Text-background Decomposition Using Adaptive Boundary Clustering

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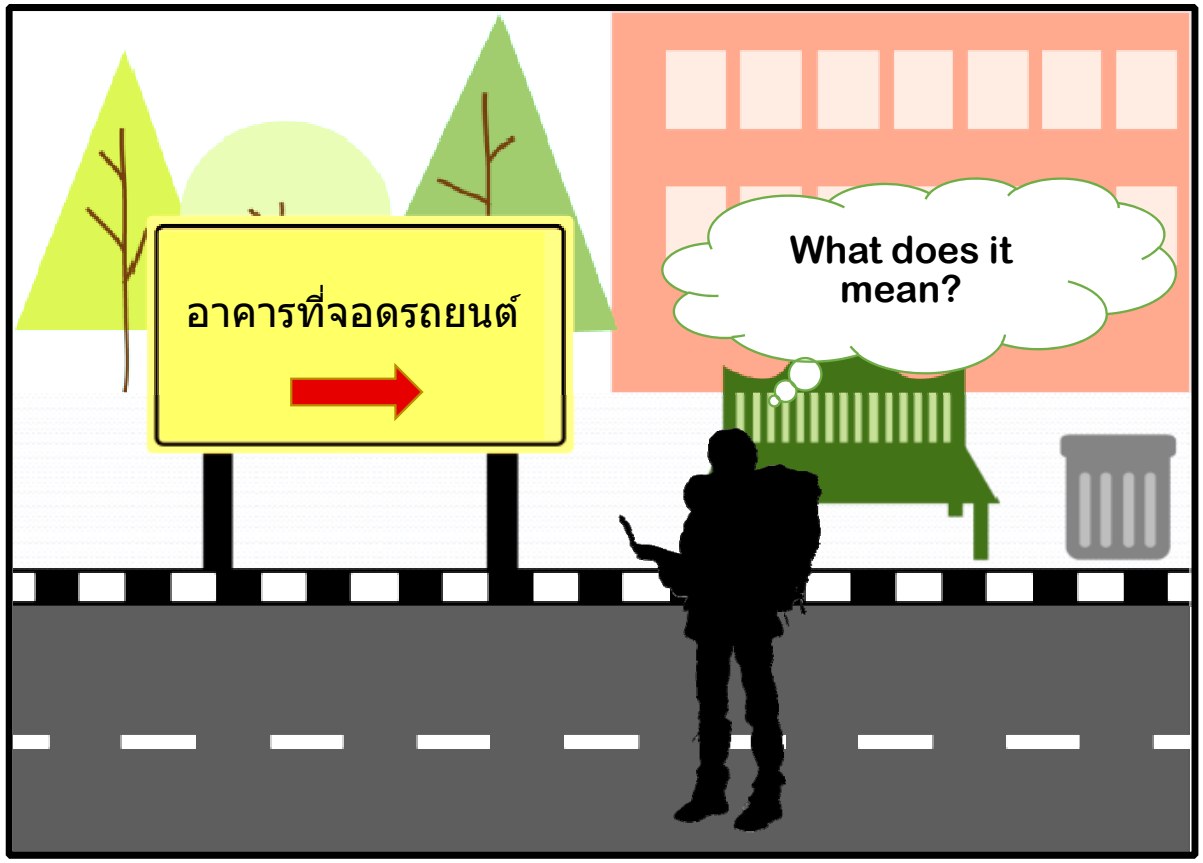
K. Woraratpanya, U. Suttapakti, K. Pasupa, P. Boonchukusol, T. Titijaroonroj, R. Hokking, Y. Kuroki and Y. Kato, "Text-Background Decomposition for Thai Text Localization and Recognition in Natural Scenes," the 6th International Conference on Information Technology and Electrical Engineering, October 7-8, 2014, pp. 138-143.

