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DOCUMENT IMAGE ENHANCEMENT

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Background and Motivation

More and more documents are digitalized everyday. Many digital images are taken with text information in the scene.

It would be very useful to convert the characters from a image format to a textual format.

However, there are many different kinds of distortion within many digital images that make the textual information inaccessible.
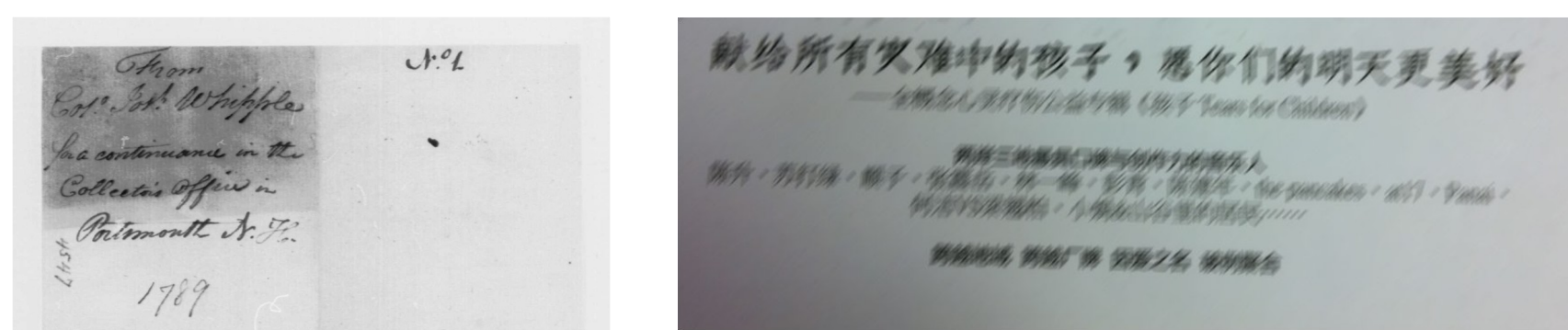
Document image enhancement techniques improve the document image quality not only to enhance human perception, but also facilitate subsequent automated image processing.

During my Ph. D. study, I focus on two following aspects:

Document Image Binarization

Document Image Binarization is to cover a gray-scale document image into a binary version for ensuing document analysis tasks.
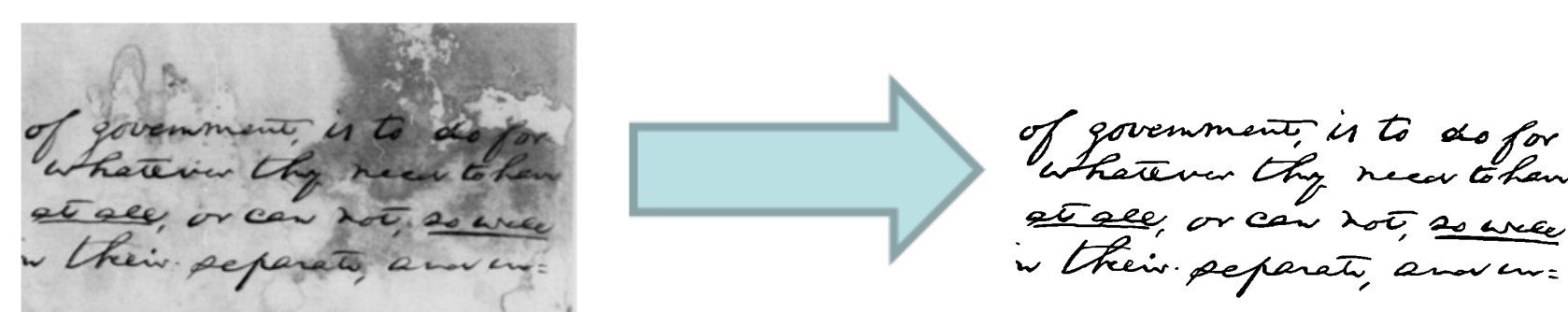
The modelling of the document foreground-background is very difficult due to various types of document degradation

The high intensity variation within both the document background and foreground caused by degradations makes it difficult to design an uniform classification method that correctly separates text and background for all kinds of degraded document images.

