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A New Method for Extracting Map Elements by Their Colors and Shapes from Color Cartographic Maps

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Abstract

A new method to extract map elements from color cartographic maps was developed. The proposed method is divided into three major sections: pre-processing, crude color segmentation, and extraction of map elements using their shapes. The whole segmenting process was done in the HSV color coordinates[1] instead of the RGB color coordinates. The pre- processing transforms the inputted RGB image into an HSV image. Then, a crude result can be achieved by applying a crude color segmentation process to the HSV image. After the color segmentation, each map element can be extracted by using its shape and color information. The proposed method can be the first process of a fully automated color map mapping system.

1 Introduction

To extract map elements from cartographic maps is one of the most important process to generate a digital map. The extraction method has to be changed according to the map to be processed. It is because the map elements were drawn differently according to the type of the map.

Many studies were performed in the binary images[2, 3]. In these researches the road detection was the best topic. It is because the road is the most valuable to use. Besides in CAD line drawings, the elements were characterized by their geometrical shape[4]. It is geometric analysis that can help to obtain each map element for binary image.

In case of color cartographic maps, the technique of treating colors was needed. There are various color coordinate systems[5]. We choose an HSV color coordinate system because it is similar to the human color sensing system[6].

In this paper, it was shown that the map elements can be extracted from color cartographic maps using color and their shape information.

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2 Analysis of Color Cartographic Maps

Color cartographic maps can be classified by their reality. Buildings, roads, rivers, and green fields exist not only on the map but also on the earth. These elements are called "real elements." On the contrary, names of elements, symbols, and border lines on the map do not exist in the real world. These "abstract elements" must be made for convenience. Real elements can be separated into two types: line elements and region elements. Each element was shown below by this classification.

- Line elements: railways, latitude and longitude lines
- Region elements: roads, residential area, rivers
- Abstract elements: symbols, names

These elements should be vectorized differently. When a line element is vectorized, the center lines must be considered. In case of a region element the boundary lines should be vectorized, and the symbols and the characters were coded into special codes such as ASCII codes.

In color cartographic maps, map elements were colored with several special colors. The red elements represent man-made architectures, the greens do trees or forest, and the blues do water. The color information is the most important characteristics and enables to separate map elements from color maps. The below list shows the colors which correspond to the map elements.

- Dark red: main street, big area, contour lines
- Light red: city area
- Blue: river, sea
- Green: mountain, national park, green area
- White: land
- Black: name, building, railway, border line, longitude and latitude line

3 Automatic Extraction of Map Elements from Color Cartographic Map

Main extraction process was shown in Fig. 1. The process consists of three major sections: preprocessing, crude color segmentation, and map elements' extraction. A color cartographic map was scanned by an optical color scanner and converted into an RGB color coordinates image. The post-processing transforms the RGB (Red, Green, and Blue) color image into an HSV (Hue, Saturation, and Value) color image. It is because the color segmentation process was designed to segment the HSV coordinate image. Then, the crude color segmentation was done in a hue coordinate and in a saturation and value coordinates. Finally, the map elements were extracted by their shape information after post- processing.

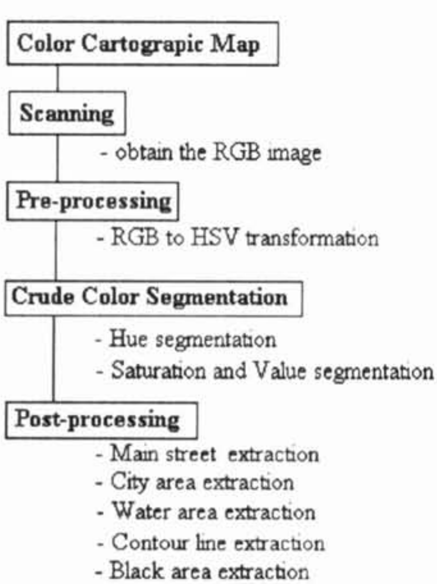


Fig. 1. Main Segmentation Process

3.1 Pre-processing

A color cartographic map was scanned by an optical scanner and transformed into an RGB color image. The scanning resolution was chosen by 250 DPI, and the value corresponds to 0.1 mm error range.

The pre-processing transforms the inputted RGB color image, scanned by an optical color scanner, into an HSV color coordinate image. The colors of map elements were chosen to identify each element easily. This can be achieved by big spacing in hue or saturation or value. Thus, the HSV color coordinates are better than the RGB color coordinates in color map segmentation.

Fig. 2 shows the scanned image that is the map of Taejon area in Korea. For convenience, only the intensity component image was shown.

Fig. 2. Scanned image (intensity component)

3.2 Crude color segmentation

A crude global thresholding method was used for the color segmentation. All maps use only several colors to express each map element differently. This permits the crude segmentation. The colors were separated widely in an HSV plane, and a global thresholding is best for the rough segmentation.

The process starts to segment the hue image. Maps usually have only three hue values: red, green, and blue. These are separated widely in hue level and can be segmented easily by thresholding. The segmentation process requests the principal hue values before starting the process. It is because the main hue values can be changed according to the map. Using the inputted hue values, the image can be segmented by detecting valleys in the hue histogram.

After the hue segmentation, the segmentations on the saturation and the value components were performed. The same as the hue case, the colors of the map elements are widely separated in saturation or value planes to be recognized easily. For example, main streets are colored with a dark red: a high saturation and low value. City areas are tinted with a light red: a high saturation and high value. Buildings are colored with black: a low saturation and low value. Thus, a simple global threshold scheme is sufficient to segment the image at this stage. We choose threshold levels by the median of the maximum and the minimum values in the saturation and in the value components. Finally, we can get seven separated regions: high saturation and high value red region, high saturation and low value red region, low saturation and high value red region, low saturation and low value red region, high value green region, low value green region, and blue region. The result of the crude color segmentation is shown in Fig. 3.