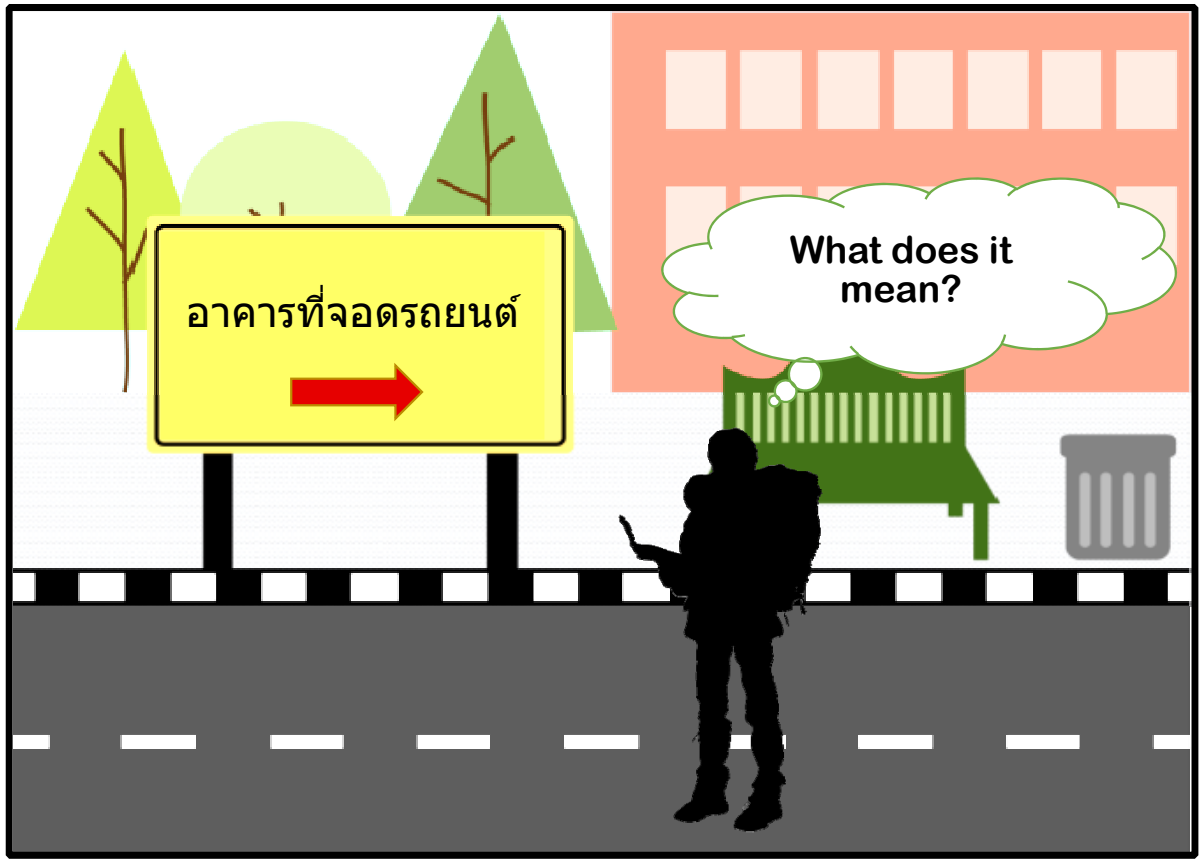
Outline

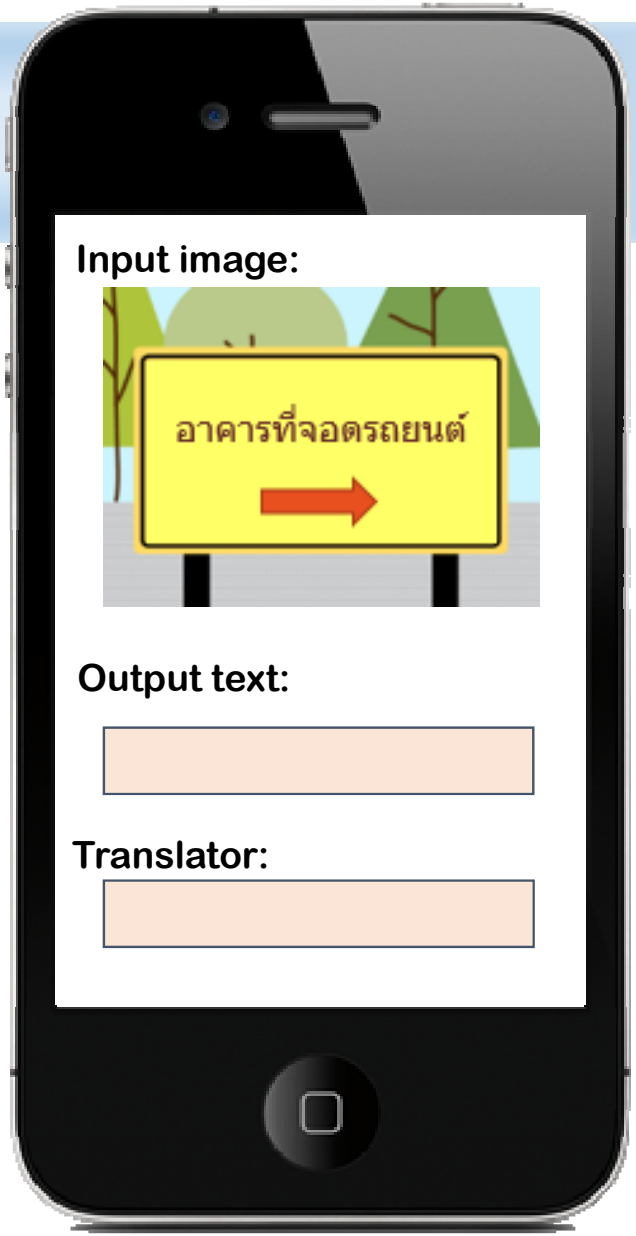
- Introduction
- Proposed methods
- Experimental results
- Conclusion

Introduction

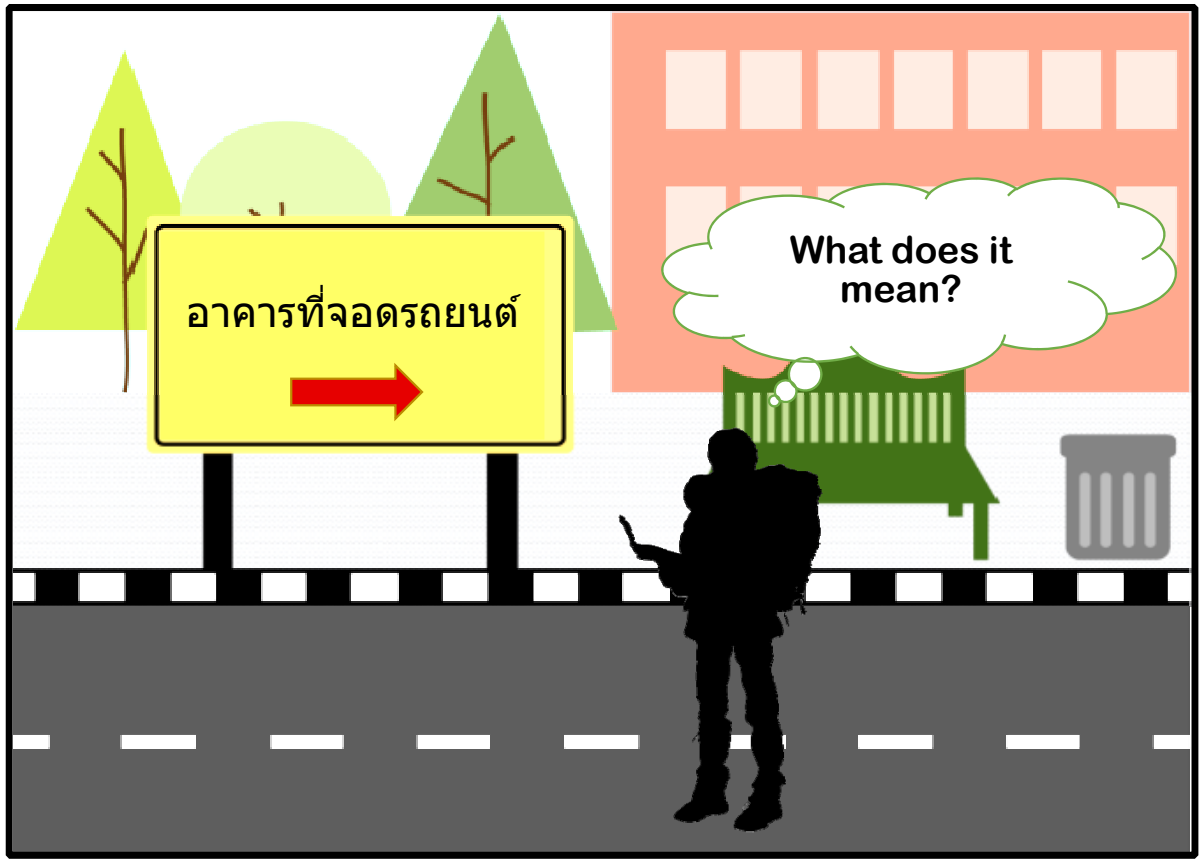


Introduction

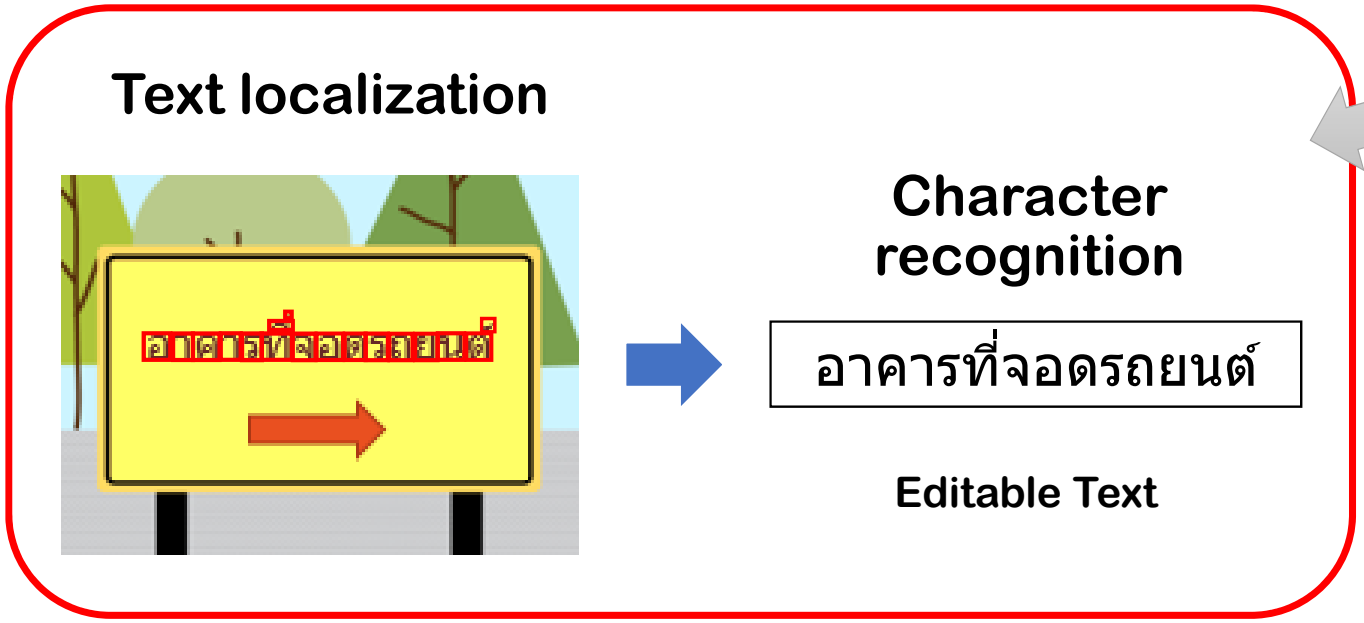




Introduction



Introduction



Challenges

I) Structure of language

Upper level

Middle level

Lower level

Thai text

English text

Challenges

II) A variety of text fonts, sizes, styles, colors, and orientations

III) Complex background

IV) Lighting condition

Related work

Multilayer Separation [1]

