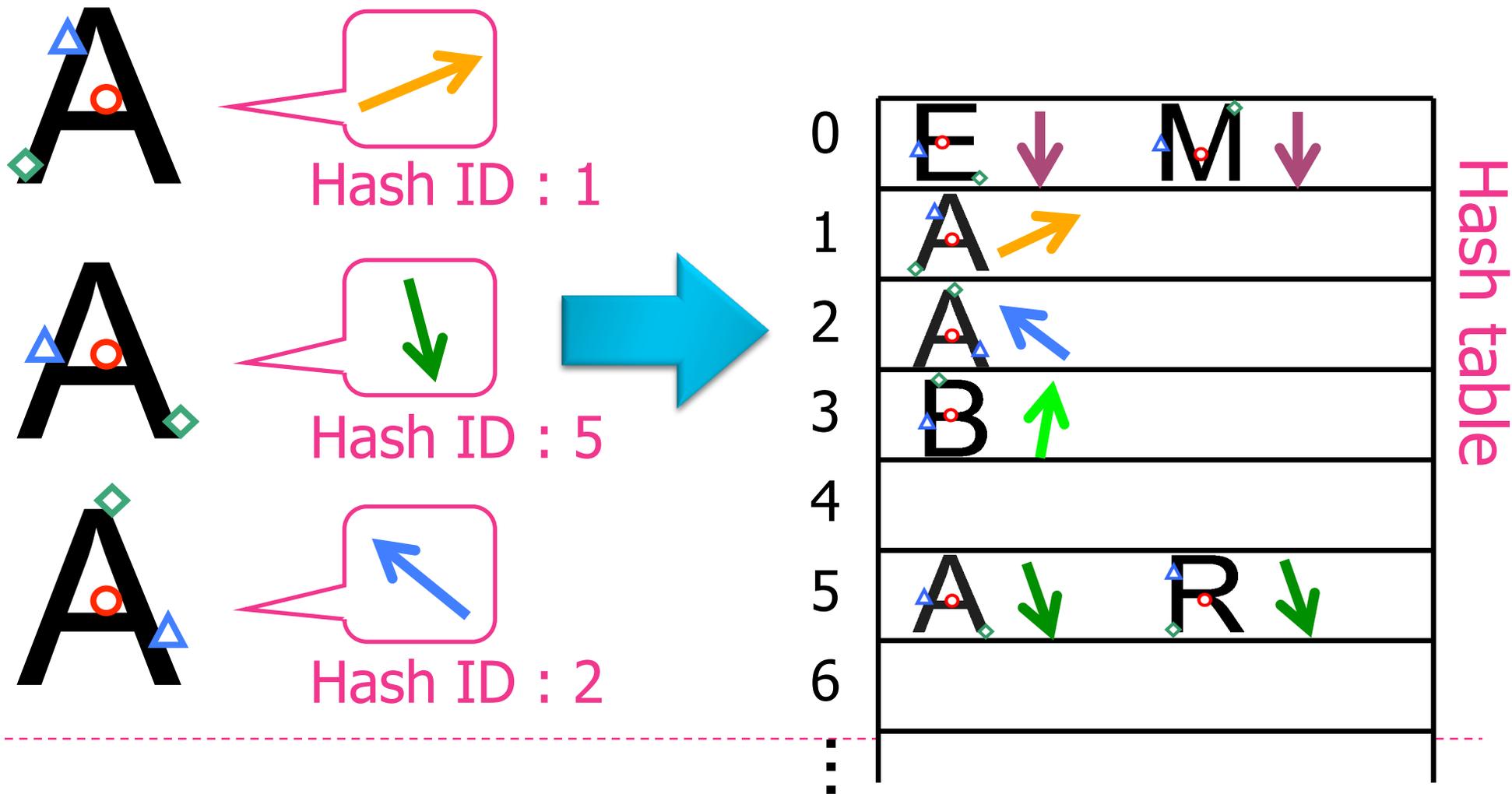
4x4 Mesh Feature



Feature Vector

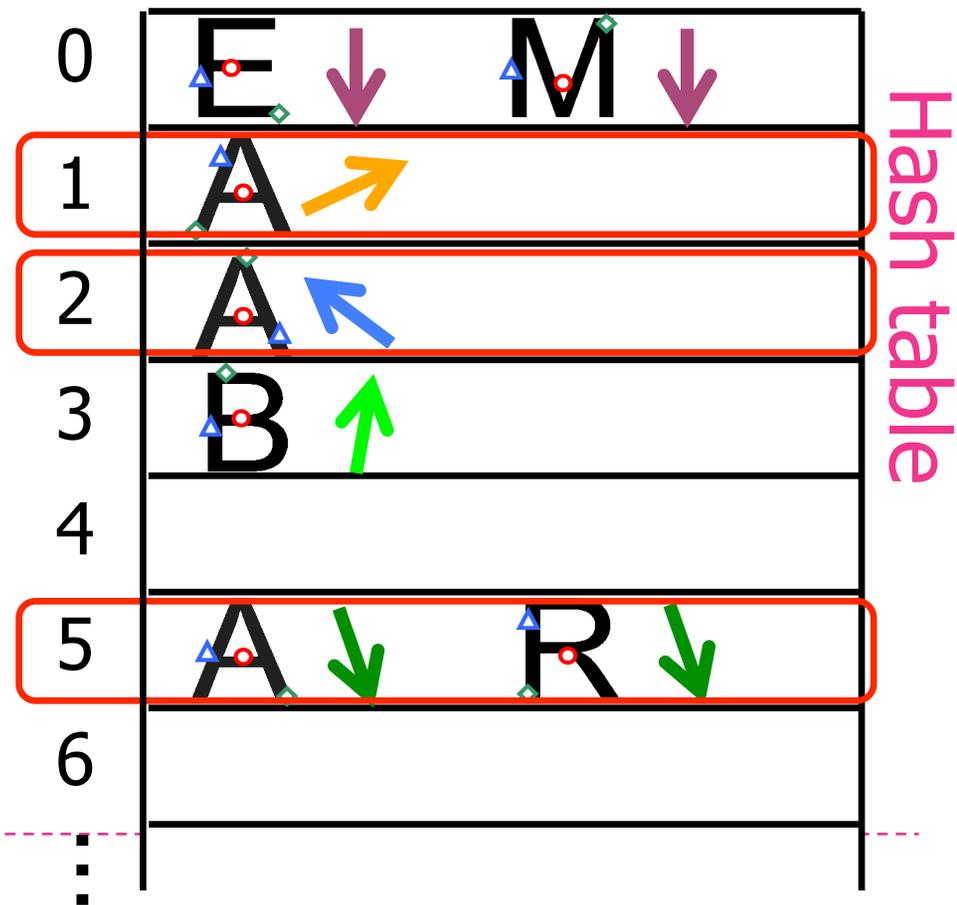
