Region of Interest Extraction For Print Defect Detection and Analysis and Image Quality Assessment

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INTRODUCTION

- The purpose of the project is to develop a method with which to identify and extract regions of interest (ROI) on a digital image, which may contain said print defects.
- ROI extraction method is based on the digital image object map, which includes three different labels: raster (pictures or photos), vector (background and smooth gradient color area) and symbol (symbols and texts).

OBJECTIVES

- Generate a symbol object map to detect and distinguish symbol, raster, and vector objects. Use the largest possible rectangle to label each object to have the greatest change at detecting the print defect.
- Apply Greedy Algorithm to extract the most useful area.

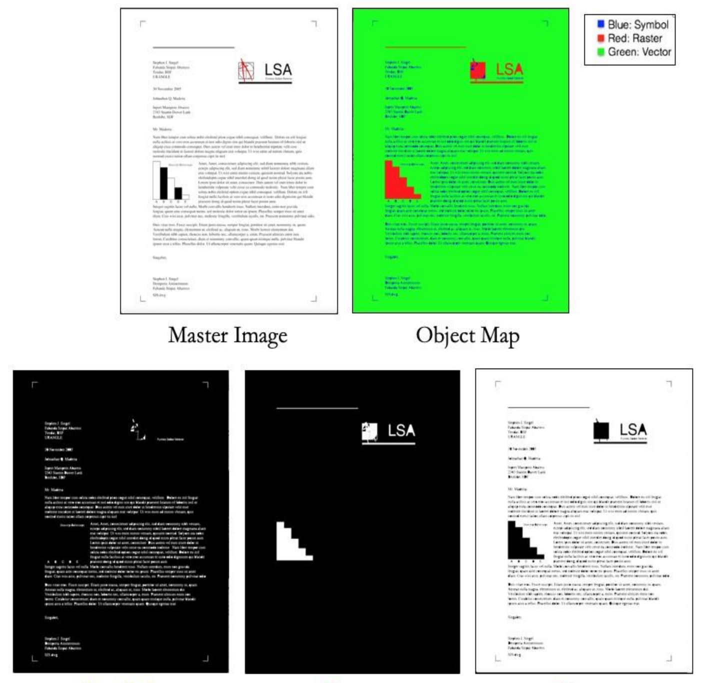

Fig. 1: The input images: master image and object maps

TECHNIQUES & RESULTS

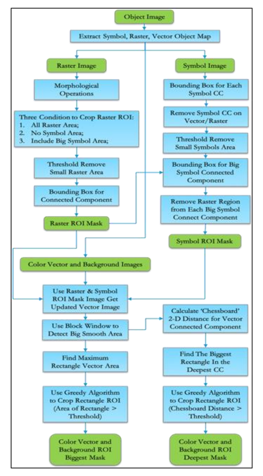

Fig. 2: The overall pipeline of ROI extraction

- We first use edge detection the Sobel edge detection and Connected Components for object maps. For the raster object map we initially do the morphological operations, to remove imperfections. We use the average of connected symbol component height as morphological operation kernel size, then, process erosion with one kernel size, dilate six kernel size and erode five kernel size. We then use connected components algorithm for new raster object map and use the bounding box to label each raster connected components for three conditions: first, raster object pixels makeup over 80% of bounding box of the connected component and the bounding box of the connected component is retained as interest raster object. Second, raster object pixels makeup over 20% of bounding box of the connected component, with no symbol object pixels in the remaining area. Here, the bounding box is interest raster object. Third, raster object pixels account for over 20% of bounding box and a big symbol area remains. We cut smallest rectangle area, including all symbol object. After processing bounding box of each raster component, we get a new raster object map.
- Next we extract symbol object map and raster ROI result. In the object map, most symbol area is disconnected text characters. We crop big area to include symbol object. First, we use connected component algorithm to label independent text characters. We observe distance between adjacent elements of each connected component in one paragraph in Photoshop. Based on the observing result, we use the average height of all text characters as the morphological operations kernel size to erosion the symbol object map, Connecting all the text characters in paragraphs. We use bounding box for new symbol object map connected component result to get the significant symbol ROI result. In this symbol extraction result, we find it includes a raster object, which is unwanted. We cut smallest rectangle area from one symbol ROI to retain majority. Generally, we want to cut the small area.
- Secondly, we extract color vector and background ROI in two methods: extract maximum rectangle area and extract deepest rectangle from background big smooth area. For the latter, define a vector area about any coordinate dimension. Find where distance between two vectors is greatest. Ex) Points P and Q have Cartesian coordinates (x1,y1) and(x2,y2), their chessboard distance is:
- Distance in shape of rectangle. Calculate chessboard background distance big smooth area. Normalize distance to 0 -255 to view. Deepest area located by number of white pixels. We use greedy algorithm to obtain most useful ROI region. Lastly, use MATLAB GUI Tool to label ground truth and verify accuracy.