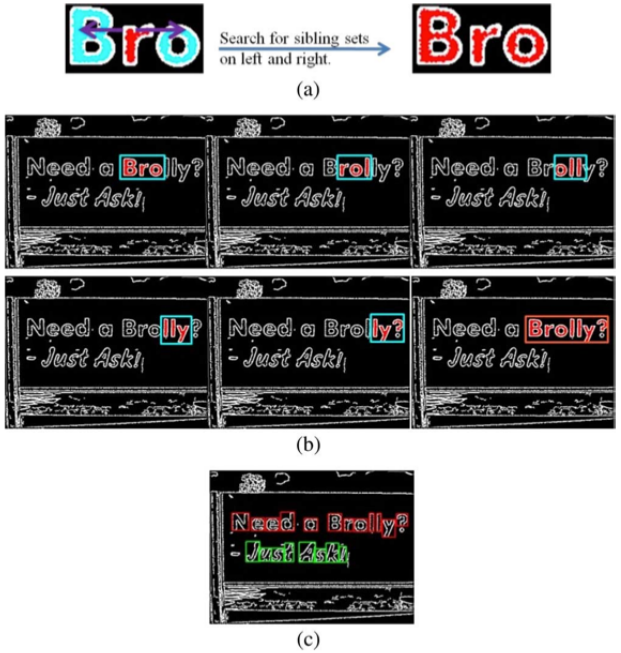
- Based on intensity value of the reduced-color image

[1] Kumar, M., Kim, Y. C., and Lee, G. S., "Text Detection using Multilayer Separation in Real Scene Images," Proc. 10th IEEE International Conference on Computer and Information Technology, pp. 1413-1417,2010.

Related work

Color-based partition [2]

- This algorithm detects text based on connected pixel with similar colors.



Cannot completely detect Thai text, especially vowels and tonal marks

Many detected non-text components

[2] Yi, C. and Tian, Y., "Text String Detection From Natural Scenes by Structure-Based Partition and Grouping," IEEE Trans. on Image Process., vol. 20, no. 9, pp. 2594-2605. September 2011.

Related work

Boundary Clustering (BC) [3]

- The color feature of BC method is averaged from all edge pixels of each feature boundary.
- A number of clusters is fixed, 5 clusters.

Long Computing Time

5 clusters

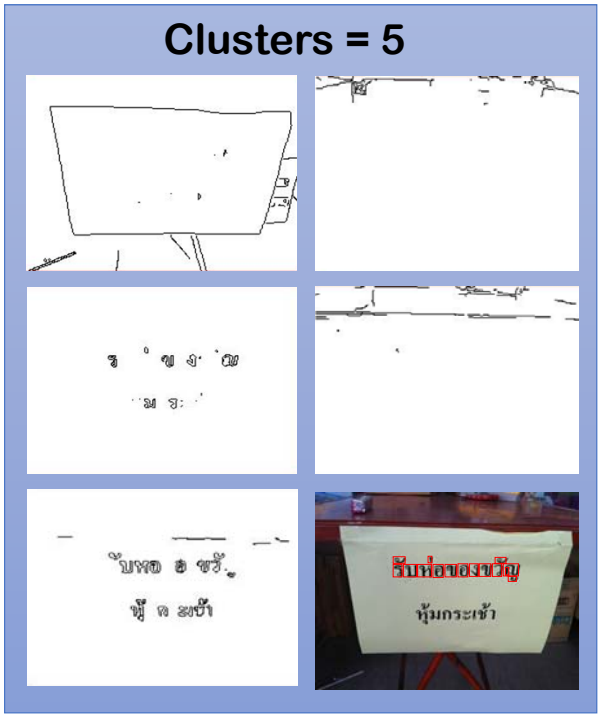
[3] Yi, C. and Tian, Y., "Localizing Text in Scene Images by Boundary Clustering, Stroke Segmentation, and String Fragment Classification," IEEE Trans. on Image Process., vol. 21, no. 9, pp. 4256-4268. September 2012.

Related work

Fast Boundary Clustering (FBC) [4]

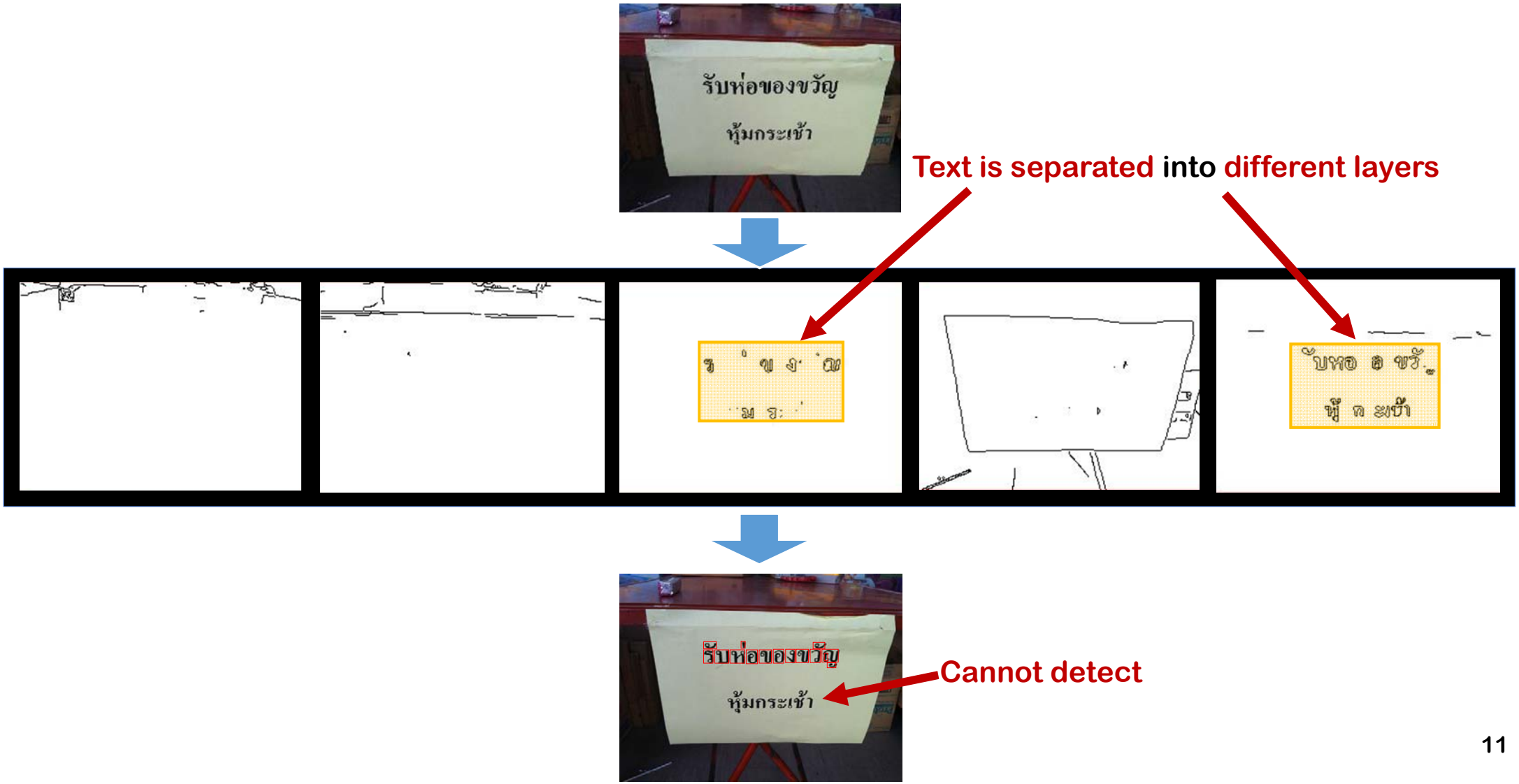
- FBC method extracts color features based on a pixel boundary.
- A number of clusters is fixed, 5 clusters.

