DETECTING TEXT SEGMENTS IN ROAD SIGNS BASED ON THE IRBP METHOD

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ABSTRACT

A study on collecting images and automatically detecting attribute information based on a mobile mapping system was conducted recently. It is usually difficult to read certain patterns of road signs because the sizes of the road signs'plates, the sizes of the lettering, and their placement are not fixed, and other structures, such as trees, interfere with the line of sight. In this research, a text detection method that does not rely on a Korean character template is required to efficiently detect the target text in road signs with diversely sized Korean texts or symbols. The incremental right-to-left blob projection (IRBP) method was suggested, and its potential and its enhancement asa solution was also assessed. To test the performance of the developed IRBP, it was compared to the existing method that uses Korean templates, and through a review of 60 videos that recorded street sign images, it was verified that text detection can be improved by using the IRBP method.

KEYWORDS: Road signs, IRBP, text segments detection, Korean templates, image analysis

INTRODUCTION

Among numerous supplementary road facilities that display pertinent information, road signs are important in instructing motorists on their destinations. A road sign system is in place to guide the public in the use of road signs. An optimal information system could be adapted through the analysis of sign lettering, but due to manpower and budget constraints, no appropriate information database has been constructed. Thus, the technology to automatically detect road sign attribute information based on pictures of road signs must be developed. In recent years, road sign images were studied to automatically detect lettering by using the mobile mapping system[1]. The technology aims to detect Korean text from road sign images, and to recognize texts from Korean text area images based on OCR open source. The Korean lettering was detected at 75~80% based on road sign images, and at 85% using the OCR word listing function (59% when not using the word list).

Diverse methods have been used to detect text from paper documents, such as hough
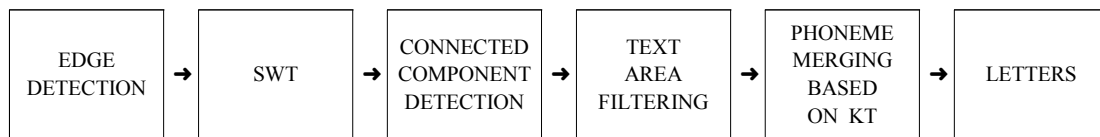
transform ⁻ which takes a longer time to transform the data - [2], histograms to detect individual text images [3], and the borderline tracking method [4]. These methods, however, are all text detection methods where gray scales are required, making it difficult to apply them in diverse colors and patterns, such as road signs. Also, the edge-based text area detection method [5, 6] is widely used, but its capacity to detect texts is not reliable when there are many adjoining edges, like road signs with arrows, route numbers, and boundaries. Some studies have been conducted to recognize vehicle registration plates [7-9], and the method used was found to be fit only in situations involving certain text arrays and patterns.

A detection method based on actual natural images should have over 90% Korean text detection rate,and a 90~95% word recognition rate to work effectively. Thus, this study sought to enhance Korean text area detection rates.

In this paper, the contents for constructing the integrated environment for Korean text detection and recognition modules, and the technique for enhancing Korean lettering detection and recognition in road signs were used. To effectively detect texts, the IRBP (Incremental Right-to-left Blob Projection) ⁻in which text blobs are individually projected onto a virtual left axis to find the text ⁻is used to detect the lettering area in non-standard road sign images.
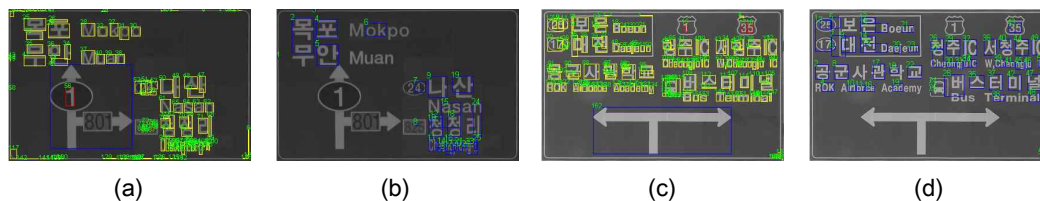
KOREAN LETTER DETECTION METHOD BASED ON KOREAN TEMPLATES

<Figure 1> shows the procedure for detecting Korean text, namely, names of locations in Korea, in road sign images. The process of combining blobs of Korean vowels and consonants using Korean templates was found to be significantly influenced by surrounding non-text blobs in many cases.

