Smart Glasses for the Visually Impaired People

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Abstract. People with visual impairment face various problems in their daily life as the modern assistive devices are often not meeting the consumer requirements in term of price and level of assistance. This paper presents a new design of assistive smart glasses for visually impaired students. The objective is to assist in multiple daily tasks using the advantage of wearable design format. As a proof of concept, this paper only presents one example application, i.e. text recognition technology that can help reading from hardcopy materials. The building cost is kept low by using single board computer raspberry pi 2 as the heart of processing and the raspberry pi 2 camera for image capturing. Experiment results demonstrate that the prototype is working as intended.

Keywords: Visually impaired · Text recognition · OCR · Raspberry pi 2

1 Introduction

The number of visually impaired people is growing over the past decades. As reported by the world health organization (WHO), about 285 million people worldwide are estimated to be visually impaired [1]. However, until now many schools and jobs cannot accommodate them mainly due to lack of assistive technologies and economic barriers [2]. As a result, 90 % of them still live in low level of income [1]. Even when the new aids or technologies become available, they are either too expensive ($3000 and above), or affordable ($200) but with single or limited task functions only [3].

Among all assistive devices, wearable devices are found to be the most useful because they are hand free or require minimum use of hands [4]. The most popular type is head mounted device. Their main advantage is that the device points naturally at the viewing direction, thus eliminates the need of additional direction instructions, unlike other devices [5]. This paper presents a new design of smart glasses that can provide assistance in multiple tasks while maintaining at a low building cost. The design uses the new raspberry pi 2 single board computer, a camera, and an earpiece to convey information to the user. Due to page limit, we only demonstrate reading task only. The experiment results and how additional tasks may be added are discussed.

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2 Related Works

The most popular reading device is Braille reader which can read and/or write using an arrangement of dots to form different letters [4]. Another device is the audio book which read books or newspaper saved in audio format by certain suppliers [6]. Screen reader and e-book readers read digital content from computer screen, and convert the text to an audio format using a text-to-speech synthesizer [6].

Eyewear devices are the most recent technology. OrCam is a commercially released glasses that use an embedded computer with a gesture (a point of finger) recognition system to perform different tasks includes reading and convey them to the user in an audio format [7]. Esight is another eyewear technology for people with low vision. It captures and processes live scenes, and displays them back on a specialized screen in front of the user's eyes [8] (Table 1).

Table 1. Comparison between proposed design and available assistive devices

Device	Functionality & No. of tasks	Price	Remarks
Braille readers [4]	Reading and writing (two tasks)	$1000–$3000	Only support tactile materials
Audio books [6]	Reading (one task)	$25 per month	Only for certain available books
Screen reader [6]	Reading digital format (one task)	$150–$1000	Only for digital content
OrCam [7]	Multitask - includes reading	$2,500	Non affordable price
Esight [8]	Re-display the live scenes for visually impaired to see (multitask)	$15,000	Non affordable price and only for people with low vision, but not total blindness
Proposed design	Proposed as reading. Has the capacity to be multitask	$100–$150	Limited by performance and accuracy of hardware

3 Proposed Smart Glasses Design and Implementation

Smart eyewear design depends mainly on the processing unit, which is the raspberry pi 2, in this case. The main hardware is a Linux based ARM processor that accepts a micro SD card and thus allows us to increase the number of task functions as we wish. A raspberry pi camera was used for image acquisition. It was connected to the raspberry pi using a flex cable, and was fixed on the top middle of the glasses for optimal image capturing. The raspberry pi has an audio port which connects to earpiece. The raspberry pi GPIO port was configured to receive input from push button switches. To

identify the text easier, the reading material is placed within a customly-designed frame with red borders.

The general principle of operation for such glasses is by giving instructions via switches and listening to the output through an earpiece. Similarly in this case, the user starts the task mode by a push of the button. For text recognition mode, the glasses will first confirm if the text area is correctly positioned and readable. Otherwise, it will ask the user to change the orientation of the material. After confirmation, the view is processed in real time to get the image sent to an optical character recognition (OCR) software for text extraction and subsequently forwarded to a text-to-speech synthesizer. The text is then read through the audio output port.