Faster than



[4] K. Woraratpanya, P. Boonchukusol, Y. Kuroki, and Y. Kato, "Improved Thai Text Detection from Natural Scenes," Proc. 2013 International Conference on Information Technology and Electrical Engineering, pp. 137-142, 2013.

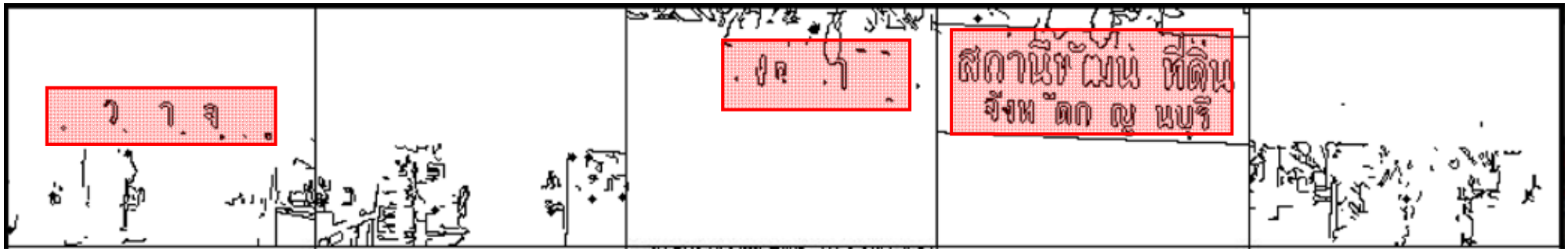
Problems: 1) The fixed number of clusters [3,4] is unsuitable, 5 clusters.



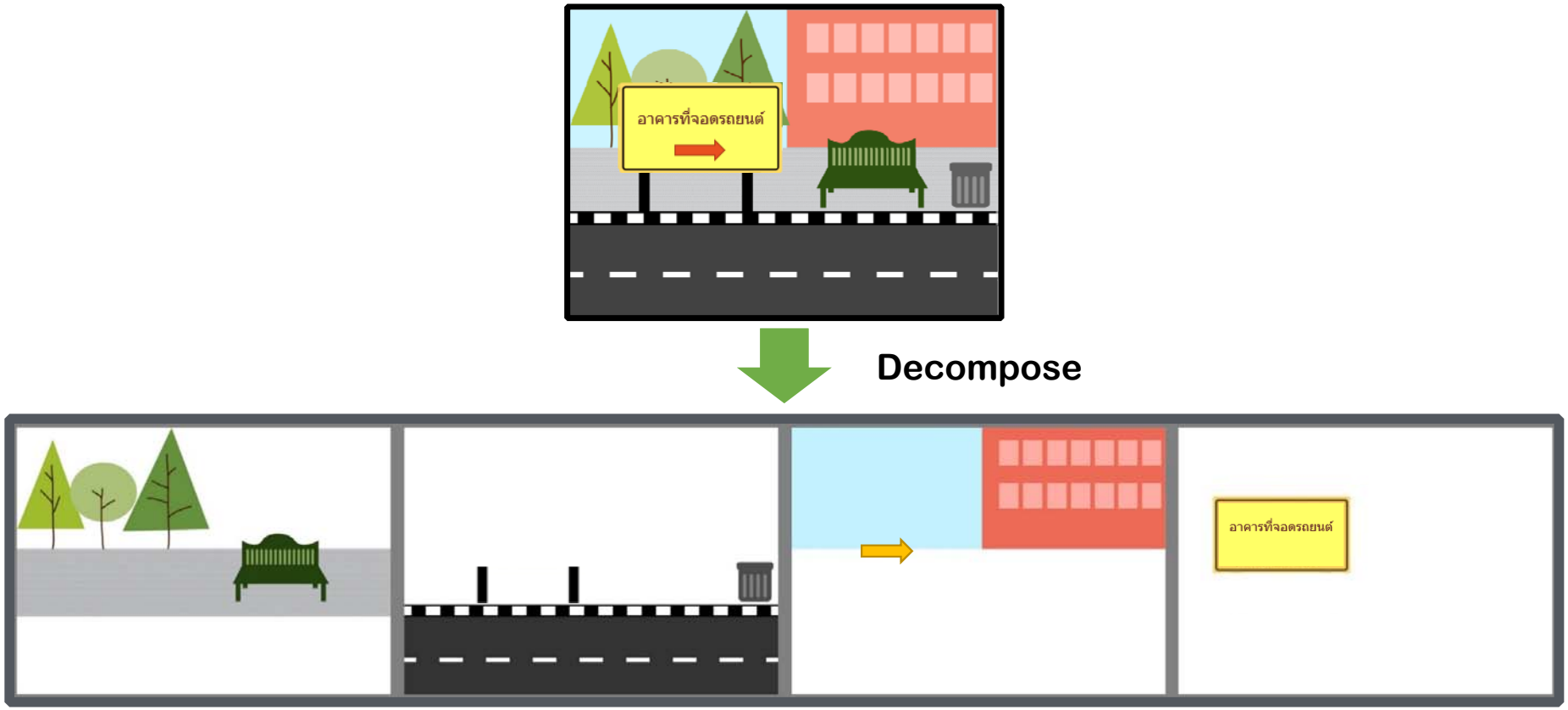
Problems: 2) The extracted color features based on a pixel boundary [4] cannot exactly represent the object when foreground and background are non-uniform colors.

Shadow

A failure of text-background decomposition

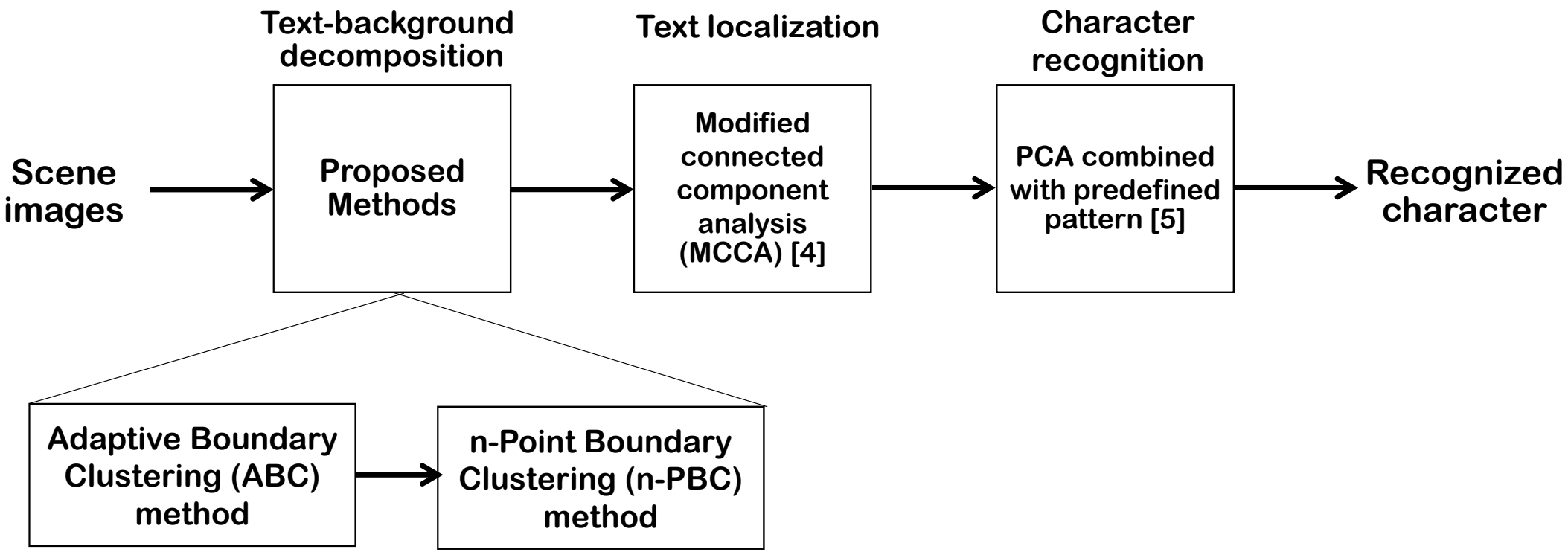


Text-background decomposition



Objectives: To improve the precision of text localization and the accuracy rate of character recognition

