Bus Label Detection for Blind People using Image Processing Technique

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Abstract. *Assisting the blind to read or recognize signs in daily life is important in modern advanced communities. I constructed a device which enables the blind to read or recognize destinations appearing on a bus: all components were attached to a walking stick. A camera captured an image of the bus label: to recognize destinations, the letters on the image were detected, classified and compared using the EMGU library, Tesseract OCR and the Levenshtein distance computation. The device was tested at different distances and sizes of the bus labels. The test results showed that the destinations were read correctly at the acceptable distance. Thus, this low cost device is useful and feasible for assisting the blind.*

Keywords:

assistive technology, blind, tesseract ORC, EMGU, levenshtein,

1. Introduction

Nowadays, the assistive technology [1] has called attention from researchers to develop various devices to support the blind to reduce the obstacle for travelling in the public places. Reading the bus label representing the destination of the bus is one of interesting problems in developing the assistive device for the blind, since the destinations are presented by the letters on the bus labels as shown in Fig 1. Even though many researchers have developed the assistive device as seen in literature [2] [3], they were mostly constructed using the Radio Frequency Identification (RFID) devices. However, the device with RFID technology is expensive and incompact, which would not be practical for the blind to use.

In this study, our research group designed the assistive device to satisfy the requirements in terms of lower cost and practical for usage. Thus, the device was designed to be installed on the walking stick for the blind. Also, the knowledge of image processing was applied to solve this problem, since the cost of the device such as cameras; microcomputers, etc are a lot cheaper than the RFID devices. Once, the prototype of the assistive device was constructed, it was tested to read the target of bus label at different distances and sizes of the targets.

The rest of the paper is organized as follows. The design and development of the device are presented in section 2. In section 3, the experimental results and discussion are given. The conclusion is stated in section 4.

Fig. 1: Bus label in Bangkok Thailand

2. Bus Label Detection

The design of the bus label detection is presented in this section. The components of the proposed system are presented in Subsection 2.1 and the software design for the proposed device is presented and explained in subsection 2.2.

2.1 System Design

The all components of the assistive device are attached in the stick as shown in Fig. 2. The Web camera (Logitech C920) was used as a vision sensor to capture the image of the bus label representing the destination which the blind would like to go. The intel-stick 2 computer is the used as a processor to recognize the letter, and to translate the image. Then, the set of the detected word was read through the speaker.

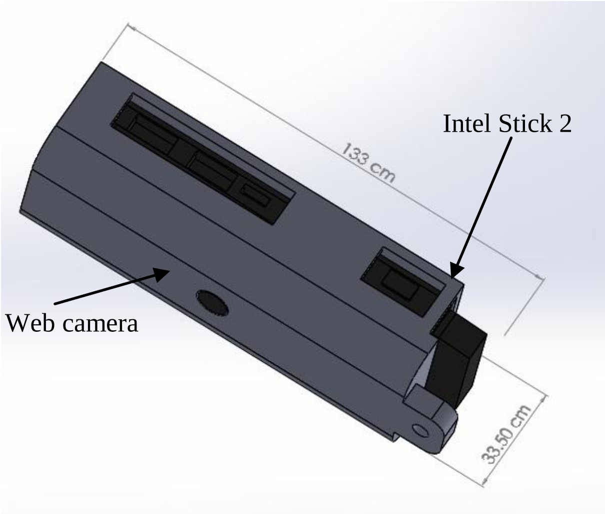

Fig. 2 : Bus label detection design

2.2 Software design

The software was developed by using Visual Studio C#. The flow chart of the program is shown in Fig. 3. The program can be divided into 3 processes as follows.

(i) the square frame detection
(ii) the letter analysis
(iii) the word translation

Then, the voice signal is sent through the speaker to the user.

Detection of the square frame algorithm used in this device is EMGU, which is an *OpenCV* library [4]. The function "FindContourTree" of the program is used to detect the square frame of the bus sign representing the destinations is shown in Fig. 4.

The Tesseract [5] engine is utilized for the detection of the letters in the previous process. It is a tool for optical character recognition (OCR) which can detect the letters as shown in Fig. 5. The translation of the set of letters in OCR step can be achieved by using Levenshtein algorithm [6]. The concept of the algorithm is to compare the captured letters from OCR with the template as shown in Fig. 6 and determine the probability of the letters from OCR to be classified as one of the letters in the template as shown in Fig. 7. If the probability is satisfied with the desire value, the program reads the word for the blind.

3. Experimental Results

In order to test the feasibility of the proposed assistive device, the experiment test-rig was conducted in this study. The experimental tests were divided into three main parts: test of square detection, test of optical character recognition and test of word selection, which having details in Subsection 3.1, 3.2 and 3.3, respectively.

