EXTRATING ROAD DIRECTION INFORMATION FROM ROAD SIGN IMAGERY TAKEN BY MOVILE MAPPING SYSTEM

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ABSTRACT

Since road signs are officially managed by local government, they are reliable information for drivers. For systematic managing the road sign information, it is necessary to construct road sign database. In this paper, we deals with automatic road direction information extracting algorithm from road sign imagery obtained by MMS (Mobile Mapping System). Our algorithm consists of three phase. In the first phase, we convert the gray-scale image to binary image with Otsu algorithm to distinguish the objects (arrow, character, symbol etc.) from the background. This phase is followed by automatic extracting arrow region with the proposed algorithm. Proposed algorithm is finding the seeds of arrow region by increasing the size of search window. After finding the seeds, region growing method is applied to extract the arrow region. In the final phase, we recognize the direction information from the arrow by LSM (Least Square Matching) algorithm. From the arrow area, all the corner points are detected. Not all the corner points comprise the arrow heads. Hence, LSM (Least Square Matching) algorithm is applied to the corner points to extract the direction information. For the LSM algorithm, eight direction arrow head shaped templates are used. Proposed algorithms are applied to 100 test images, which are obtained by MMS.

INTRODUCTION

Road signs provide road information including direction and the destiny, and they secure safe and easy driving environment for drivers. The main role of road signs is to provide information for the correct movement of drivers and for smooth traffic flow. Incorrect placement of road signs must be minimized, because road signs have to provide relevant real-time information to drivers. In addition, it is necessary to manage information on loss occurrence (Lee and Yun, 2013). Currently, many nations manage the road signs by using IT-based system. In collecting and updating road sign information, many processes are manually conducted (Kim et al., 2011). Manually collecting data is a tedious and time consuming work. Therefore, we need to automatically extract road sign information. Particularly, the direction information of road signs performs an important role, and incorrect direction information can cause great confusion for the driver.

The automatic extracting techniques for traffic related signs with images are divided into two; automatic traffic sign detection and road sign detection. This topic has been studied by many researchers, but most studies have focused on automatically detecting traffic signs within an image (Fang et al., 2004; Hu, 2013). Yang (2012) presented an effective image improvement method to differentiate the existence of traffic signs automatically. Kahn et al. (2011) developed a method that can automatically extract traffic signs by comparing them with a template of known traffic signs using segmentation and shape analysis. Recently, determining the location of traffic sign method by using MMS(Mobile Mapping System) is presented in Choi and Kang(2012). It is difficult to apply traffic sign recognition techniques directly to road signs, since the information included in signs are different forms. Therefore, automatically recognizing the attribute information for roads signs are still a challenging topic.

The attributes information of roads signs are word, direction, and symbol. Studies on recognizing information
through word extraction or symbol extraction methods to recognize detected characters have been conducted (Wu and Yang, 2005; Reina et al., 2006; Epshtein et al., 2010; Gonzalez et al., 2012; Huang et al., 2012). Sastre et al. (2005) studied automatic recognition of direction information through determining the Hausdorff distance in an ideally formed skeleton model by applying a skeleton algorithm to a simple one-way direction sign. However, the limitation of this approach is that it cannot be applied when more than one piece of direction information exists within a sign. Vavilin and Jo (2006) applied a template matching technique to downtown road signs using an algorithm that detects direction information within the sign. They presented a result that extracts complex downtown intersection structure information from a road sign by merging the images obtained from three cameras using different exposures. In this paper, the direction that the road sign points and consideration of a connecting plan was omitted.

This paper describes the automatic road direction information extracting algorithm from road sign imagery obtained by mobile mapping system. Proposed algorithm is consists of three main phase. First, the gray-scale image is converted into binary image. Second, arrow region in the road sign imagery is extracted. Third, direction information is recognized.

**METHODOLOGY and RESULTS**

To extract information from the image, the process, which detach the object from scene, is needed. Binarization is the simple method for that. Binarization is converting gray value for the pixel as 0 or 1(0 or 255). In other words, if the gray value of the pixel is more than threshold value, then the pixel value for the binarized image is converted into 1. If others, the pixel value is converted into 0. One of the issues for the binarization is determining the threshold value. Otsu algorithm is a famous method to automatically determine the threshold value for binarization. In Otsu algorithm, the threshold value is calculated by using statistical method. We apply Otsu algorithm for binarization. Figure 1 shows the result of binarization. Figure 1(a) is the original image, and Figure 1(b) presents the case that applying threshold value as 128. The result of determining threshold value with Otsu is presented in Figure 1(c). Comparing Figure 1(b) and Figure 1(c), the characters in the upper right area is more clearly expressed when we apply Otsu algorithm.

Second step is determining arrow region. This step is divided into two. First one is extracting seed area of arrow region. The idea of determining seed area is to find the wider width, because the width of arrows is wider than characters'. Second is extracting full arrow region from the seed area. Seed area of arrow region is extracted with following steps.

- Determine the size of the circle type template window as expected column width part of the direction area
- Search the image and find the point which circumscribed in column part of direction area

After finding the seed area of arrow region, then region growing method is applied for extracting full arrow region. Figure 2 shows the results. Figure 2(a) and Figure 2(b) shows the original image and binarized image respectively. Figure 2(c) presents the determined seed area of arrow region. Extracted full arrow region by region growing method from seed area is presented in Figure 2(d).
For recognizing road direction from the arrow region, template matching method is applied. The direction information in the road sign is same with direction of arrow head. So, various types of arrow head template are used for this approach. Even we extracted arrow region, matching the templates to the whole area is not effective. We find the corner points before applying template matching method. In order to extract the corner points, “good features to track” algorithm is applied. The good features to track algorithm is an object-tracking algorithm for which the Newton–Raphson method was extended based on the similarity transformation of the image. Figure 3 shows the extracted corner points in the arrow region area. In Figure 3, circles represent the extracted corner points. Arrow head templates are presented in Figure 4. Near each corner points, the west, east, north, south, northwest, southwest, northeast, and northwest templates are prepared. The location and direction information feature can be recognized by matching it to the template that has the highest correlation coefficient.

Recognized road direction information for the experimental image after binarization, arrow region determination, and template matching method is presented in Figure 5. Figure 5(a), (c), and (e) shows the original image, and figure 5(b), (d), and (f) presents the recognized road direction in the scene. In Figure 5, rectangles denotes the position of the arrow head and determined directions.
CONCLUSION

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In this paper, we deal with the automatic road direction information extracting algorithm from road sign imagery obtained by MMS. Original imagery acquired by MMS was converted into binarized image. For the binarization threshold, Otsu algorithm is applied. With the binarized imagery, arrow region is extracted by region growing method after determining the seed area of arrow region. Finally, the direction information was extracted with template matching method. 8 arrow head shape templates are used for template matching.

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