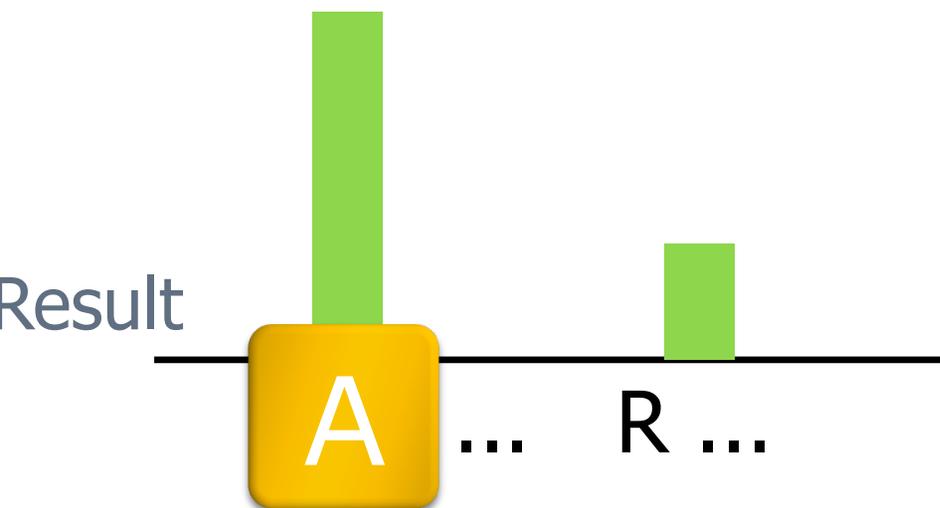
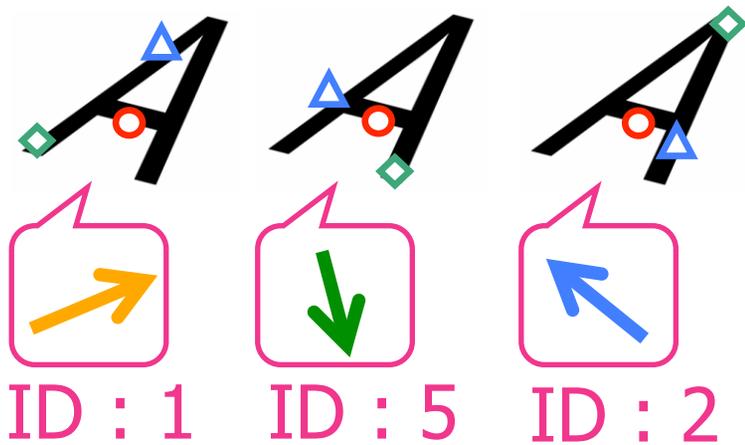
Contour Version of GH: Storage