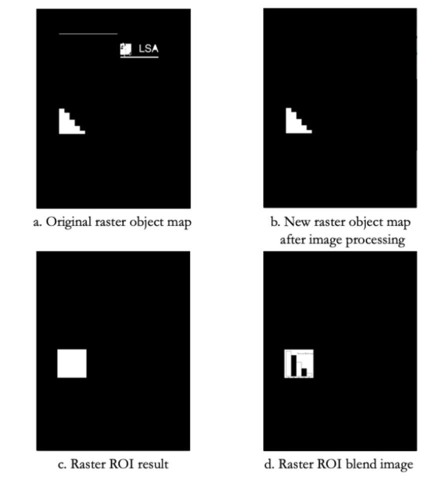

Fig. 3 : The Raster ROI Extraction process

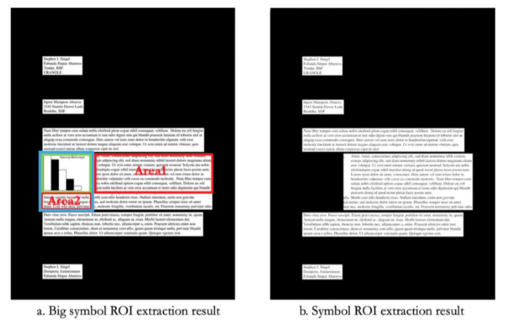

Fig. 4 : The symbol ROI Results

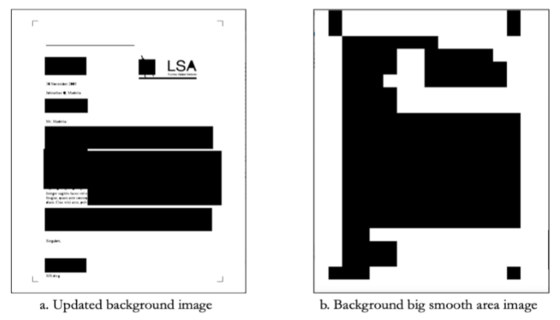

Fig. 5 : The Pre-process for Background Object Map

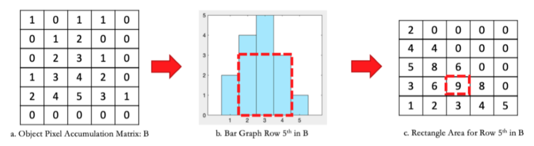

Fig. 6 : Calculation For One-row Maximum Rectangle

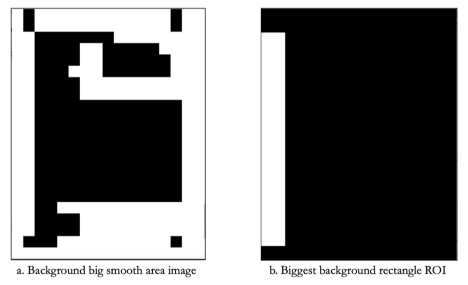

Fig. 7 : The Biggest Background ROI Result

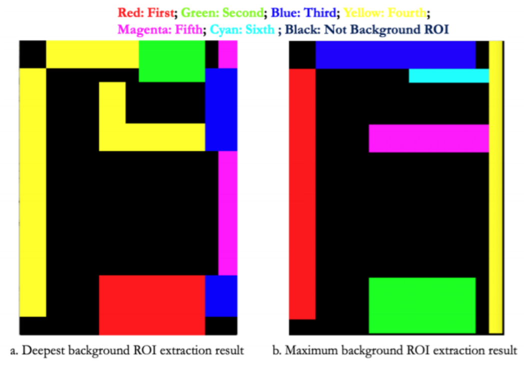

Fig. 8: Background ROI Extraction

SUMMARY

- A proposal to use digital image object map to extract the four different ROIs: objects raster (pictures or photos), vector (background and smooth gradient color area) and symbol (symbols and texts), and background, classified as a smooth gradient (color vector). We developed two methods to extract color vector and background ROI: extract the maximum area rectangle; and extract the deepest rectangle. We also use the greedy algorithm to get most useful area.

FUTURE WORK

- The team is currently developing a deep learning model to train an algorithm to autonomously label the raster, symbol, and vector objects, as well as raster. 230 images have been labeled by hand in preparation for the new stage. The finalized algorithm will further optimize the ROI procedure by enhancing efficiency and accuracy in labeling.

REFERENCES

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[2] R. Zhang, E. Maggard, R. Jessome, Y. Bang, M. Cho, J. Allebach, “Block window method with logistic regression algorithm for streak detection,” in Electronic Imaging, Image Quality and System Performance XVI, Burlingame, CA, January 2018.

[3] Z. Xiao, M. Nguyen, E. Maggard, M. Shaw, J. Allebach, and A. Reibman, “Real-time print quality diagnostics,” in Electronic Imaging, Color Imaging XIV: Image Quality and System Performance, Burlingame, CA, January 2017.