Overall framework



[4] K. Woraratpanya, P. Boonchukusol, Y. Kuroki, and Y. Kato, "Improved Thai Text Detection from Natural Scenes," Proc. 2013 International Conference on Information Technology and Electrical Engineering, pp. 137-142, 2013.
[5] U. Suttapakti, K. Woraratpanya, and K. Pasupa, "Font Descriptor Construction for Printed Thai Character Recognition," International Conference on Machine Vision Applications, pp. 45-48, 2013.

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Proposed methods

- Adaptive Boundary Clustering (ABC) method
- n-Point Boundary Clustering (n-PBC) method

Adaptive Boundary Clustering (ABC) method

To find the suitable number of clusters of each scene image

Scene image

Text-background decomposition

A number of clusters = ?

Text localization

Character recognition

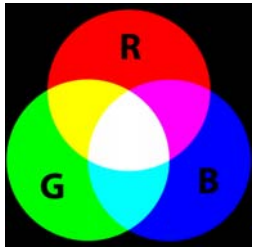
รับห่อของขวัญ
หุ้มกระเช้า

Editable text

Adaptive Boundary Clustering (ABC) method

Adaptive boundary clustering based on color quantization

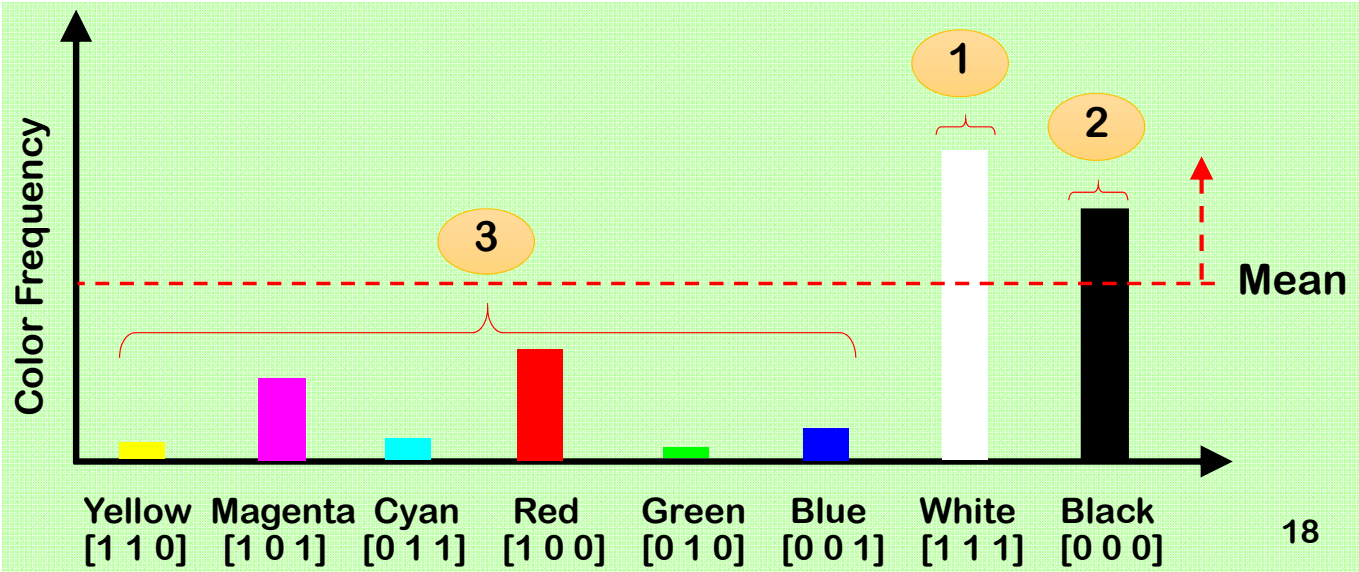
- Color quantization is a process that reduces the number of distinct colors used in a scene image.



$$k = n+1$$
$$= 2+1$$
$$= 3$$

k = the number of clusters.
n = the number of bins whose frequency is greater than mean of histogram.

Quantization

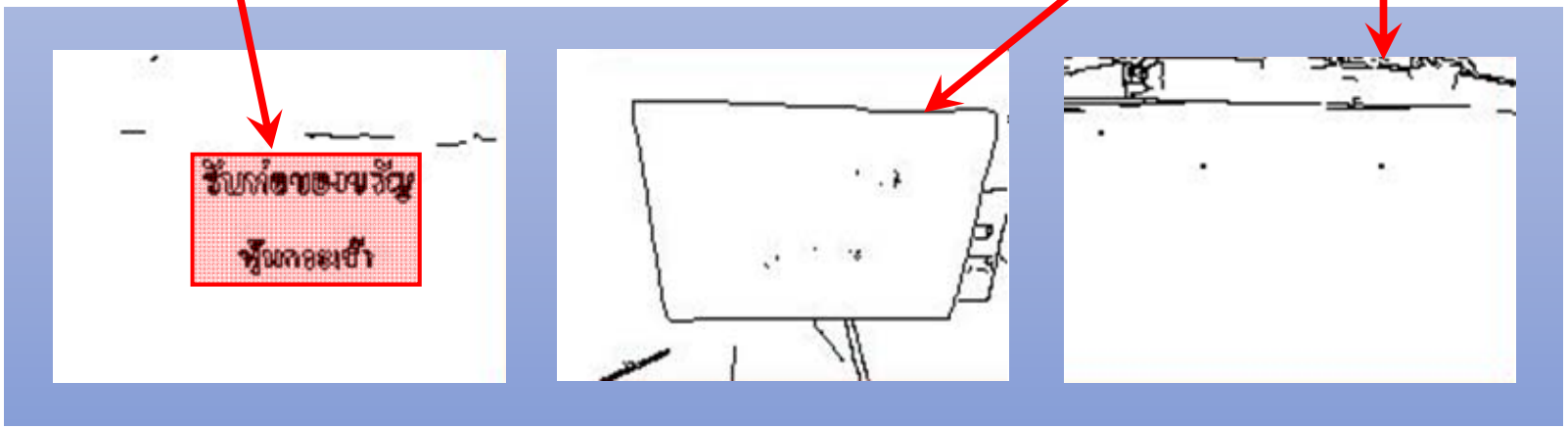


Adaptive Boundary Clustering (ABC) method

-Three clusters are suitable.