- ▶ Feature vectors are stored in the hash table



Contour Version of GH: Recognition

1. Calculate feature vectors
2. Cast votes



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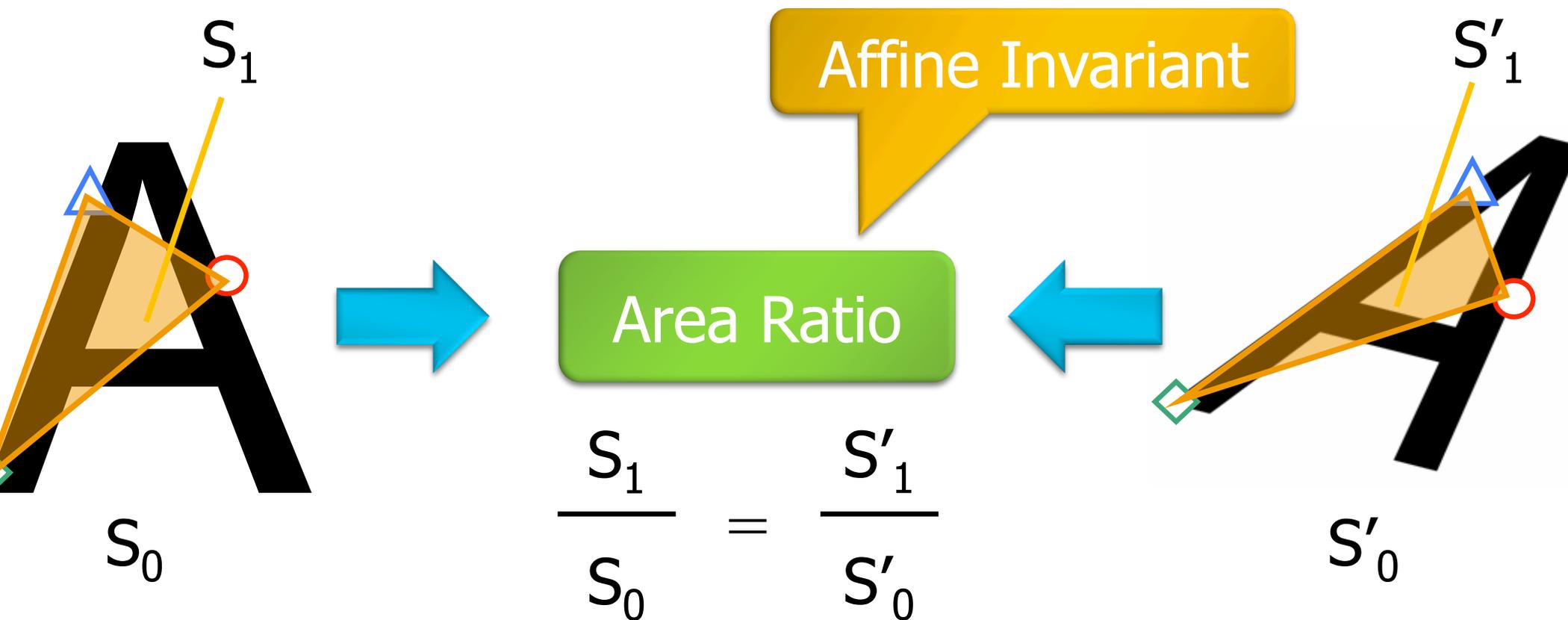


