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LED Dot matrix text recognition method in natural scene

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ABSTRACT

In recent years, light-emitting diodes dot-matrix text (LED text) is being widely used for displaying information and announcements. However, there is currently no text detection system that is capable of handling LED text. Unlike general printed text, it is not easy to detect and recognize LED text due to its discontinuity. A character of the LED is generally displayed with a matrix of segments and composed with them to generate the text. Furthermore, it is necessary to detect each character from a line of LED text for creating a robust text detection system. Thus, this paper proposes a method for LED text detection and recognition in natural scene images. To perform this goal of detection and recognition of a character and text, it consists of two main steps with the following steps: the first step, a Canny edge was used to detect character pixels which appear in LED display area from scene images. The center points of edge segments are calculated. These points are merged based on their properties to generate a character candidate. In order to obtain character feature, the spatial information such as a centroid and orientation of the character candidate are used. These values are then analyzed using a k-nearest neighbor approach for classifying the character candidate as a certain alphanumeric. In the second step, the recognized characters are later combined into a text line based on the similarity of their characteristics such as width, height, aspect ratio and color. The post-processing of text line generating is then applied for rectifying the falsely recognized characters. In experiments, our proposed method achieves 68.8% and 47% for detection and recognition rate, respectively. These results show the robustness and effectiveness of the proposed method for detecting and recognizing the LED text in natural scene images that has filled the vacancy that the printed and dense text detection system has not covered.

1. Introduction

In the era of rapid development of electronic devices, light-emitting diodes (LED) dot-matrix is being widely used for particular purposes. An LED dot-matrix is largely utilized for displaying information in text form, called an LED text. For intelligent transportation systems, the LED text is playing increasingly important roles in attempts to improve highway safety, operations, and use of the existing facilities [1]. The LED texts are mainly found as electronic traffic sign devices used for traffic warning, regulation, routing and management, and are intended to affect the behavior of drivers by providing real-time traffic-related information. In urban areas, the LED texts are shown within parking guidance and information systems to guide drivers to available car parking spaces, alternative routes, limit travel speed, warn of the duration and location of the incidents or just inform of the traffic conditions [2]. Fig. 1 shows several LED texts in urban areas.

On the other hand, text detection and recognition play a significant role in many applications such as scene understanding, robot navigation, autonomous vehicle for intelligent transportation systems and information retrieval from traffic signs. Many researchers have studied text detection and recognition with significant results [3–12]. Unfortunately, based on our survey, researchers rarely involve the LED text on their systems. In fact, this type of text should be able to be detected and recognized well in order to build a robust system. Hence, this work proposes a method to detect and recognize the LED text simultaneously in natural scene images.

Unlike general text, the LED text is quite difficult to be detected because of discontinuous character. The LED text is formed by consecutive lines of LED arrays. One character of the LED text is generally displayed by a matrix of LEDs with either a circle or rectangular shape. Also it is possible to display other complex shapes although not common in text [2]. A common matrix size for a LED character is 5×7 dots, either separated with blank lines with no dots or with lines of blank pixels (6×8 dots). The other sizes of LED character are composed of 3×5, 4×6, 5×8, and 6×7 dots.

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Fig. 1. Examples of LED text from natural scene.

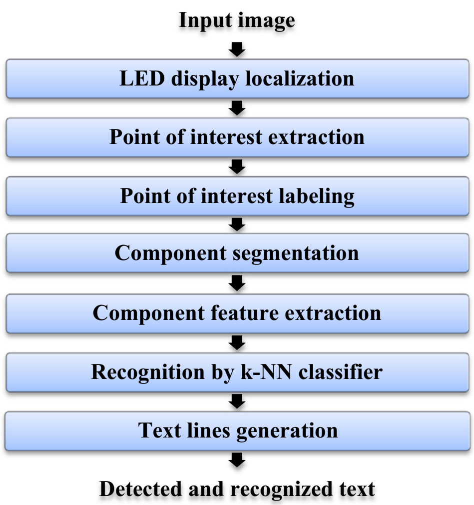

Fig. 2. Flowchart of the proposed method.

Mainly, the text detection methods in natural images can be grouped in two categories: region-based method [5–7] and texture-based method [6]. The region-based method uses similarity characteristics of character component, such as color [5,6], stroke width [7], and edge [8]. By those similarities, the pixels are connected as a region. Thereafter, the non-text connected components are filtered out by a classifier. However, this method could not be effectively applied on the LED text, since a single character always consists of more than one component (i.e., LED lights). Meanwhile, the texture-based method utilizes the texture and structure features of the text [11] to extract a candidate of text regions by sliding windows [4]. This method may still work on the LED text, but it could be time consuming.

To overcome such problems, this paper proposes a novel method for detecting and recognizing the LED text that would be described in Section 2. For evaluation, the experimental results are given in Section 3. Section 4 concludes the paper and discusses future works.

2. The proposed method

This section describes the details of our proposed method for detecting and recognizing the LED text. The flowchart of the proposed method is shown in Fig. 2.

As shown in Fig. 2 the proposed method consists of the following stages:

- *LED Display Localization*: Most of the LED texts are attached on a plate area with a black background, named LED display area. For reducing the processing time of text searching, it should be localized first and then the remaining process should be performed on this area. The localization process is based on a color segmentation method because the LED display area commonly has a black colored background.
- *Point of Interest Extraction*: The Canny edge detector [13] produces an edge map of the LED display area. The center points of a blob defined as points of interest are extracted from this map.
- *Point of Interest Labeling*: The points of interest are merged based on their properties to generate character candidates, called components.
- *Component Segmentation*: In the previous step, the extracted components may contain more than one character inside. Consequently, these components need to be segmented into several components before applying feature extraction.
- *Component Feature Extraction*: The next step is extracting some features as characteristic of the component. To do this, a new feature based on the centroid of component is introduced.
- *Filtering and Recognizing*: k-nearest neighbors classifier filters out and recognizes simultaneously every single component by comparing the component features and the template features.
- *Text Line Generation*: Character components should be combined into text lines based on their similarity properties such as aspect ratio, width, height and average color. In our assumptions, text line must contain at least 3 character components, if not the text line will be discarded. This mechanism will significantly remove the randomly scattered noise.

2.1. LED display localization

Instead of processing the entire image to extract the LED text, localizing region of interest contained LED text is performed first. This process reduces the processing time. Mostly, the LED texts are attached on a plate area, called LED display area where a LED lamp is there as foreground (commonly red and orange in color) and the background is always in black color. Therefore, it is easy to localize the LED display in natural scene image based on this characteristic. To localize the LED display, firstly, input images are converted into gray scale value. Then the candidate regions are found by using gray scale color model on the basis of our training dataset. Region detection is based on its color properties, namely, mean and variance values of gray scale. To estimates these properties, 30 images of the LED display area are taken under different lighting and weather conditions. By training from those sample data, mean and variance value of gray scale are obtained in which the sum of these two values equal to around 100. As the main color of the plate area is black; its range should be between 0 and 100. Thus, the binarization is performed as (1)

$$B(x,y) = \begin{cases} 1, & G(x,y) <= 100 \\ 0, & otherwise \end{cases} \quad (1)$$

where *G(x,y)* is the gray value of a pixel. However, color segmentation parameters are very sensitive in order to detect as many candidates as possible. For example, trees or shrubs might be detected as a candidate region which could be ignored using context analysis [14], object segmentations [15,16], or a graph-based approach [17]. Therefore, all false candidates will be filtered out in the next stages adopted from [18]. According to prior