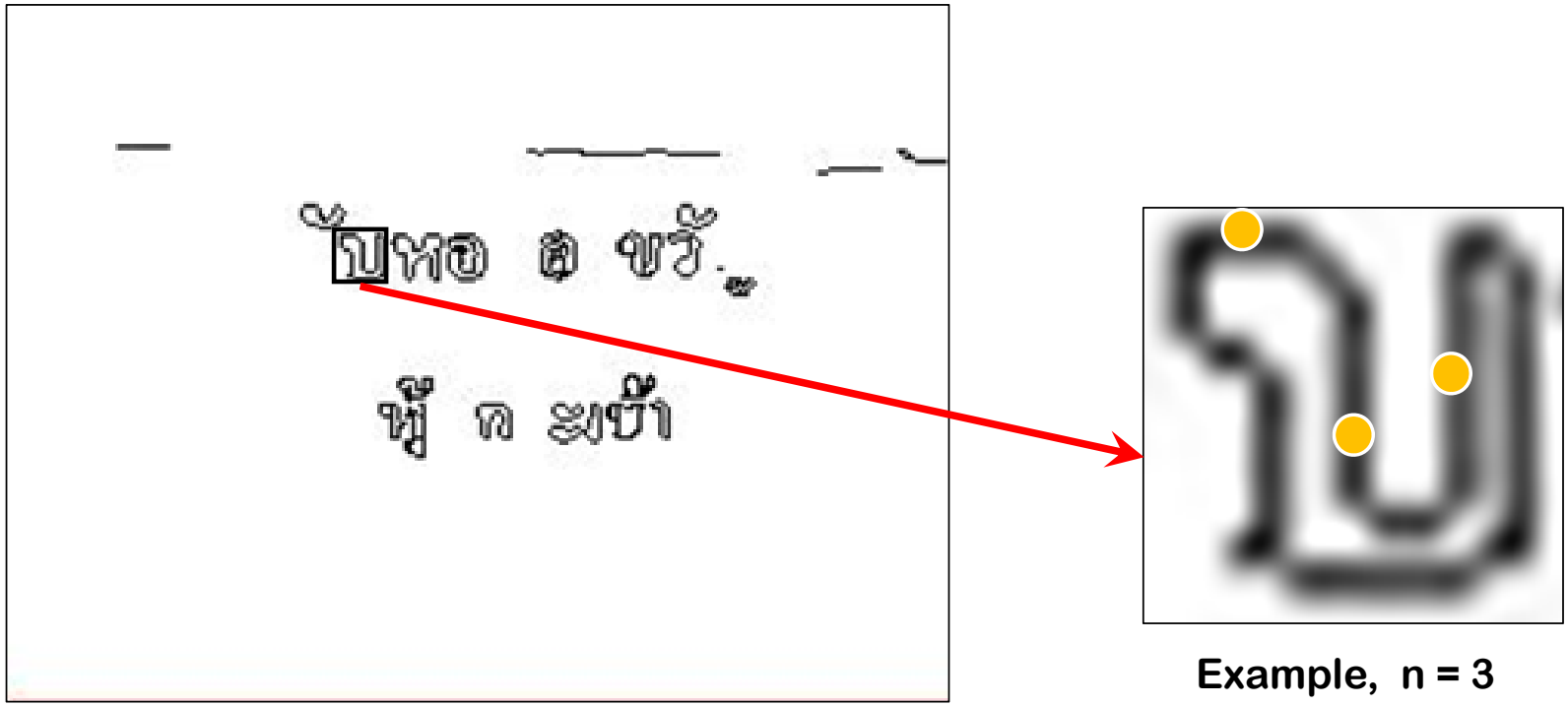
All text in the same layer.

Background Boundaries



n-Point Boundary Clustering (n-PBC) method

- The extracted color features based on an average of n-point boundary (n = 1, 2, 3, …, 8)

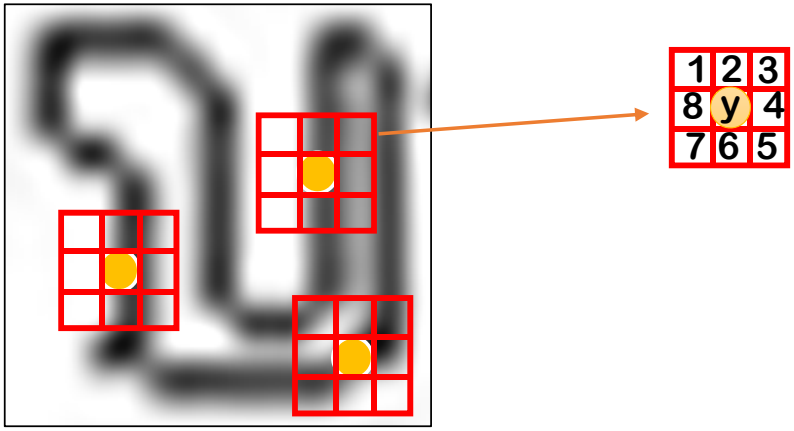


Example, n = 3

Feature vector extraction

- The feature of each object edge is extracted by determining the maximum color difference between two opposite pixels on a 3×3 mask.

Example; n = 3



An object edge

$$V_i = [R_h, G_h, B_h, R_l, G_l, B_l, C_y]_i$$

$[R_h, G_h, B_h]$ are pixel color values of the highest intensity.
$[R_l, G_l, B_l]$, are pixel color values of the lowest intensity.
$[C_y]$ is y-coordinate of the centroid of boundary.

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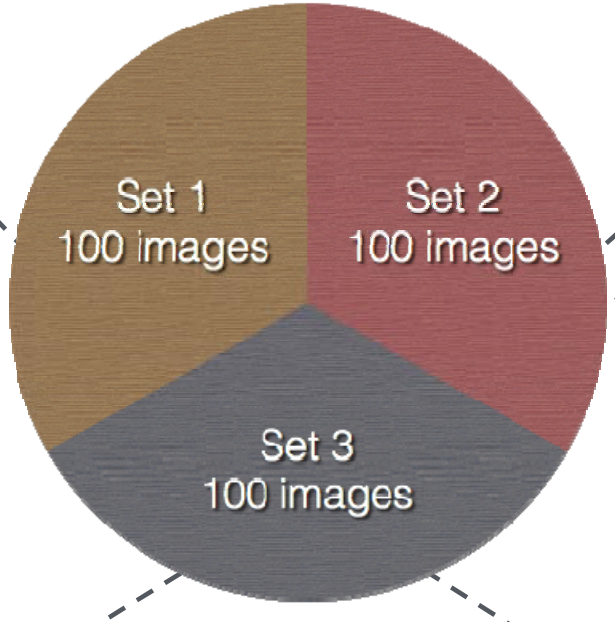
Datasets