Proposed Method 1: Real-Time Processing by Affine Invariant

- ▶ Area ratio

Usual usage

- ▶ Three-point arrangement → Area ratio

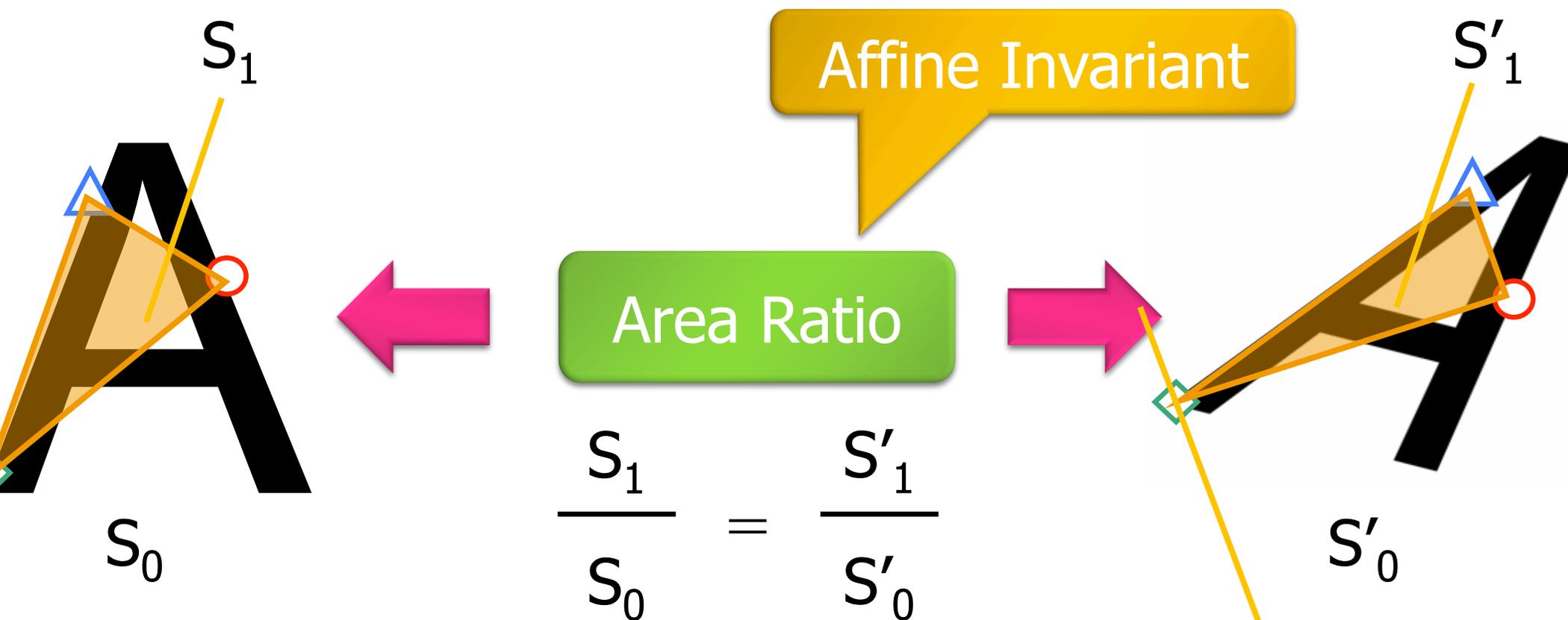


Proposed Method 1: Real-Time Processing by Affine Invariant

- ▶ Area ratio

Unusual usage

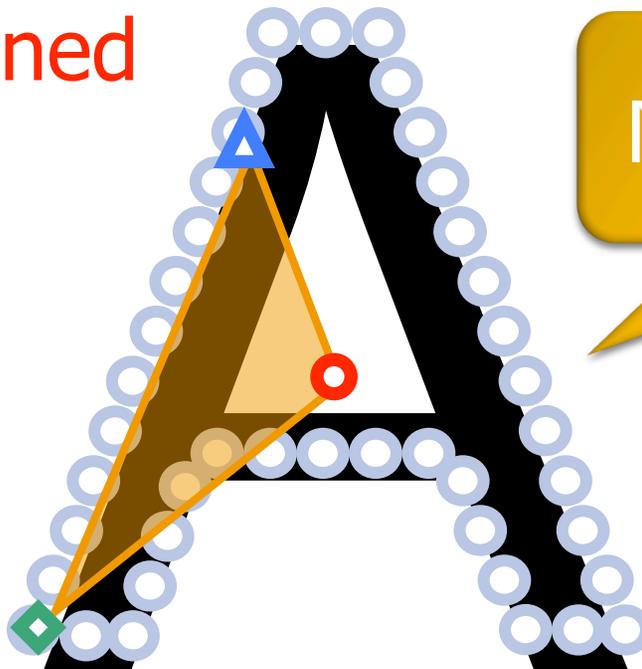
- ▶ Two-point arrangement + Area ratio → Third point



Proposed Method 1: How to Select Three Points

- ▶ ★ 1st point: Centroid (Affine Invariant)
- ▶ 2nd point: Arbitrary point out of P points
- ▶ ★ 3rd point: Determined by the area ratio

