DETECTION OF EXIT NUMBER FOR THE BLIND AT THE SUBWAY STATION

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Abstract: This paper presents an approach for detecting the exit number to enhance the safety and mobility of blind people while walking around subway station. It is extremely important for a blind person to know whether a frontal area is a correct exit number or not. In a crossing at each exit roads, the usual black exit number is painted with blue circle contour that have white background in Taejon subway station. An image-based technique has been developed to detect the isolated number pattern at the crossing roads. The presences of exit numbers are inferred by careful analysis of numeral width, height, rate, number of numerals, as well as bandwidth trend. If we have several candidates of numerals, we adapt to the OCR function. Experimental evaluation of the proposed approach was conducted using several real images with and without exit roads. It was found that the proposed technique performed with good accuracy.

1 INTRODUCTION

According to the World Health Organization statistics, approximately 40 million people are blind all over the world (Thylefors, 1995 and WHO, 1997). There are about 200,000 persons with acquired blindness in Korea. Visually impaired people have one goal that to navigate through unfamiliar spaces with out the human guide helps to establish this navigation. Mobility, which has been defined as "the ability to travel safely, comfortably, gracefully, and independently through the environment," (Shingledecker, 1978) is the main barrier for these vision-disabled people. The most widely used navigational aids for blind people are the white cane and the guide dog. However, these have many limitations: the range of detection of special patterns or obstacles using a cane is very narrow and a guide dog requires extensive training and is not suitable for people who are not physically fit or cannot maintain a dog (Whitestock, 1997). To improve the versatility of the white cane, they use many methods and devices to aid in mobility and to increase safe and independent travel as in (Diepstraten, 2004, Hub, 2006, and Matsuo, 2002).

When a visually impaired person is walking around at the subway station, it is important to get exit number information which is present in the scene. In general, way finding into a man-made environment is helped considerably by the ability to read exit number signs. This paper presents the development of an automatic detection of exit number for visually impaired people at the subway station.

The researches on text extraction from natural scene images have been growing recently. Many methods have been proposed based on edge detection (Yamaguchi, 2003), binarization (Matsuo, 2002), spatial-frequency image analysis (Liu, 1998) and mathematical morphology operations (Gu, 1997). There are also other parallel research efforts to develop a scene-text reading system for the visually impaired (Zandifar, 2002).

All these systems make evident that the text areas cannot be perfectly extracted from the image because natural scenes consist of complex objects, various lightings, giving rise to false text detection and misses. The first step in developing our digit reading system is to address the problem of text detection in natural scene images. In this paper, we assumed the fixed indoor space as same as subway

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station. At that space, the lighting condition is stable and target digit(exit number) sizes are predictable because that sign board size are uniformed by public subway company. From these assumptions, our system passes through 2 steps as Figure 1. The first step has filtering, adaptive binarization, connected component detection and decision of candidate of number region. The second step has OCR verification and selects the one number.

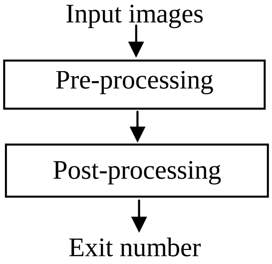


Figure 1: Processing steps of the proposed blind guidance system.

Section 2 describes system design. In section 3, we will deal with image resolution firstly. And we will propose a robust and efficient Exit number locating method which is independent of the size of Exit number. Section 4 shows experimental results. Finally Section 5 talks about the conclusion.

2 SYSTEM DESIGN

Figure 1 shows the general configuration of our proposed system. The building elements are the PDA(or notebook), the USB-camera and the voice synthesizer.

Locating digit detection algorithm involves scenarios. In the 'pause mode', the camera which is placed on the user's head didn't acquires an image of the scene when blind person walk to straight way. The blind met at crossing section following the guide block, the blind can push the bottom to change 'active mode' or automatically change to the 'active mode' when the blind move his body to each bridge direction that can be detected by sensors.