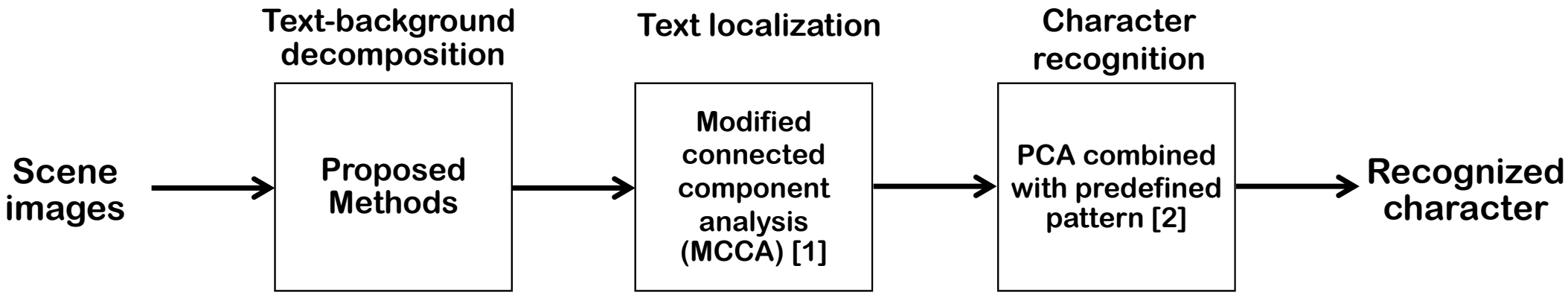
A uniform color



Complex background

Lighting condition

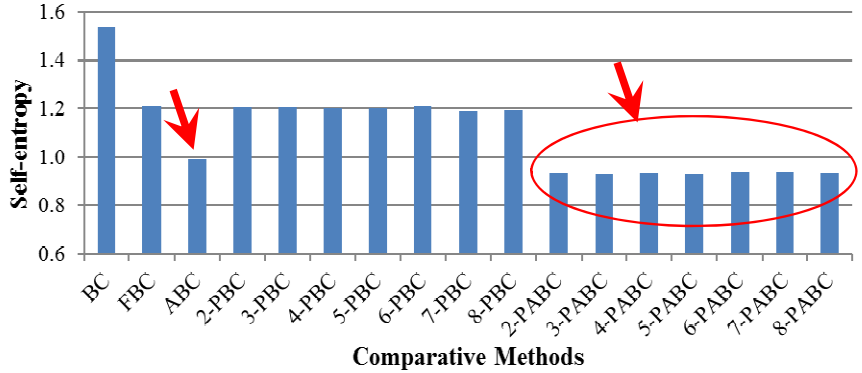
Evaluation



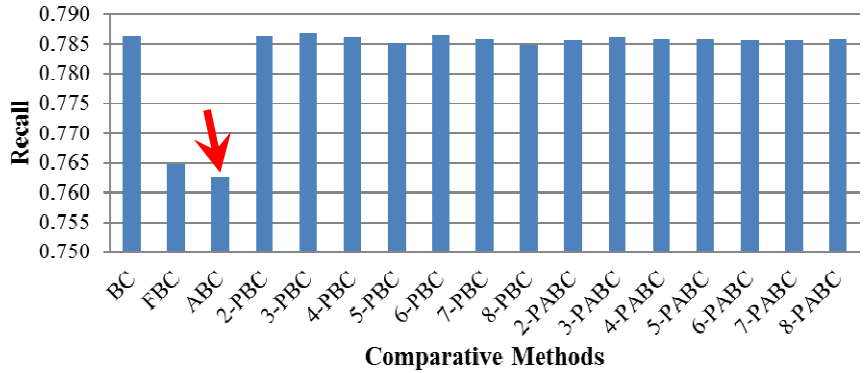
Evaluation:	Self-entropy	Precision and recall	Recognition rate
Targets:	lower, better	higher, better	higher, better
Evaluation:	Computing time	Computing time	Computing time
Targets:	lower, better	lower, better	lower, better

Experimental results

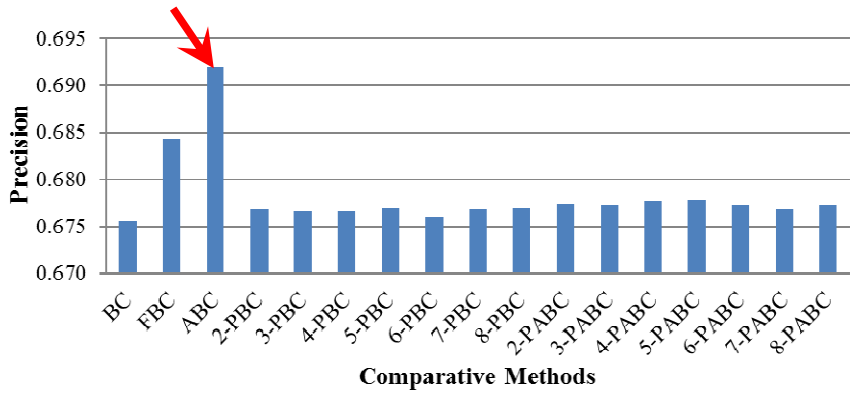
Self-entropy



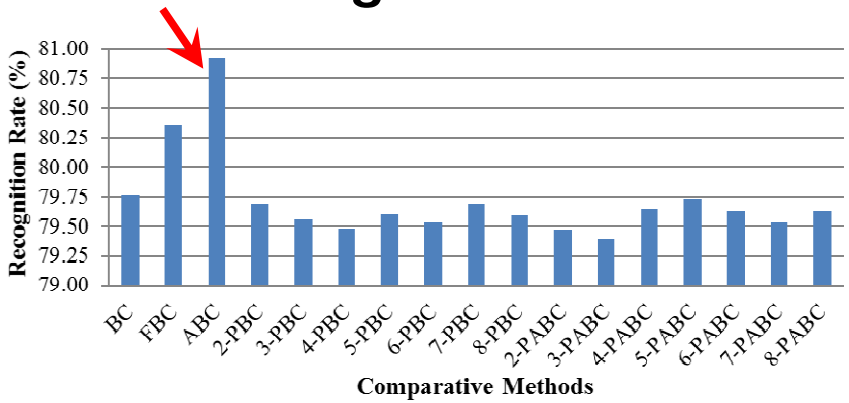
Recall



Precision

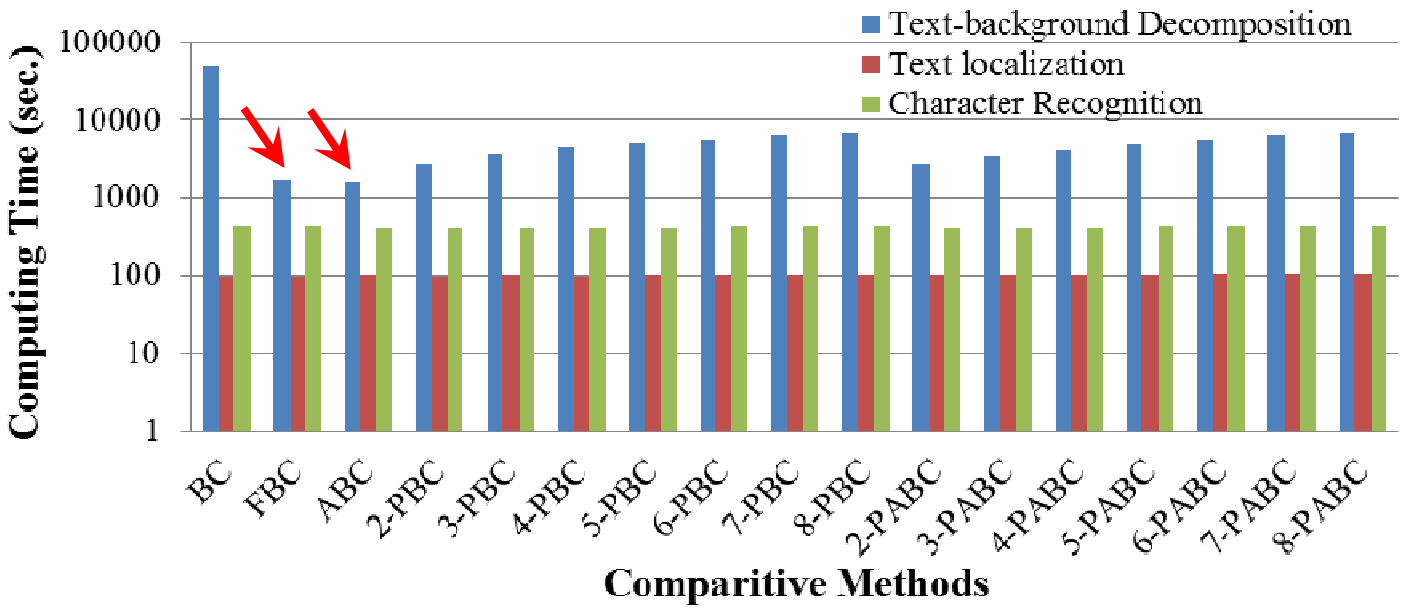


Recognition rate



Experimental results

Computing time



Conclusion

- The ABC method achieves the very low self-entropy, that is the good decomposition of text and background.
- The ABC method helps increase the precision of text localization and improves the accuracy rate of character recognition, when compared to the conventional methods.