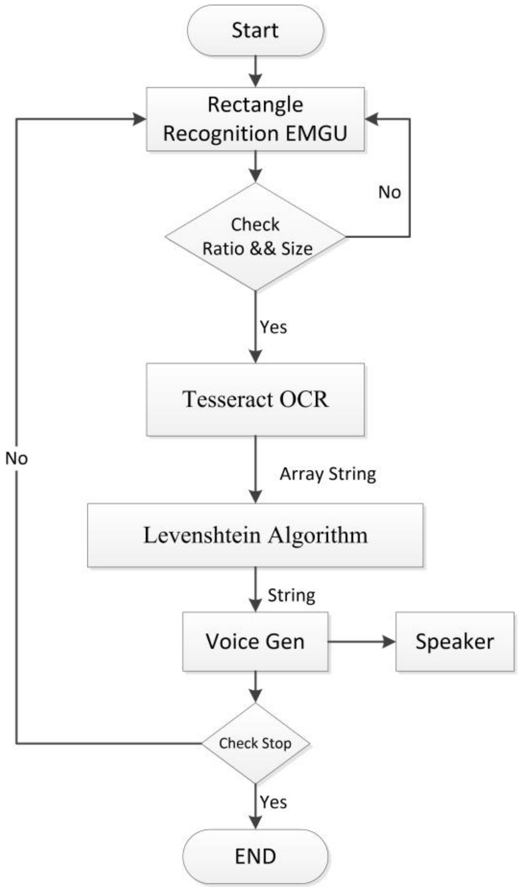

Fig. 3: Program Flowchart

Fig. 4: EMGU Square Detection

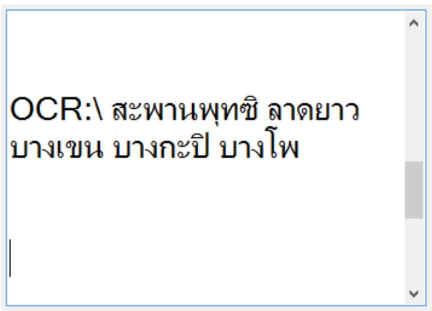

Fig. 5 : Tesseract OCR

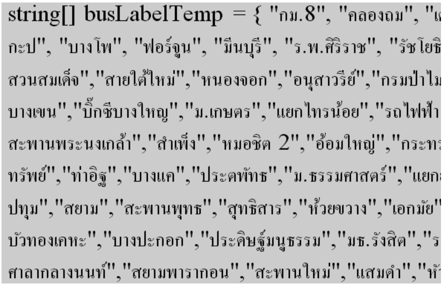

Fig. 6: Example of template for Levenshtein Algorithm

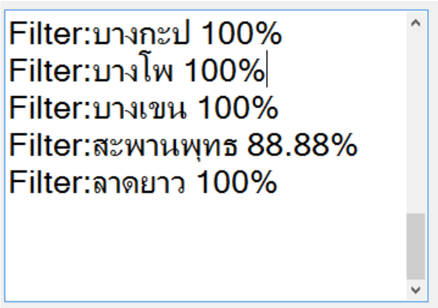

Fig. 7: Example of results by Levenshtein Algorithm

3.1 Square Detection

The square detection is one of an important part since it is use to detection the plate attached on the body of the bus. The function "FindContourTree" in EMGU is used to detect the square frame.

In the experiment, shown in Fig 4.was used as a target to test the algorithm with two different size of the target at different distances from 200 to 500 cm. The algorithm is used to detect the picture with the dimension of 1280 x 720 pixels. The ratio of the filter is between 1.1 and 3.5 (width / high). The target size is larger than 8000 pixel which can be reduced by the filter to actual size of the real plat on the bus. It is clear from Table 1 that at the largest size of 100x80 and 100x30 cm can be read at the maximum distances up to 400 and 450 cm, respectively.

Table 1: EMGU Square recognition

Size cm	Length (cm)						
Width x high	200	250	300	350	400	450	500
100 x 30	O	O	O	O	O	X	X
100 x 80	O	O	O	O	O	O	X

3.2 Optical Character Recognition

In this subsection, the ability of OCR to recognize the letters was test with different amount of letters on the plate at different location. The results are shown in Table 2.

Table 2 : Number of Strings by Tesseract OCR

Distance (cm)	Number of strings											
	5 string			7 string			11 string			15 string		
	1	2	3	1	2	3	1	2	3	1	2	3
100	5	5	5	7	7	7	11	11	11	15	15	15
150	4	5	5	6	7	6	10	12	12	15	16	16
200	7	5	6	8	9	8	14	14	12	17	17	18
250	7	4	6	8	8	7	13	13	14	16	18	19
300	6	7	4	5	6	5	13	12	11	14	14	13

Based on the results, it is shown that the more amount of distance the error of recognition increases. This result is only the number of letter which can be recognized. However, these captured letters are not check with the template.

3.3 Word Selection

From the set of letters from the test in previous subsection, the set of the letters are analyzed and validate with the template by the Levenshtein Algorithm for 81 words. The experimental results are presented in Table 3.

Table 3: Word Selection by the Levenshtien Algorithm

Distance (cm)	Select word Levenshtein Algorithm											
	5 string			7 string			11 string			15 string		
	1	2	3	1	2	3	1	2	3	1	2	3
150	o	o	o	o	o	o	o	o	o	o	o	o
200	o	o	o	o	o	o	o	o	o	x	o	o
250	x	o	o	x	o	o	x	o	o	o	x	o
300	o	x	x	x	x	x	x	x	x	x	x	x
350	x	x	x	x	x	x	x	x	x	x	x	x

The error increases as the distance of the target increases. The program work inaccurately when the distance of the target is more than 250 cm.

4. Conclusions

Based on the results of this study, the developed assistive device for the bus label-detection using image processing technique has been proposed. The proposed device is feasible to be used at the acceptable distance. The developed assistive device is not only being practical and useful, but it is also cheap and compact; where all the components are installed on only one walking stick. In future work, the device could be able to detect at longer distance and insensitive to noises such as surrounding light.

References

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Biography

Kaned Thung-od was born in Mahasarakham, Thailand in 1987. He received his B.Eng. in Mechatronics Engineering from King Mongkut's University of Technology Thonburi, Thailand, in 2011. He received the M.Eng. in Robotics And Automation from King Mongkut's University of Technology Thonburi, Thailand in 2014. Since 2015, he has worked at the Faculty of Engineering, Mahasarakham University, Thailand. His current research interests include mobile robot design and control, image processing and sensor integrated systems.