In 'active mode', input images are captured and the search for digit areas is performed using proposed methods. These characters are recognized and read out to the blind person via a voice synthesizer. Figure 2 shows the system configuration.

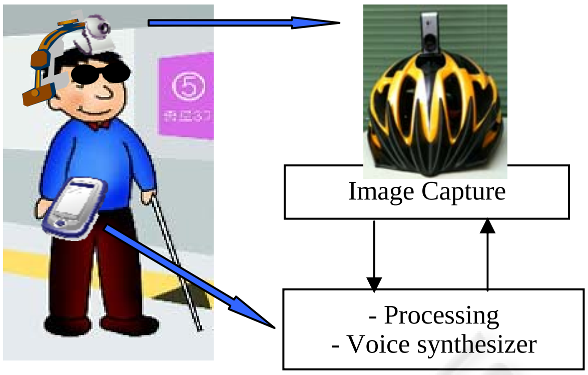
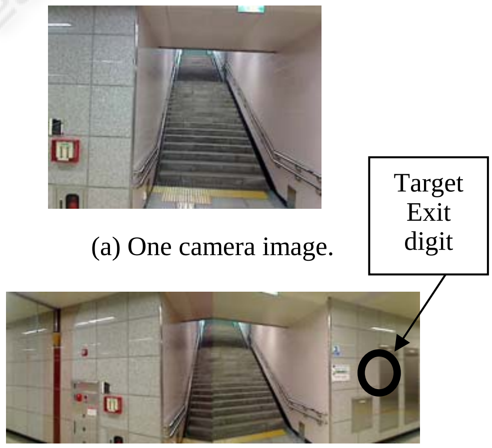


Figure 2: System configuration.

3 EXIT NUMBER DETECTION ALGORITHM

3.1 Image Capture

Our system captures colour images at high resolution(1280x480) by horizontally synchronized two USB cameras to make an as much as human view angle even through we have distortion in the middle area. Figure 3 explain the reason why need the synchronized 2 USB cameras. Figure 3(a) was captured by one camera that didn't include the exit number area.



(a) One camera image.

(b) Horizontally synchronized two camera image.

Figure 3: Input camera system.

For the processing speed, the image is firstly processed for converting to the low resolution (640x240) to identify candidate number location and then will be recover to the high-resolution (1280x480) to the OCR stage.

3.2 Pre-processing

Our exit number localization algorithm consists of several stages as outlined in figure 4.

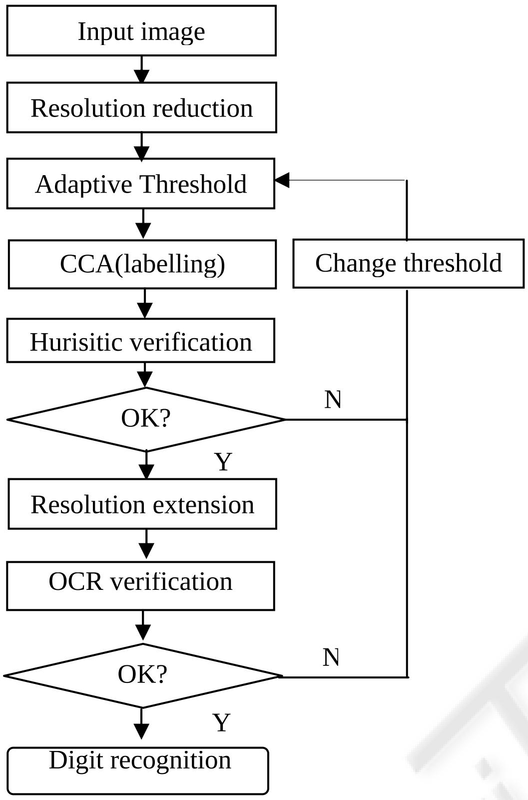


Figure 4: System flow chart for the Exit number recognition algorithm.

3.2.1 Adaptive Threshold

Figure 5: The binarization result using adaptive threshold.