Our current Progress on Document Image Binarization:

**1. Document Image Binarization Using Background Estimation**

- Make use of the document background surface and the text stroke edge information

- The foreground text like the islands separated by the ocean of image background
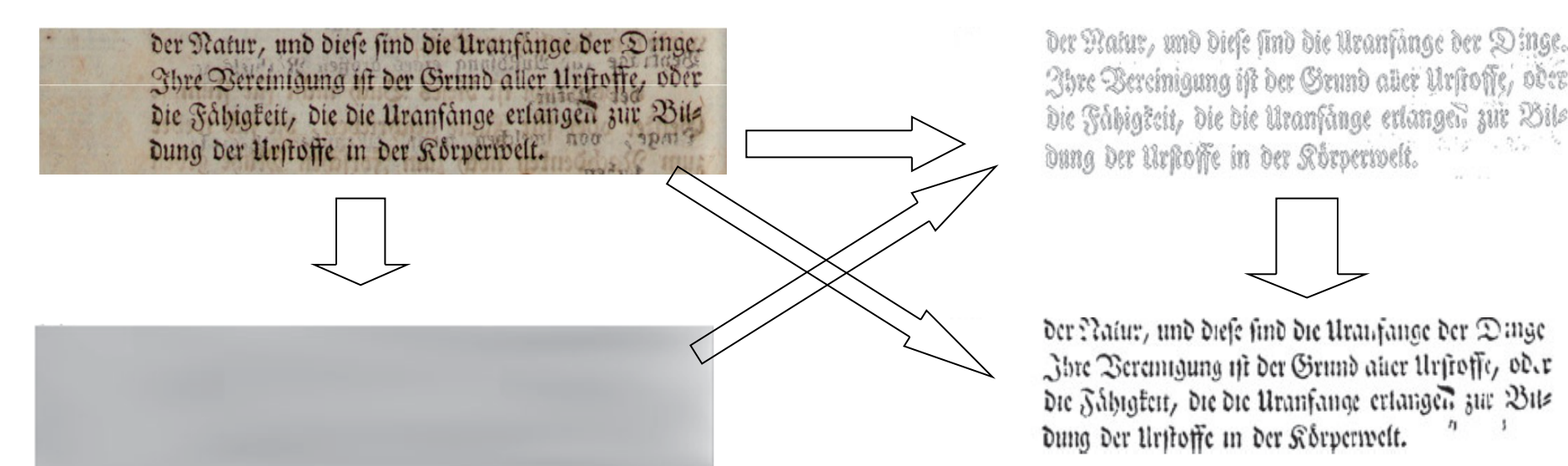
2. Document Image Binarization Using Local Contrast

Makes use of the image contrast that is evaluated by using the local maximum and minimum