★ Uniquely Determined



No. of Points : P



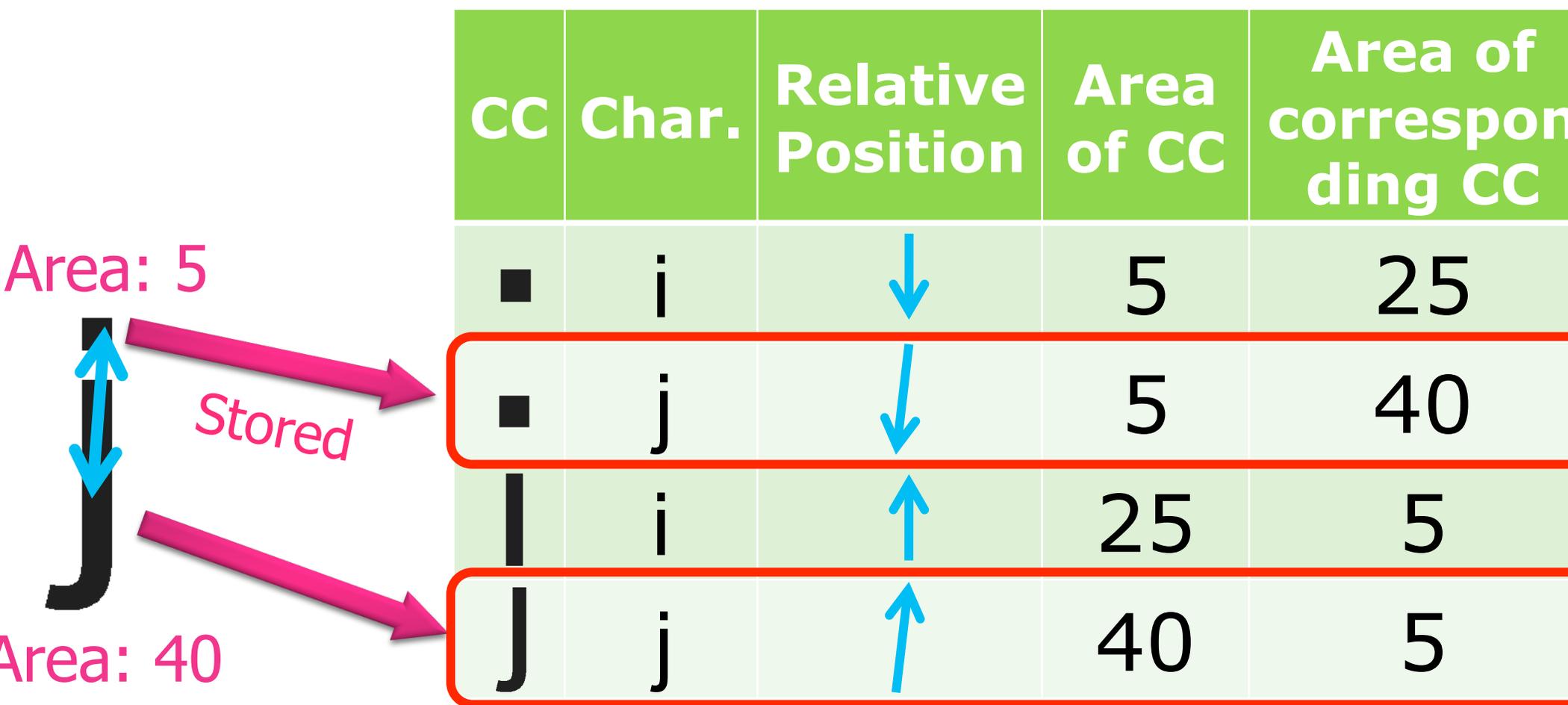
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Proposed Method 2: Recognition of Separated Characters

- ▶ Create a separated character table for post processing



CC	Char.	Relative Position	Area of CC	Area of corresponding CC
■	i	↓	5	25
■	j	↓	5	40
┃	i	↑	25	5
J	j	↑	40	5