EDGE DETECTION	→	SWT	→	CONNECTED COMPONENT DETECTION	→	TEXT AREA FILTERING	→	PHONEME MERGING BASED ON KT	→	LETTERS

Figure 1. The letter detection method based on Korean templates (KT)

<Figure 2> shows several examples of the Korean text detection method based on Korean templates that failed to detect words. (a) and (c) are blobs classified as text candidates from SWT images, while (b) and (d) are Korean text images that are detected from text blobs by matching them with templates in <Fig. 3>. Mok (목) in the letters of Mokpo (목포), and "ㅁ" in Muan (무안) are regarded as type 5, leading them to be regarded as one letter, and, consequently, making it impossible to detect the two words, Mokpo (목포) and Muan (무안). In addition, the capital letters are not detected in the case of Cheongju IC (청주IC), due to the bottom alphabet blob, and in the case of Daejeon (대전), due to the box symbol, in (c) and (d).

(a) (b) (c) (d)

Figure 2. An example of a detection failure of the Korean templates-based method
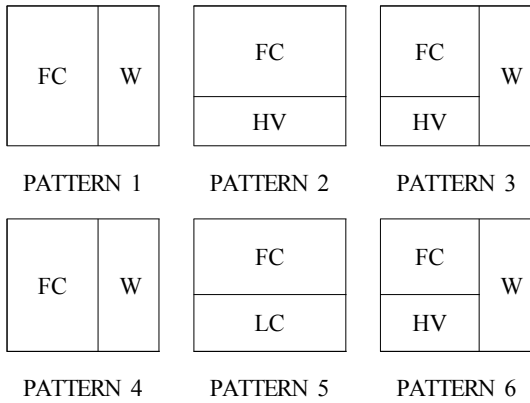
Figure 3. Korean templates

If based on Korean templates like this [10], the predetermined parameters of Korean letter size, width, etc. have to be used, so, in case, like (a) and (c), texts and their surrounding symbols are complicatedly deployed, or box symbol blobs exist in the surroundings of the text, the lettering will not be detected.

Therefore, to successfully detect Korean text in road signs where diverse-sized Korean letters exist, or where symbols are located near Korean lettering, a new Korean text detection method, which does not depend on Korean templates, is needed.

TEXT DETECTION BASED ON IRBP METHOD

Generally, text blobsin road signs share the same text line, including Korean and English text. They are located on the same line. Using this feature, an algorithm was implemented by which text blobs are individually projected onto a virtual left axis to search the text area. This IRBP method is compared with Korean templates-based detection method, as in <Table 1>.

Table 1. A comparison between the IRBP method and the Korean templates (KT) method

Method	Purpose	Concept	Strengths	Weakness
KT	• Korean phoneme detection	• Matching Korean phoneme patterns	• When regular patterns like a name card	• Detection error due to noise (line, number, etc.)
IRBP	• Korean text area detection	• Detecting Continuous blob right-to-left direction	• When irregular patterns and include other symbols • For words detection	• Separating other language errors

In <Fig. 4>, the red and blue box areas in (b) represent the road number symbol and direction indication symbol blobs, and are regarded as non-text blobs in the later process. Non-text blobs, which are excluded from the detection targets of IRBP, do not influence the detection of text segments. In (b), yellow text blobs are individually projected onto the virtual left axis to search for text segments, like in (c).
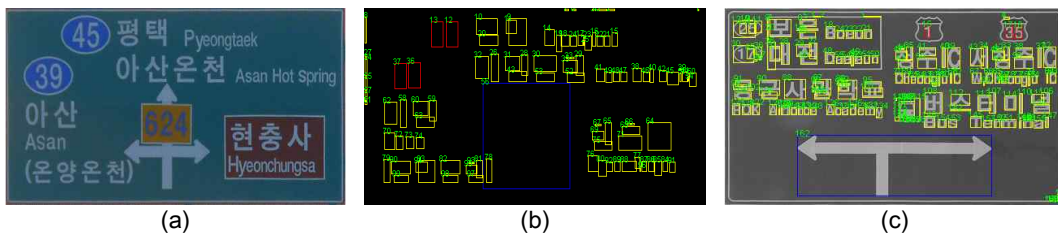