Local Contrast
$$D(i,j) = \frac{Max_{local}(i,j) - Min_{local}(i,j)}{Max_{local}(i,j) + Min_{local}(i,j) + \epsilon}$$
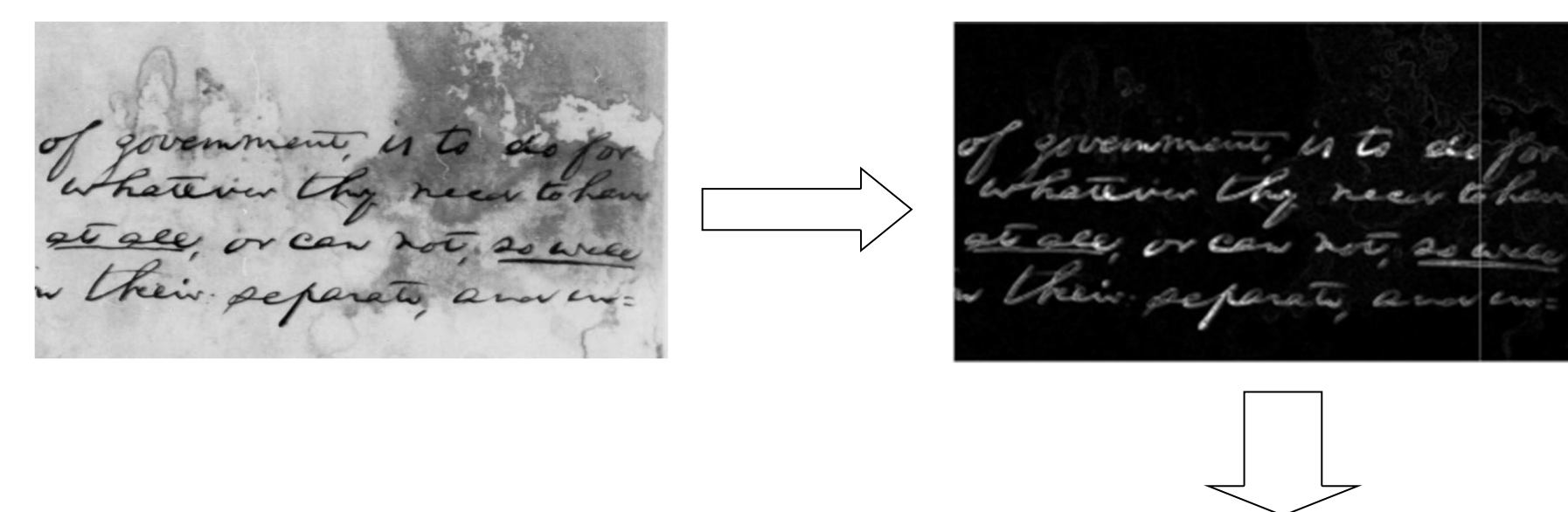
3. Improving Document Image Binariazation Techniques

3.1 A Self-Learning Document Binarization Framework

