Chinese FingerReader: A Wearable Device to Explore Chinese Printed Text

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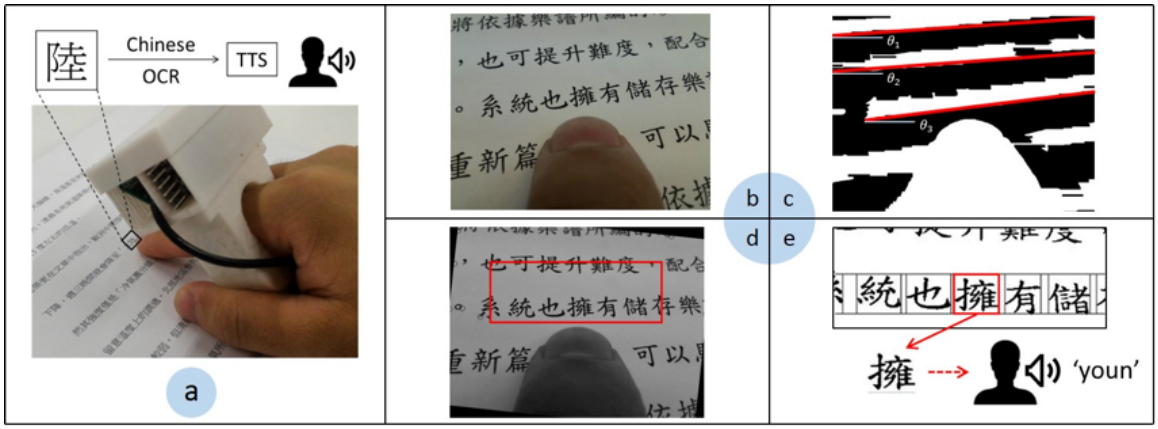

Figure 1: (a) Direct reading mode. Four steps of guidance reading mode: (b) Original image, (c) fingertip and skew angle detection, (d) Text line detection and character segmentation, (e) Character recognition and audio pronunciation.

CCS CONCEPTS

• **Human-centered computing → Accessibility systems and tools**;

KEYWORDS

Chinese FingerReader, visual impairment, reading

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1 INTRODUCTION

Reading is an essential part of daily life. When reading books, drug information, textual icons on electronic devices (e.g., microwave), and information on signs and maps (e.g., location and floor level), people must be able to recognize the words to obtain the information they need. However, for foreigners or people with visual impairment, reading text can be challenging. To assist people with visual impairment in reading English books, Shilkrot et al. have designed a wearable device called the FingerReader [Shilkrot et al. 2014]. The FingerReader utilizes a text-to-speech engine to enable visually impaired users to listen to printed text. Anhong et al. developed a mobile application to assist blind people in using otherwise inaccessible interfaces [Guo et al. 2016]. Through utilizing the phone camera, the software captures the text on an interface and then interactively describes the text beneath the user's finger.

Recent related studies have mostly focused on English character recognition and number recognition rather than Chinese character recognition, mainly because of the variety of Chinese characters (conversational-level Chinese requires knowledge of approximately 5,000 Chinese words) and the complexity of Chinese character segmentation. Therefore, the study designed the Chinese FingerReader, a device that can be used for recognizing traditional Chinese characters (Fig. 1). Portable and easy to operate, the device was designed to be worn on the index finger to perform Chinese character recognition. The device contains two modes: direct reading mode and guidance reading mode. In direct reading mode, the user points his or her finger at a character and presses a capacitance switch with his or her thumb to initiate character recognition. This mode is particularly helpful for foreigners learning Chinese. In guidance

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reading mode, the user points his or her index finger at a character, and the device notifies the user when to move the finger to continue reading. This mode is particularly helpful for visually impaired users to listen to printed Chinese text.

2 HARDWARE CONFIGURATION

The Chinese FingerReader comprises a camera, four vibration motors, a capacitance touch switch, a minicomputer (LattePanda), and a microcontroller system for I/O control (Fig. 2). The camera captures image information to identify the relative position of the index finger to the printed text. The microcontroller system controls the vibration motors to guide the user to move his or her index finger to the appropriate location to continue reading. The capacitance switch is used only in direct reading mode. The Chinese FingerReader employs LattePanda as the core computation component; it is portable, compact, and can perform real-time image processing, Chinese character recognition, and provide audio feedback.

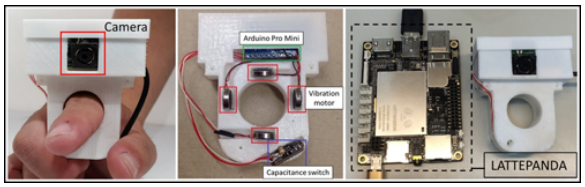

Figure 2: Hardware configuration of the Chinese FingerReader.

3 GUIDANCE READING MODE

In this mode, the vibration motors are used to provide haptic feedback to assist visually impaired users with targeting the proper location with their index finger. There are three types of haptic feedback: (A) guidance to the start of the line, in which the user's finger is directed to the start of a line that is closest to the finger (Fig. 3a); (B) skipped line notification, in which the user's index finger is directed to the original location when the user skips a line or deviates from the original line (Fig. 3b); and (C) end-of-line notification, in which the user is guided to the start of the following line after the current line has been read (Fig. 3c).

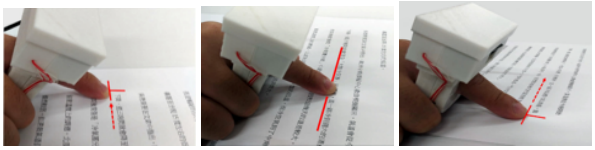

Figure 3: Haptic feedback mechanism of guidance reading mode. (a) Guidance to the start of line, (b) Skipped line notification, (c) End-of-line notification.

4 CHARACTER SEGMENTATION AND RECOGNITION

In this study, we develop a new character segmentation and recognition method to deal with Chinese characters. We first apply Otsu's

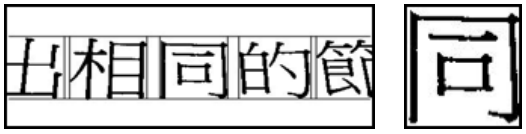

Figure 4: (a) Applying vertical projection method to segment Chinese characters, (b) Segmentation result.

binarization, opening and closing operations to detect the location of fingertip and the skew angle to document (Fig. 1(c)), then evaluate the height of the text line. We use vertical projection method to segment each Chinese characters in the text line (Fig. 4). However, for some Chinese characters (e.g. '化', '川'), they will be divided into two or three individual thin blocks. The information of line's height is then applied to merge the thin and neighboring blocks into a complete character. Figure 4(b) shows the result by segmenting Chinese character '同'. Finally, the segmentation image is then recognized by the Chinese OCR classifier. In this study, we used 371,238 training patterns for 5,731 classes of Chinese character, and then applied linear SVM to construct the Chinese OCR classifier. The accuracy rate is 97%. After identifying the Chinese character, the Microsoft speech platform is used to pronounce the voice of the Chinese character. It can help visually impaired users to listen the corresponding voice of printed Chinese text.

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