(a)   (b)   (c)

Figure 4. An example of the text segment detection process by IRBP

<Fig. 5> shows the text-detection algorithm flow based on IRBP. The algorithm determines whether to add text blobs to the existing segments, or to create new text segments and add them to the existing segments. This process is repeated for detection purposes. The process is explained below.

① If text blobs are confirmed and provided through SWT (stroke width transform), the connected component analysis, and blob filtering, the process will first organize the left and top areas in descending order.

② The process creates new text segments in the first blob, and adds blobs to the created segments.

③ The process checks the next blobs to see if there are horizontally overlapping segments in the existing segments.

④ If there are overlapping segments, check if the segments - which are created when adding blobs to such segments ‑ change in height within a certain scope. If the height deviates from the established threshold, do not add the current blob, but return to the process ③. If the text height criteria are met, add the current blob to the nearest segment among the overlapping segments.

⑤ If there are no overlapping segments in the process ③, search those segments ‑ which are within a certain distance from the current blob ‑from the projected left axis, and check if the relevant individual segments ‑ when adding the current blob to such segments ‑ meet Korean letters'geometric patterns. If they are met, add the current blob to the relevant segments. Otherwise, create new segments, and add the current blob to such segments.

⑥ Perform processes ③~⑤ for all blobs.

IRBP can successfully detect text segments, except for road numbers and symbols located before Korean text, and except for heavy text that narrow text lines. Without using Korean templates, IRBP not only requires a small number of parameters, but is less influenced by such requirements. This method projects text blobs onto the left to detect text segments, so if road numbers or sign symbols exist on the left of the text, and if some blobs of such symbols are not removed in the SWT process, it will create problems in detecting text segments, which include blobs that were not removed. To address such shortcomings, symbol blobs should be effectively removed before using IRBP, or detected text segments should undergo a post-treatment process. Considering the restoration process, the latter method was implemented and evaluated.

Figure 5. The flow of the IRBP algorithm

ANALYSIS

The improvement in IRBP's performance was evaluated after using 60 road sign images incomparison with the existing method of using Korean templates. Overall, the IRBP method improved Korean text detection performance. Of the 60 road sign images, those that differentiated IRBP from the Korean templates method in terms of Korean text detection performance are selected and shown in <Table 2>.

Such images were examined; as in (c) and (f), in cases where two different lettering sizes were spotted within the same road sign, the two text segments were difficult to detect when using Korean letter size parameters, while the IRBP method easily detected the segments.

Table 2.   Examples comparison between IRBP method and Korean templates method

	Korean templates method	IRBP method
(a)		
(b)		
(c)		
(d)		
(e)		
(f)		