We use confidently classified pixels that are far away from the threshold surface created by existing thresholding method to train a classifier to re-label those remaining pixels.

Self-Training
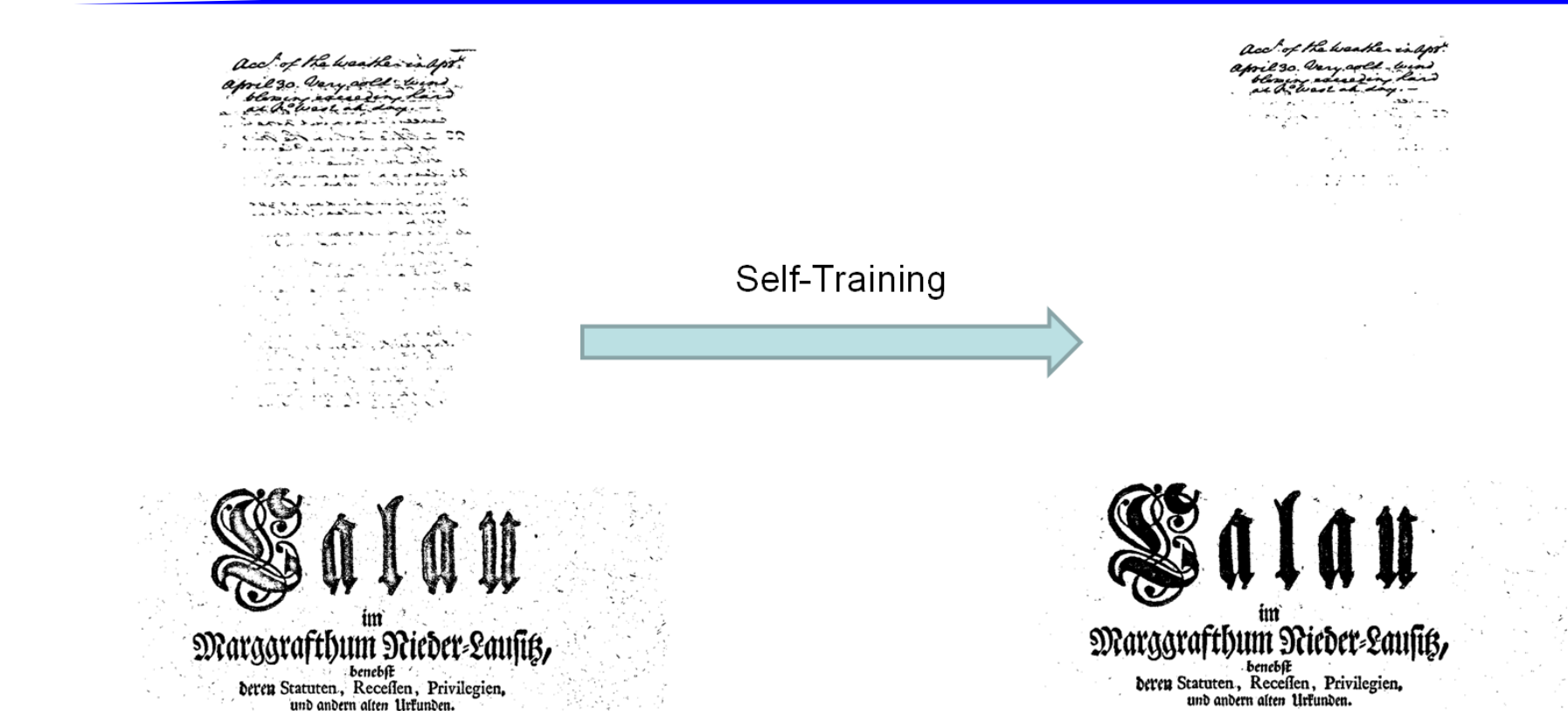
3.2 Combination of binarization results