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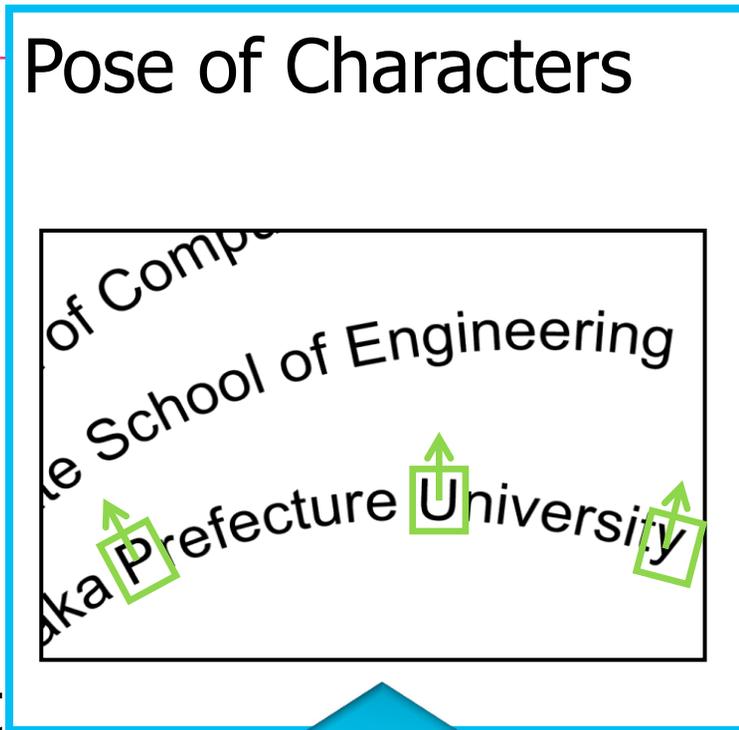


Proposed Method 3: Pose Estimation

- Estimation of the pose of the paper



Parameters



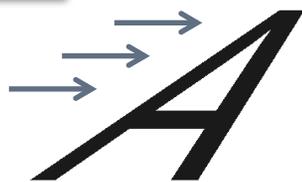
Parameters

Refinement
Parameters

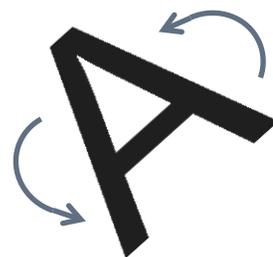
Parameters



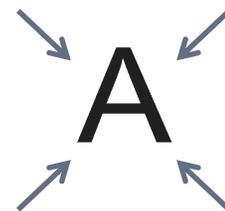
Independent
Scaling



Shear



Rotation



Scaling

Contents

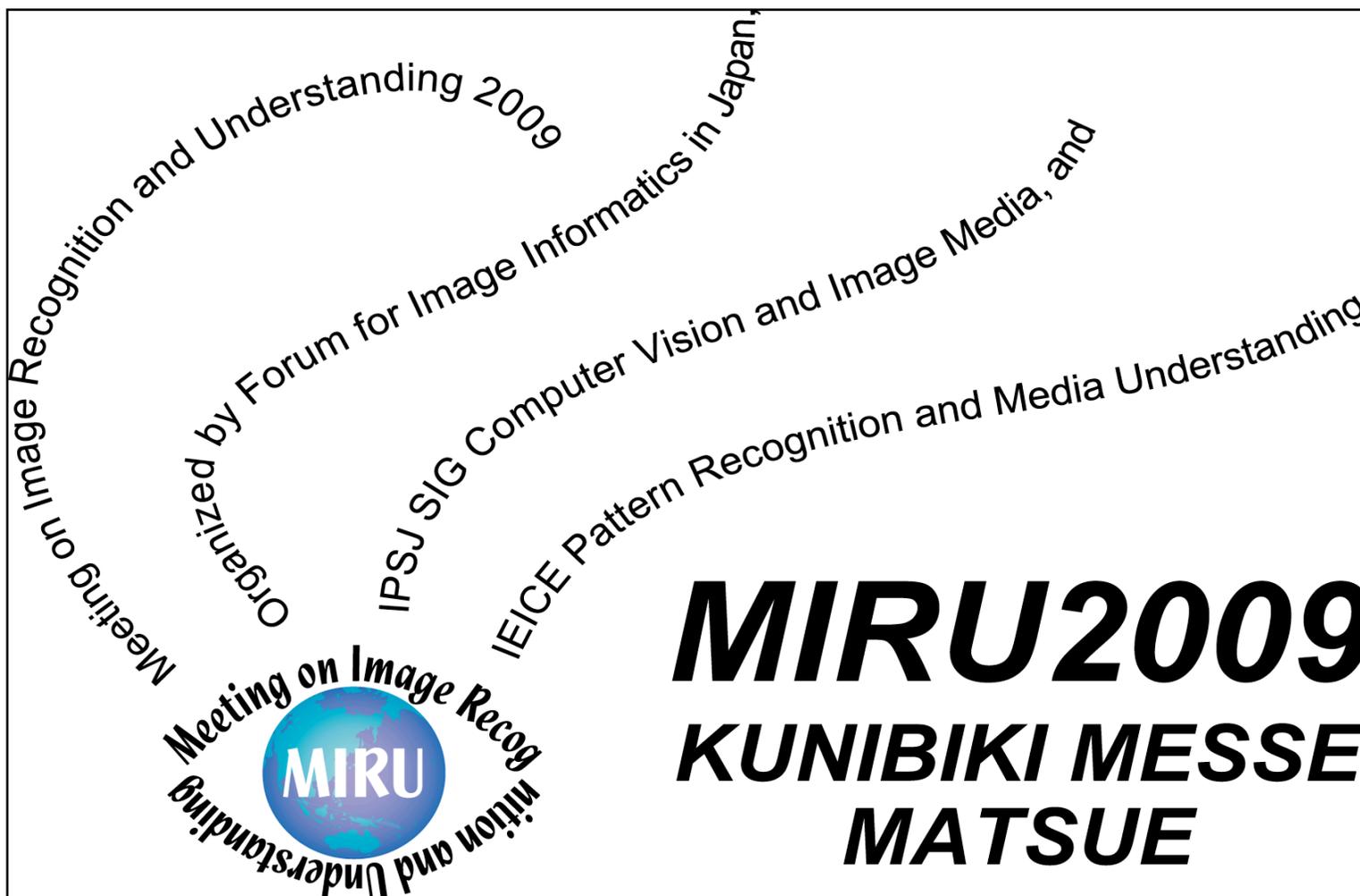
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6. **Conclusion**