(g)	목천 Mokcheon 천안 Cheonan 남S 북N 진천 Jincheon 21 21 독립기념관 Independence Hall 병천 Byongcheon	목천 Mokcheon 천안 Cheonan 남S 북N 진천 Jincheon 21 21 독립기념관 Independence Hall 병천 Byongcheon
(h)	17 대전 Daejeon 석곡사거리 Seokgok Jct 가경동 Gagyeong-dong 버스터미널 Bus Terminal	17 대전 Daejeon 석곡사거리 Seokgok Jct 가경동 Gagyeong-dong 버스터미널 Bus Terminal
(i)	36 조치원 Jochiwon 청주IC Cheongju IC 서현초등학교 Seohyeon Elementary School	36 조치원 Jochiwon 청주IC Cheongju IC 서현초등학교 Seohyeon Elementary School
(j)	버스터미널 Bus Terminal 13 영암 Yeongam 시의회 City Council 시청 City Hall 300m	버스터미널 Bus Terminal 13 영암 Yeongam 시의회 City Council 시청 City Hall 300m
(k)	71 동서울터미널 Dongseoul Bus Terminal 자양사거리 Jayang Junction 한 강 공 원 Hangang Park	71 동서울터미널 Dongseoul Bus Terminal 자양사거리 Jayang Junction 한 강 공 원 Hangang Park
(l)	남영삼거리 Namyeong Jct 효창공원 Hyochang Park 서울 역 Seoul Stn 21 21	남영삼거리 Namyeong Jct 효창공원 Hyochang Park 서울 역 Seoul Stn 21 21
(m)	17 596 청주 Cheongju 오창 Ochang 508 508 오창과학단지 Ochang Science Complix	17 596 청주 Cheongju 오창 Ochang 508 508 오창과학단지 Ochang Science Complix

Furthermore, there were cases where Korean characters at the end of the right and left sides of Korean text were better detected, as in (a) ("관" in "서울세관"), in (d) ("리" in "청정리"), in (i) ("청" in "청주IC"), and in (k) ("사거리" in "자양사거리"). The existing method searched for Korean text and combined the detected letters into words, making it difficult to restore Korean text, which were not detected in the Korean text detection stage. In the meantime, IRBP gradually adds blobs to text segments, making it possible to easily detect the right-end lettering.

In the case of (m) and (n) images, the resolution was low, making it impossible to detect the blobs of the Korean texts of "오창과학단지," "천안,"and "병천," and consequently failing the Korean text detection stage. However, the IRBP ‒ since there were blobs of relevant Korean texts ‒ could easily detect the text segments.

In (b), (g), (i), and (n) images, English text segments could not be removed, because the resolution was low, leading the alphabets to be detected as 2-3 blobs deployed at the top and the bottomareas; thus, the English texts could not be removed by the English text segment removal heuristic method.

In (c), (d), (h), and (i) images, the whole or part of the symbols on the left side was detected as Korean text segments. The simple heuristic was designed to remove symbols from SWT images, but failed to remove them all.

The results in detecting the 60 images using the Korean templates method and the IRBP method are shown in <Table 3>.

Table 3. A performance comparison between the IRBP method and the Korean templates method

Method	The number of images	Resolution	The number of Korean text	The number of detection	Accuracy
Korean templates	60	500 pixels (vertical)	237	171	72.2%
IRBP				225	94.9%

CONCLUSION

In this study, the IRBP-based area detection method was used to automatically detect Korean text information in road sign images. Road signs have non-standard Korean lettering patterns, unlike Korean letters in business cards and other Korean text types, and express the contents in word units, makingit important to detect words in Korean text.

Two methods designed to detect and remove English segments from Korean and English text segments were tested. As a result, the method using the difference in the height of Korean and English text was more effective in detecting blob changes than the method using the horizontal gap, namely, pitch difference. When Korean and English texts adjoin closely due to narrow spaces in the road sign, there are many partial blobs of box symbols on the left and right sides of the text, causing errors in pitch detection.

To boost post-treatment efficiency in line with the results of this study, a camera with an appropriate resolution that can keep the gap withinthe character string of over 3 pixels should be used to acquire the images of road signs at an appropriate distance, namely, at a distance where the road sign area is maximized in the whole image. Also, to prevent the serious distortion of road signs within the images, optimal locations must be selected, considering filming location, angle, the target object's height, and the moving speed. Moreover, high-resolution images are needed to detect not only Korean text, but also route numbers, arrows, and other diverse information. Thus, high-resolution images, photographed using high-performance cameras, are necessary. In this case, where the processing speed declines, diverse resolutions must be explored. If the text recognition method is employed by using the dictionary based on detected text areas, it would be possible to construct information attribute databases not only on road signs, but also on other road facilities that provide information.

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