We use those pixels that labelled the same by different methods (which is usually correctly classified) to iteratively re-classify the remaining pixels

Document Image Deblurring

Blurring is one of the most common artifacts in digital photography. There are two main kinds of blurring: one is motion blur, which is caused by the relative motion between the camera and object during image capture; the other is defocus blur, which is due to the incorrect focal length setting when taking photos. Blurring induces the degradation of image quality, especially for document images where the text information is easily lost due to blur.
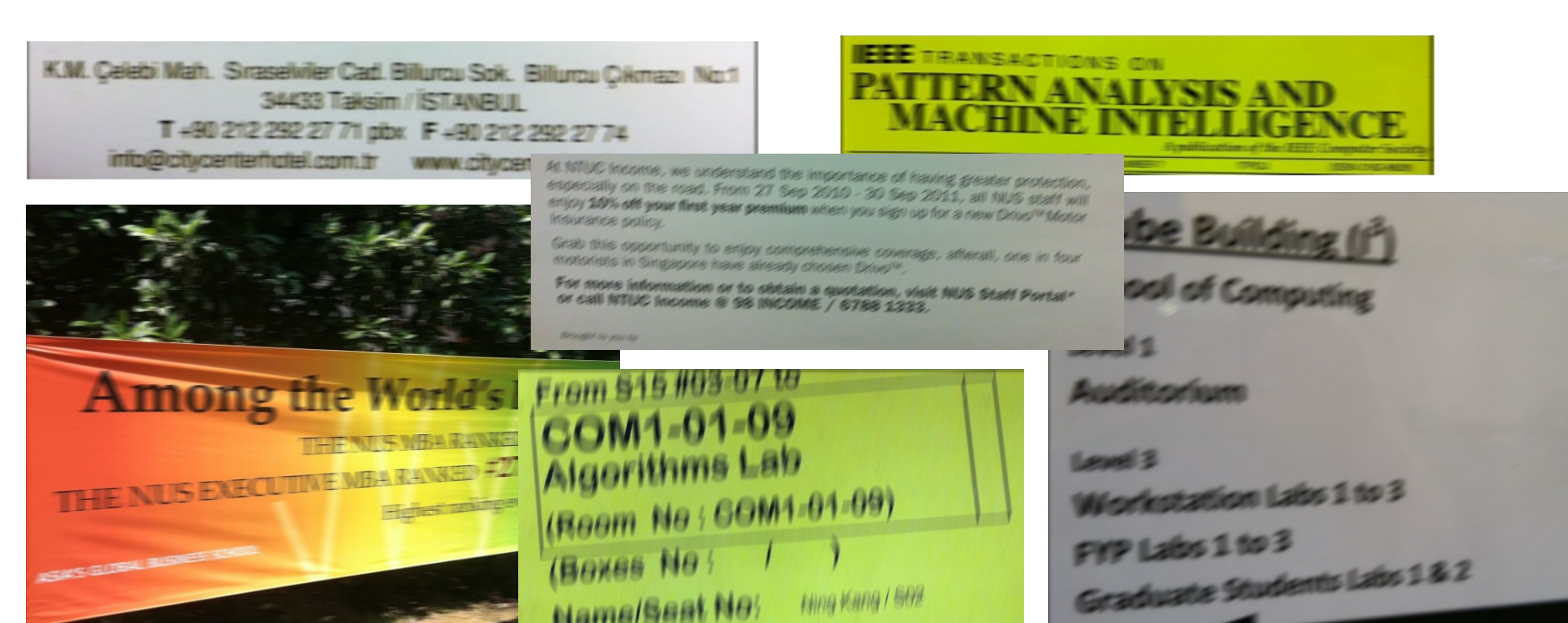
Blurring Detection and Classification