Experiment: Recognition Target

3 Fonts

236 Chars



Meeting on Image Recognition and Understanding 2009
Organized by Forum for Image Informatics in Japan,
IPSS SIG Computer Vision and Image Media, and
IEICE Pattern Recognition and Media Understanding

MIRU

MIRU2009
KUNIBIKI MESSE
MATSUE



Experiment: Recognition Target

- ▶ Captured from three different angles
- ▶ A server was used
 - ▶ CPU: AMD Opteron 2.6GHz



Angle: 0 deg.



Angle: 30 deg.



Angle: 45 deg.



Experiment: Conditions

- ▶ Some characters are difficult to distinguish under affine distortions
 - ➔ Characters in a cell were treated as the same class

0 O o	W w
6 9	X x
C c	N Z z
I l	p d
S s	q b
u n	7 L V v



Experiment: Recognition Result

- ▶ Achieved high recognition rates and high speed by changing a control parameter

180-210 characters/sec

Settings	High recognition rates			High speed		
	0	30	45	0	30	45
Angle (deg.)	0	30	45	0	30	45
Time (ms)	7990	7990	7020	1300	1260	1140
Recog. Rate (%)	94.9	90.7	86.4	86.9	81.8	76.3
Reject. Rate (%)	0.4	3.0	6.4	6.4	9.3	16.5
Error Rate (%)	4.7	6.4	7.2	6.8	8.9	7.2