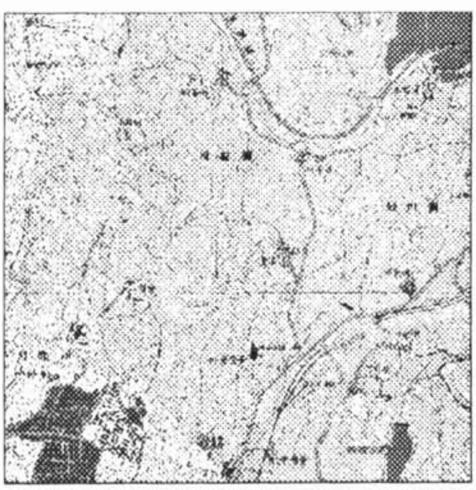
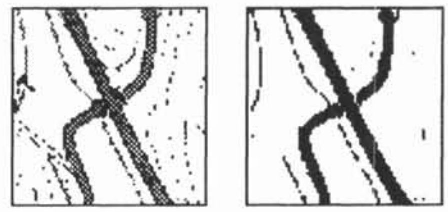


Fig. 3. The result of crude color segmentation

3.3 Post-processing with shape information

Post-processing beautifies the segmented images and extracts the correct map elements. The main idea of segmentation is that each element has its own color and shape characteristics. This information can help the map elements to be achieved easily.

Main streets can be obtained from the high saturation and low value region. Unfortunately, contour lines are drawn by a dark red – the same as that of the main streets. The differences between the two are the thickness of the lines and the black boundaries. Main streets are delineated by two parallel black lines (Fig. 4). Using this information the main streets can be obtained easily. At first, construct the candidate regions which were obtained from the dark red regions and the black pixels which are the neighbors of the dark red regions. Then, the main streets are obtained from segmenting the image with the width of the regions (Fig. 5).



(a) (b)

Fig. 4. Include black pixels into main street candidate: (a) before and (b) after inclusion

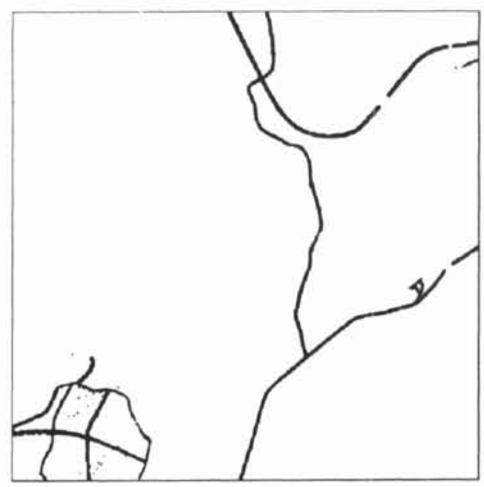


Fig. 5. Extracted main street

The crude city area can be obtained from the high value and low saturation regions. However, the crude image is just crude. The city area can come from the dark red regions because the previous color segmentation process is not precise. After adding the rest of the above result, the city area can be extracted by calculating the width of elements (Fig. 6).

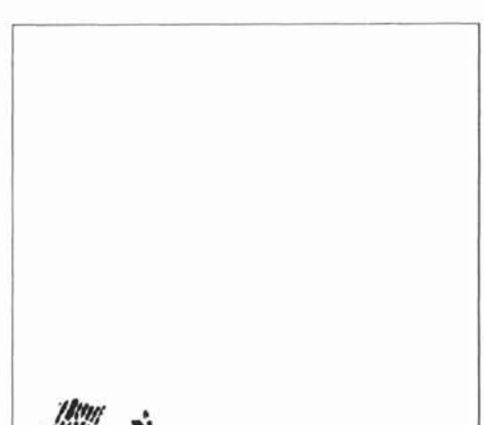


Fig. 6. Extracted city area

Black regions are very important in maps. They represent railroads, border lines, names, buildings, etc. The black can be obtained from the low value regions. Unfortunately, they may contain the contour lines with low value and fairly high saturation. The main difference between the two is the value of saturation component. Contour lines have a fairly high saturation value. Thresholding the saturation components[7], we can get both: the black regions (Fig. 7) and the contour lines (Fig. 8).

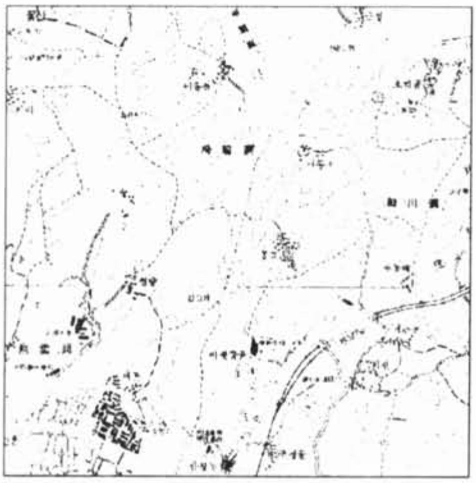


Fig. 7. Extracted black area

Fig. 8 Extracted contour lines

The blue regions can be obtained easily from the first hue separation process (Fig. 9).

Fig. 9. Extracted water area

4 Conclusion

A new method for extracting map elements from color cartographic maps was developed. It uses the map elements' color and shape information. Main streets, city area, water area, black area and contour lines were extracted. This process can be the first process of a fully automated color map mapping system.

Acknowledgments

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