automatic image blur detection and classification are useful for learning the image information, which can be used in different applications such as motion based object extraction, region-based image retrieval, and image enhancement segmentation.
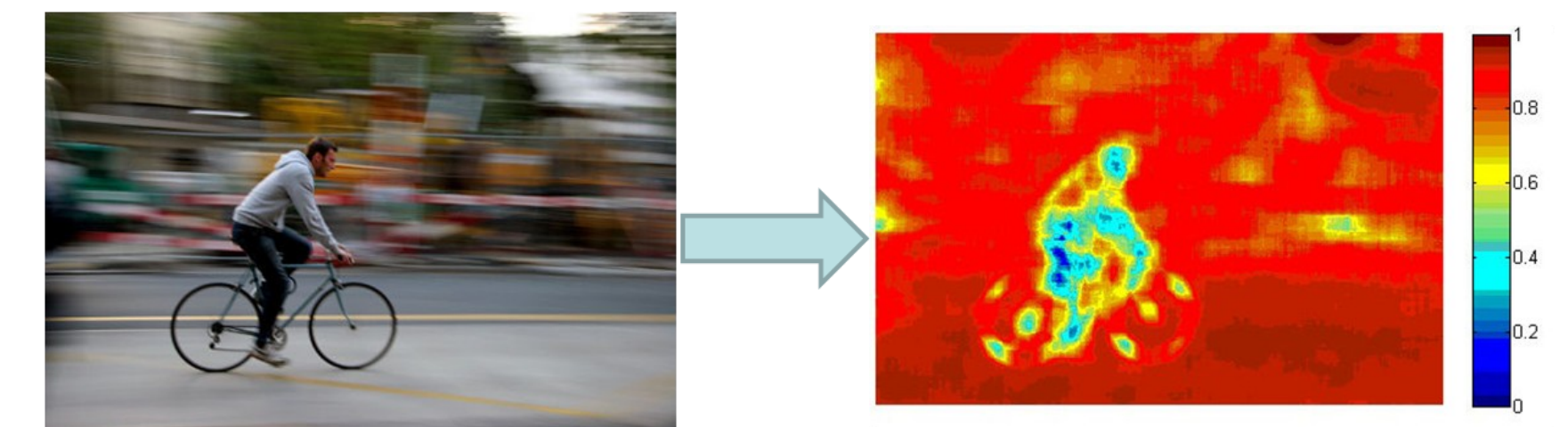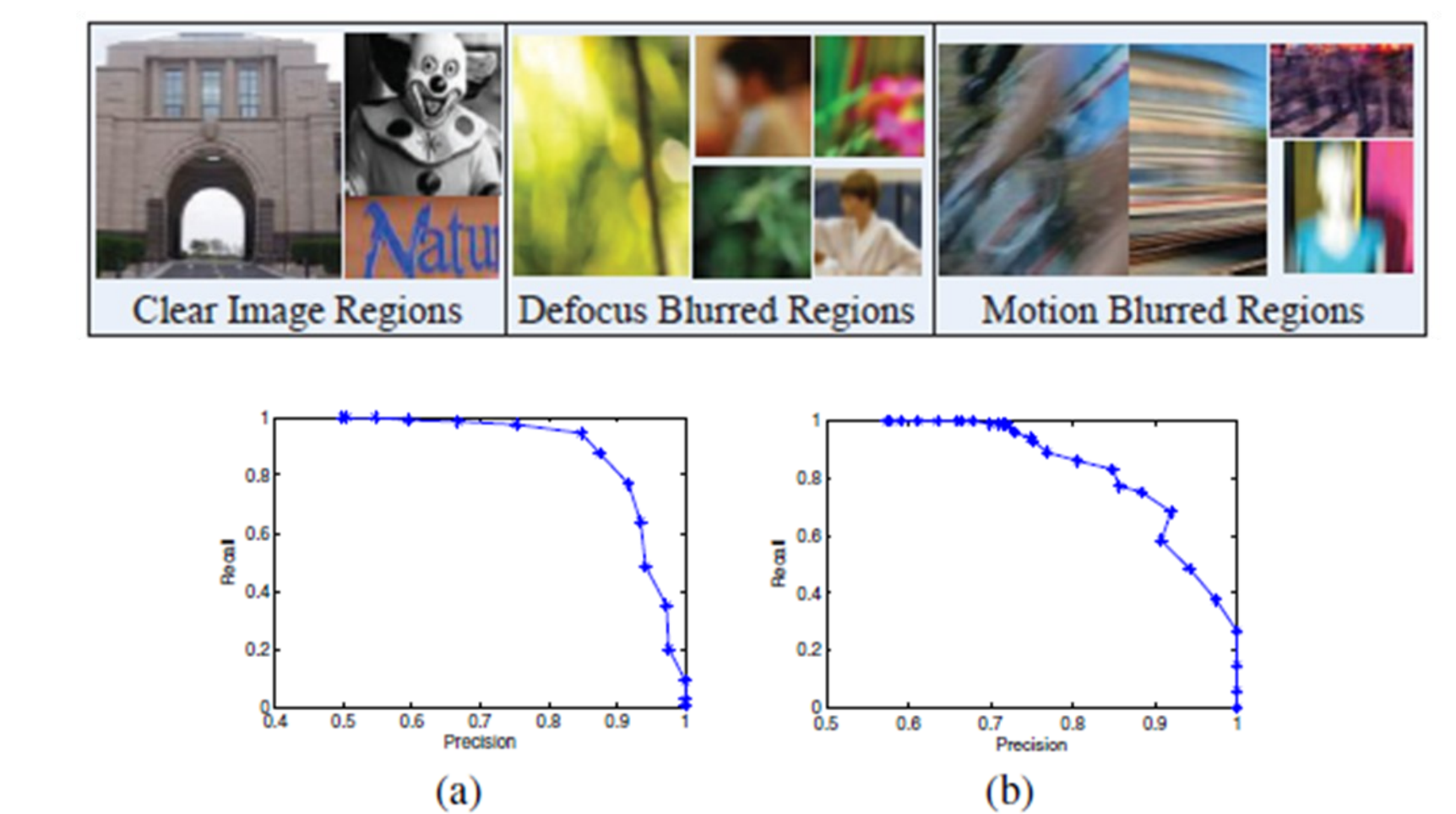
The proposed technique first constructs a blur map that encodes the blur degree of an image. The blur degree is estimated by the ratio between the first few most significant singular values and all singular values that are computed over a local image patch surrounding each image pixel.