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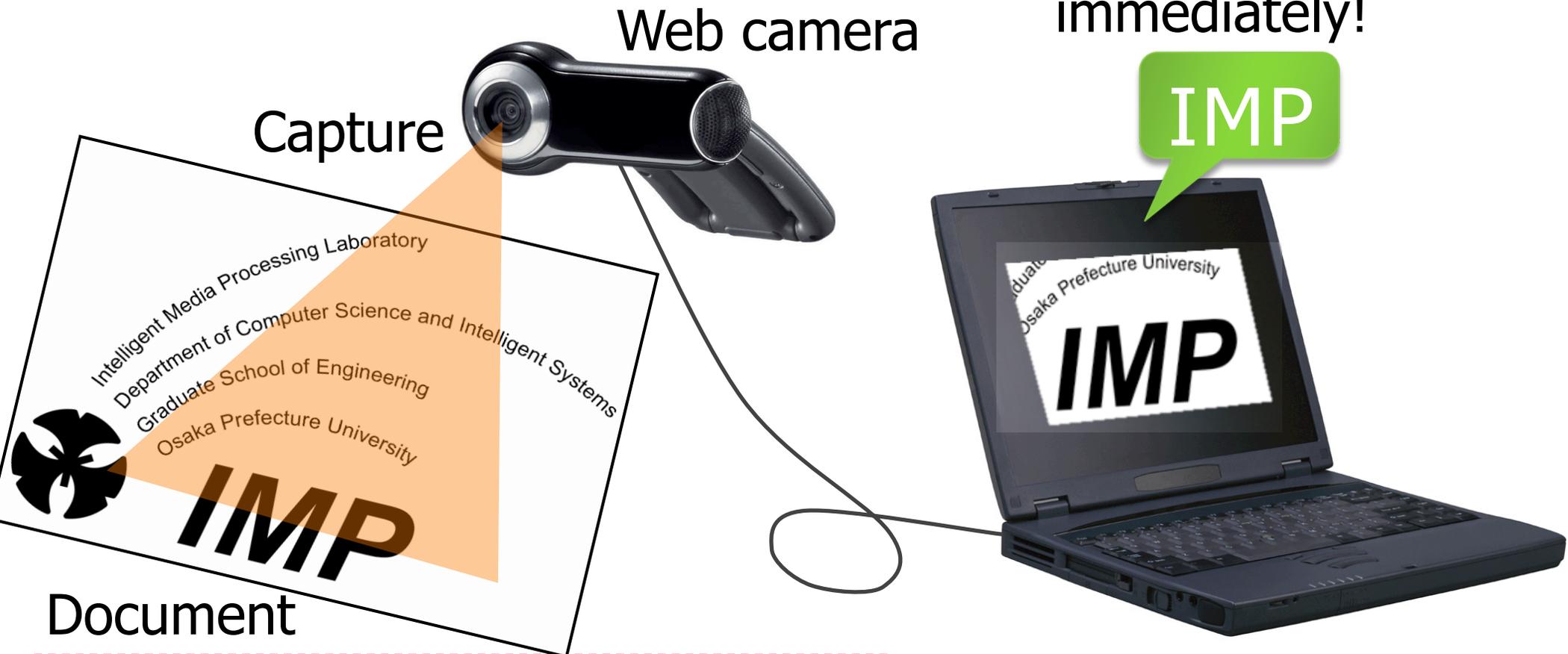
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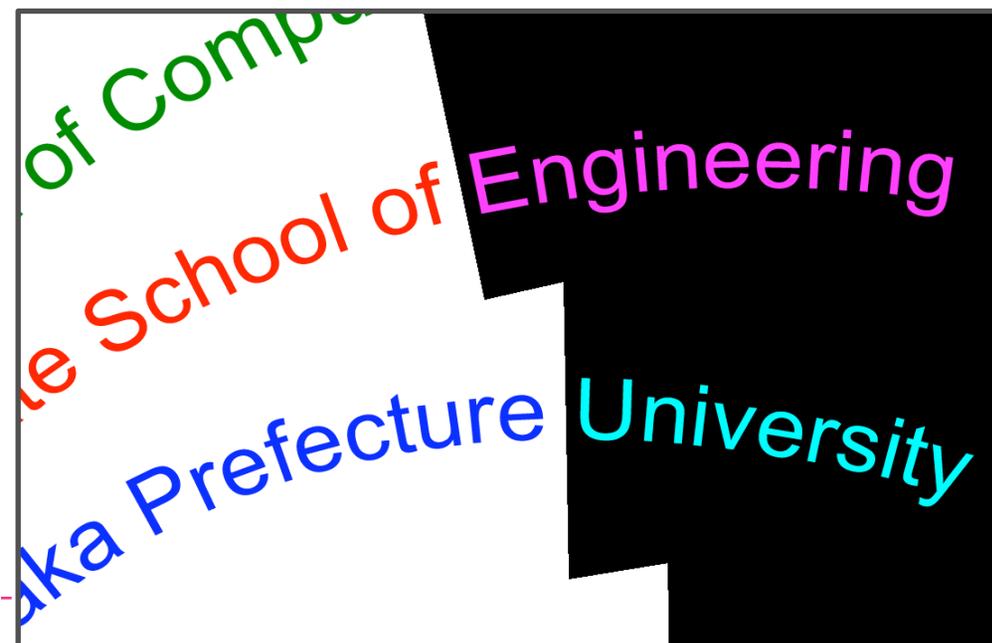


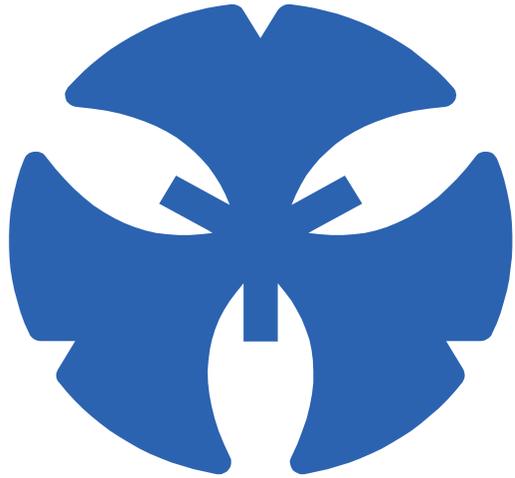
Document



Future Work

- ▶ Recognition of Chinese characters
- ▶ Improvement of segmentation for
 - ▶ Broken connected components
 - ▶ Colored characters





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Real-Time Camera-Based Recognition of Characters and Pictograms

M. Iwamura, T. Tsuji, A. Horimatsu, and K. Kise