Thank you for your attention

Evaluation

- **Self-entropy**

$$E_s = -\sum_{i=1}^{k} \left(P(x_i) log\, P(x_i) + P(y_i) log\, P(y_i) \right)$$

where $P(x_i)$ is the ratio of the number of text boundaries to the total number of boundaries.

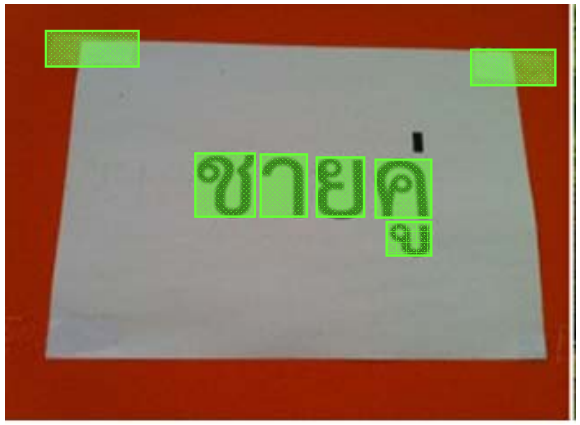
$P(y_i)$ is the ratio of the number of non-text boundaries to the total number of boundaries and k denotes the number of clusters.

The low self-entropy implies the purity of text-background decomposition.

Evaluation

$$precision = \frac{tp}{tp + fp} = \frac{5}{5+2} = 0.71$$

$$recall = \frac{tp}{tp + fn} = \frac{5}{5+1} = 0.83$$



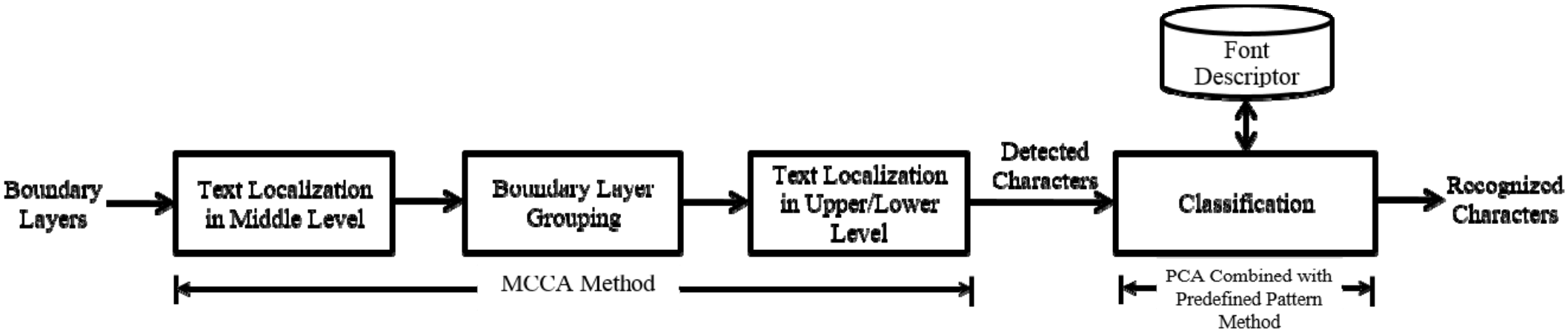
Predicted class

Actual class

Classes	Text	Non-text
Text	$tp = 5$	$fn = 1$
Non-text	$fp = 1$	$tn = 0$

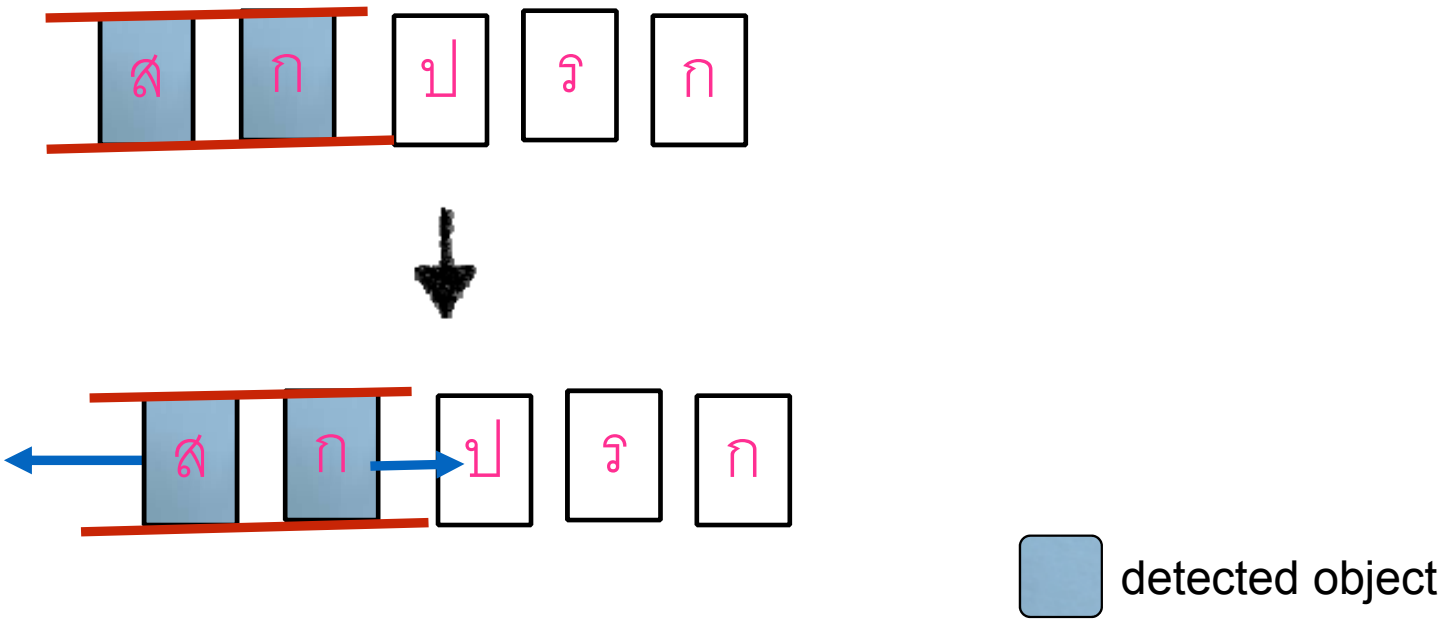
Text Localization and Character Recognition

- A diagram of text localization and character recognition.



Text-background Decomposition

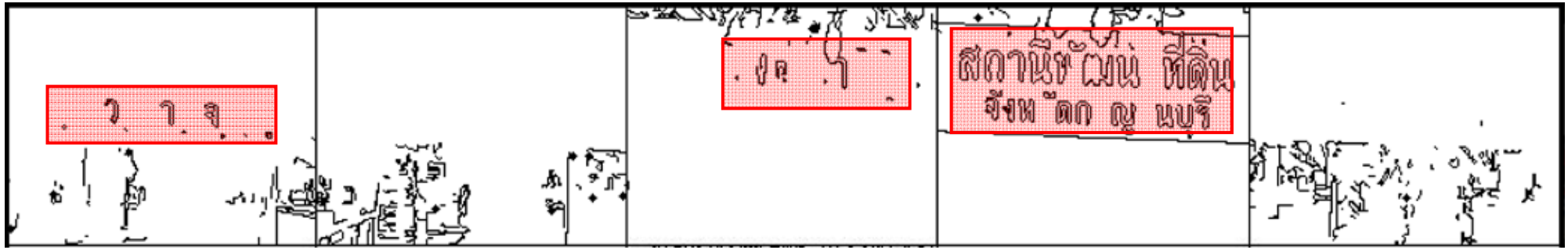
Modified Body of Text Detection



Scene image

Comparative FBC and n-PBC method

A failure of text-background decomposition of FBC method



A success of text-background decomposition of n-PBC method