Such estimation is based on the observation that the first few most significant eigen-images of a blurred image patch usually have higher weights (i.e. singular values) than an image patch with no blur (because image blurs often suppress the high-frequency image details that is reflected within those less significant eigen-images).

Once the blurred image regions are extracted, the blur types of those blurred regions are further identified based on the gradient distribution patterns of the alpha channels.

Input Image → Blur Region Detection (Singular Value Feature) → Blur Classification (Alpha Channel Feature) → Defocus Blur / Motion Blur

Blurring Detection and Classification Accuracy

Clear Image Regions | Defocus Blurred Regions | Motion Blurred Regions

(a) (b)

It can be used as a preprocessing step to identify different blur degree of input images for ensuing deblurring or segmentation tasks
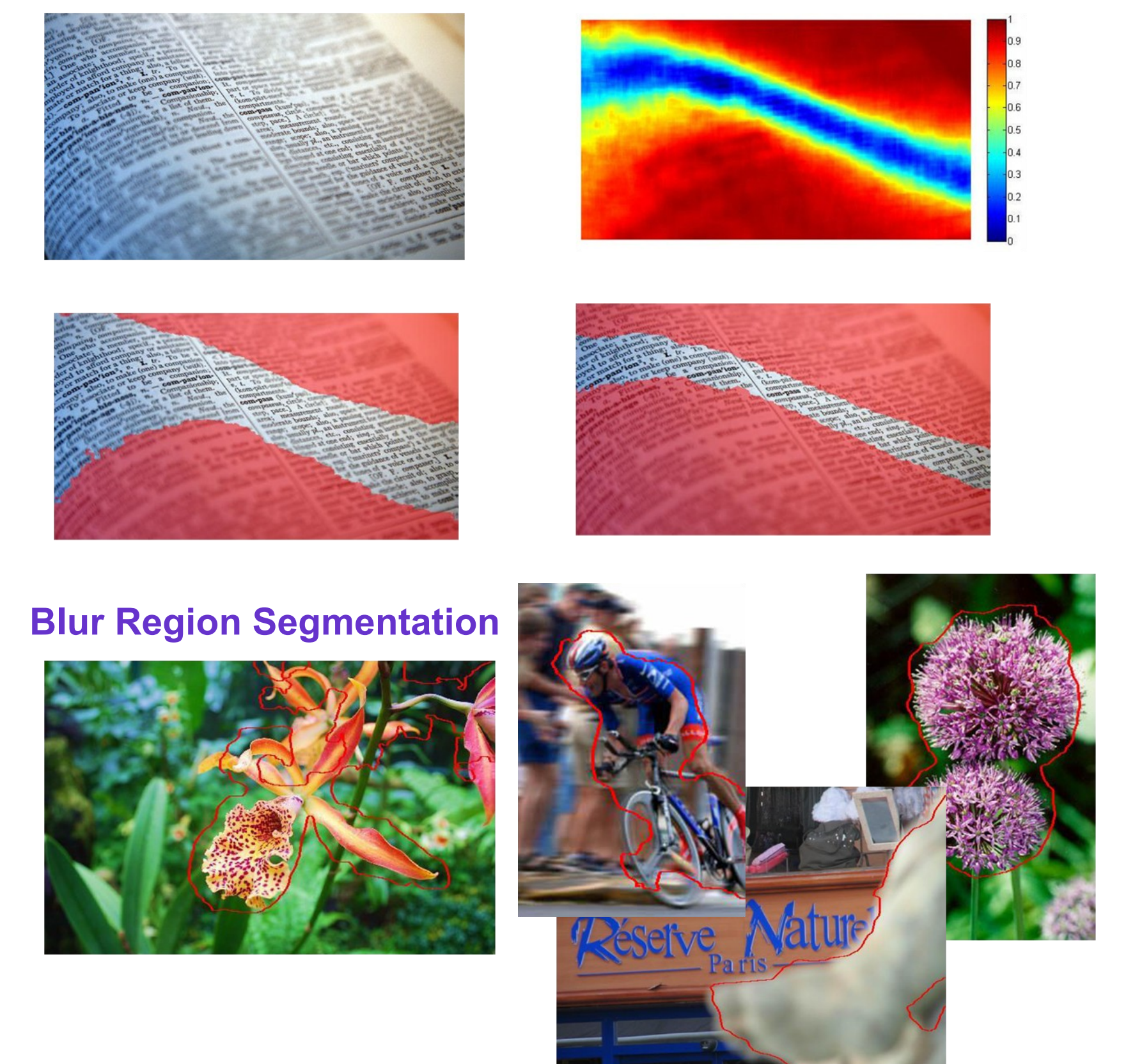
Blur Region Segmentation

Conclusion and Future Plan

Summary of my work:
- Document Image Binarization techniques: background estimation and local contrast
- Improving the existing document image binarization techniques: self-training document framework and binarization result combination
- Blurred Region detection and classification
- Blurred Document Image Restoration(Unpublished, Under Progress)

In my remaining Ph.D. study:

2 months on document image binarization,
try to propose a better framework for combining existing binarization techniques and improving the performance of reported methods

6 to 8 months on document image deblurring
develop some techniques for document image blur detection and restoration

2 to 4 months to explore other document enhancement techniques
apply methods to other domains