The threshold is a very critical parameter for object detection, thus, a main problem is how to determine the optimal threshold. Basically, there are two forms of the methods that can set the threshold. One is to preset the threshold by experimental results; the other is to set the threshold automatically based on the input image data. We used the adaptive threshold method as same as OpenCV libary(OpenCV, 2006).

3.2.2 CCA (Connected Component Analysis)

Next stage is a connected component analysis procedure to make isolated regions information. We used general 2-pass labelling algorithm. The output results of labelling algorithm are location, size, several rates from each isolated regions.

3.2.3 Heuristic Verification

From the CCA steps, there are a lot of isolated regions. To search correct digit region, we used two verification methods as global and local approaches. The global verification approach has four noise deletion rules using priori knowledge about experimental results of correct digit information.

Global rule-1(size constraints):

$$T1_{\min} < vertical\ \ length_i < T1_{\max} = \begin{cases} true\ :\ candidate\ \ region \\ false\ :\ noise\ \ region \end{cases}$$

$$T2_{\min} < horizontal\ \ length_i < T2_{\max}\ region_i = \begin{cases} true : candidate\ region \\ false : noise\ region \end{cases}$$

Global rule-2(ratio constraints):

$$T3_{\min} < \frac{vertical\ \ length_i}{horizontal\ \ length_i} < T3_{\max} = \begin{cases} true\ :\ candidate\ \ region \\ false\ :\ noise\ \ region \end{cases}$$

$$T4_{\min} < \frac{\#\ of\ \ black\ \ pixel_i}{Area_i} < T4_{\max} = \begin{cases} true\ :\ candidate\ \ region \\ false\ :\ noise\ \ region \end{cases}$$

The local verification approach has four noise deleting rules using priori knowledge about current constraints.

The local verification approach has similarity measuring rules using priori knowledge as same as global rules. If *ith* region's digit score is higher, *ith* region will be high probability that is correct digit region.

Local rule-1(size constraints):

$$\|\ standard\ \ size - region\ \ size_i\ \| = \begin{cases} minimum : Vsize_i = 1 \\ otherwise\ : Vsize_i = 0 \end{cases}$$

Local rule-2(area constraints):

$$\|\ standard\ \ area - region\ \ area_i\ \| = \begin{cases} minimum\ : Varea_i = 1 \\ otherwise\ : Varea_i = 0 \end{cases}$$

Local rule-3(rate constraints):

$$\|\ standard\ \ rate - region\ \ rate_i\ \| = \begin{cases} minimum : Vrate_i = 1 \\ otherwise\ : Vrate_i = 0 \end{cases}$$

Local rule-4(location constraints):

$$\|\ standard\,location - region\,location_i\ \| = \begin{cases} minimum : Vlocation_i = 1 \\ otherwise : Vlocation_i = 0 \end{cases}$$

Figure 6: The CCA and heuristic verification result.

3.3 Post-processing

From the previous steps, 3 ~ 10 candidates regions are remained. To decide correct digit regions, we tried to OCR verification

3.3.1 OCR Verification

Our OCR (Optical character Recognition) system based on the (Kye Kyung Kim, 2002) that consist of MLP(multi layer perception) with 198 input neurons, 100 hidden neurons and 10 output neurons. All candidates regions will be recognized by this MLP, and selected one or two regions to correct digits.

4 EXPERIMENTAL RESULTS

Our experiment environment consist of Intel Pentium 2G-Hz, 1G Ram Notebook, Visual C++6.0 under the Windows XP OS. From the system configuration in figure 2, we captured and tested a lot of video scenes. We can get the high Exit digit recognition rate over 90%.

5 CONCLUSIONS

This paper presents an approach for detecting the Exit number to enhance the safety and mobility of blind people while walking around subway station. An image-based technique has been developed to detect the isolated number pattern at the crossing roads. The presences of exit numbers are inferred by careful analysis of numeral width, height, rate, number of numerals, as well as bandwidth trend. If we have several candidates of numerals, we adapt to the OCR function. It was found that the proposed technique performed with good accuracy. Future work will focus on new methods for extracting and all kinds of text characters with higher accuracy and on the development of a full demonstration system.

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