The image processing adopted in this work were implemented by using Simulink (Mathworks, Natick, MA). In the reading mode, the main challenge is the image quality, text position and orientation in the image. Therefore, the first step is to detect the red borders and the frame orientation. To simplify subsequent image processing, we propose an indicator to inform user if the image is skewed significantly or part of the frame is cropped. Once the text area is localized and cropped, image is enhanced by noise filtering, contrast enhancement (histogram matching technique) and morphological operations. Tesseract OCR engine [9] is used in the last step to extract the text before converting into audio output.

4 Results

Several sample texts were prepared and tested. Figure 1 shows an example reading text and the experiment results with the proposed smart glasses. Admittedly the text is relatively simple, but it proves the basic concept of our design. Future works include

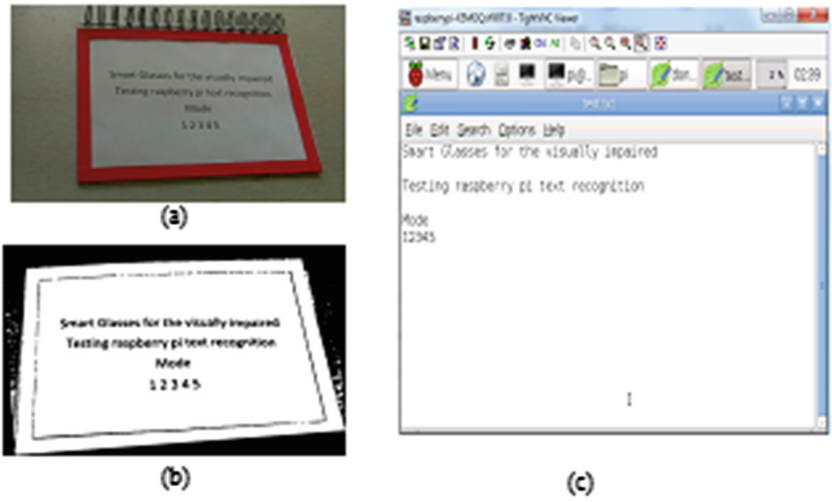

Fig. 1. Text recognition: (a) original image, (b) image after enhancement, (c) Tesseract OCR result of reading material. (Color figure online)

implementing additional image processing and more robust text recognition technique to compensate for the low quality images from the raspberry pi camera.

5 Conclusion and Future Work

This paper presents a new concept of smart glasses designed for visually impaired people using low cost single board computer raspberry pi 2 and its camera. For the demonstration purpose, the glasses are designed to perform text recognition. The system capability however can be easily extended to multiple tasks by adding more models to the core program, albeit restricted by the size of the raspberry pi SD card. Each model represents a specific task or mode. The user can have the desired task run independently from the other tasks. The system design, working mechanism and principles were discussed along with some experiment results. This new concept is expected to improve the visually impaired students' lives despite their economic situations. Immediate future work includes assessing the user-friendliness and optimizing the power management of the computing unit.

References

1. WHO|Visual impairment and blindness. WHO, 7 April 1948. http://www.who.int/mediacentre/factsheets/fs282/en/. Accessed Oct 2015
2. Unisco. Modern Stage of SNE Development: Implementation of Inclusive Education. In: Icts in Education for People with Special Needs, Moscow, Kedrova: Institute For Information Technologies in Education UNESCO, pp. 12–14 (2006)
3. Low vision assistance. EnableMart (1957). https://www.enablemart.com/vision/low-vision-assistance. Accessed Oct 2015
4. Velázquez, R.: Wearable assistive devices for the blind. In: Lay-Ekuakille, A., Mukhopadhyay, S.C. (eds.) Wearable and Autonomous Systems. LNEE, vol. 75, pp. 331–349. Springer, Heidelberg (2010)
5. Jafri, R., Ali, S.A.: Exploring the potential of eyewear-based wearable display devices for use by the visually impaired. In: International Conference on User Science and Engineering, Shah Alam, 2–5 September 2014
6. The Macular Degeneration Foundation, Low Vision Aids & Technology, Sydney, Australia: The Macular Degeneration Foundation, July 2012
7. OrCam, OrCam. http://www.orcam.com. Accessed Dec 2015
8. Esight. http://esighteyewear.com/
9. Smith, R.: An overview of the Tesseract OCR engine. In: ICDAR 2007, pp. 629–633 (2007). doi:10.1109/ICDAR.2007.56