A Voice E-book Reading System Designed for the Visually Impaired People

Hsiao Ping Lee, Chung Shan Medical University, Taiwan
Tzu-Fang Sheu, Providence University, Taiwan
I-Wen Huang, Chung Shan Medical University, Taiwan

The Asian Conference on Education & International Development 2020
Official Conference Proceedings

Abstract
No matter in life, study, or at work, reading is one of the major sources to obtain information. However, traditional books are mostly printed on paper. The books are not suitable for visually impaired persons to read. Though such a situation can be improved by Optical Character Recognition (OCR) technology. However, the quantity or timeliness of such resources exhibits a big gap versus that of normal sources of information for the general public. While E-books have become increasingly popular, due to the lack of consideration of the special needs of the visually impaired, as well as appropriate reading systems, the visually impaired still face many difficulties in E-book reading. In this project, we proposed a voice reading system for the visually impaired. The system provides an accessible E-book reading environment with content parsing and speech synthesis technologies. Additionally, an accessible E-book reader App is also developed with friendly interface designs for visually impaired persons. This system supports the common-used E-book format, offers a better, faster, and more convenient E-book reading environment for the visually impaired, and improves the situations of insufficient amount and poor timeliness. This improved E-book reading system for the visually impaired people would help the visually impaired people in E-learning and information access.

Keywords: E-learning, Assistive Technology, Visually Impaired.

Introduction

One indicator to evaluate the degree of social civilization and evolution is through the barrier-free living space and the supply of appropriate and adequate assistive devices for the disabled and the elderly. There are several assistive devices for the living and education designed for the visually impaired (Hersh & Johnson, 2008; Sivan & Darsan, 2016). The assistive devices are usually in high prices due to a small market scale and lack of product variety. Many demands of the visually impaired cannot be met. Thus, it is the responsibility of a modern society that emphasizes equality and sharing to develop assistive devices for the visually impaired, to solve their problems, and to enhance their life quality and social competitiveness.

No matter in life, study, or at work, reading is one of the major sources to obtain information. However, traditional books are mostly printed on paper. The books are not suitable for visually impaired persons to read Due to their visual impairment. Though such a situation can be improved by Optical Character Recognition (OCR) technology (Budelli, 2010). However, the quantity or timeliness of such resources exhibits a big gap versus that of normal sources of information for the general public. While E-books have become increasingly popular, due to the lack of consideration of the special needs of the visually impaired, as well as appropriate reading systems, the visually impaired still face many difficulties in E-book reading. They sometimes even fail to completely operate the E-book reading systems or read the full content. Unfortunately, the reading problems of the visually impaired have not been improved along with the development of the E-books.

The survey made by the World Blind Union reported that, in 2011, the published books are converted to be suitable for the visually impaired to read account for less than 5% (World Blind Union, 2017). It leads to unequal opportunities for the visually impaired. Thus, we can clearly see that books for the blind are far from enough.

The root cause of the insufficiency and poor timeliness of books for the visually impaired lies in that the current books for the blind are prepared through manual reproduction based on printed books. As there are many steps, it takes a long time to prepare. That is why the quantity and timeliness cannot be met. Because the design of the user interface cannot satisfy the need of the visually impaired, the difficulty in reading still exists. If the content parsing and conversion technologies of E-books can be further developed to improve the automation degree, the reliance on manual work can be reduced, then books for the blind can be developed along with E-books. The cost and time to produce books for the blind can be effectively reduced. The existing shortcomings of the preparation of books of the blind will be overcome. The use of an accessible user interface for the visually impaired is helpful. Additionally, as The Marrakesh Treaty (World Blind Union, 2018) has been passed, which promote the exposure of the visually impaired to printing materials, the appropriateness and legality of converting E-books directly to books for the blind have been secured. Through the format conversion, the problem of quantity and timeliness of books for the blind can be solved.

In this paper, we designed a system B-Reader, an E-book reading system for the visually impaired. This system supports the common-used E-book format, offers a

better, faster, and more convenient E-book reading environment for the visually impaired, and improves the situations of insufficient amount and poor timeliness. B-Reader is made up of a cloud database and client App. The client App of B-Reader uses a portable smartphone or tablet as its development and operation platform, making it convenient for the visually impaired to carry without any limit of time or space. To allow the visually impaired to operate independently, we considered Web Content Accessibility guidelines (WCAG 2.0) (W3C, 2017) and Universal Design (Wikipedia, 2019), followed the basic design principles of being simple, intuitive, user-friendly, and consistent, set up an operational model and user interface suitable for the visually impaired. B-Reader adopts Text-to-Speech (TTS) technology to convert text into speech, and provides guiding messages in operation. The B-Reader cloud database integrates the E-books of external databases for the blind, parses the text content from the E-books, and uses an automatic format conversion to replace manual reproduction, thus reducing the manpower and time to produce books for the visually impaired and enhancing the quantity and timeliness of such books.

The B-Reader System

B-Reader is made up of client App and a cloud database, as shown in Fig. 1. The system integrates existing book resources for the blind. Through content parsing technology, E-books are automatically converted to the format accessible for the visually impaired. The production of books for the blind has been upgraded from manual reproduction to the extension of the E-book, so that books for the visually impaired can be developed along with the E-book. The insufficiency in amount and poor timeliness of books for the blind can be solved. It also offers an accessible user interface with voice feedback, boosts sufficient reading aids, and establishes an accessible reading environment suitable for the visually impaired.

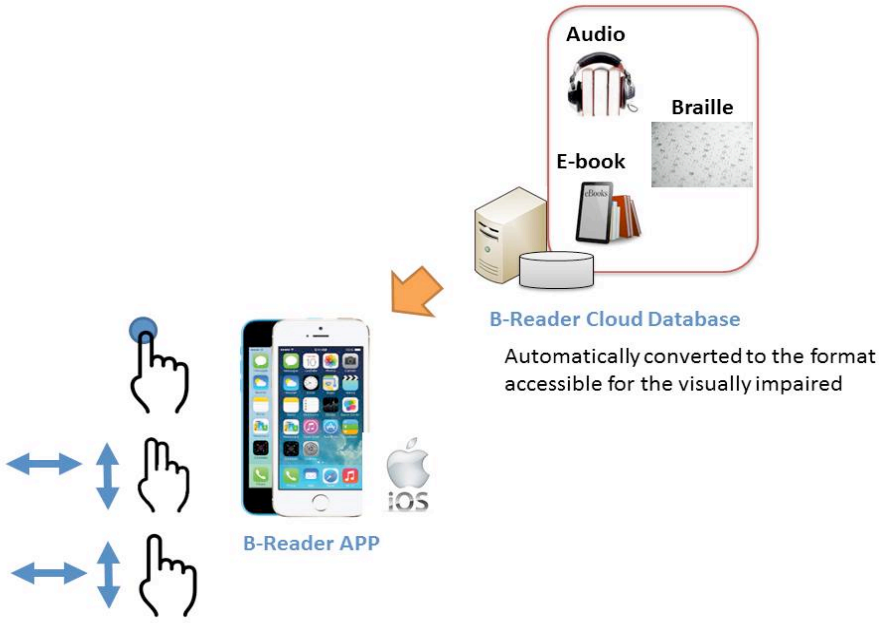

Figure 1: The architecture of the B-Reader system.

B-Reader's client App runs on handheld smart devices, for example mobile phone or tablet. In order to meet the operating habits and needs of the visually impaired, we not only follow the concept of universal design and the principle of WCAG 2.0 in the design of the user interface, but also properly define the system functions and simplify

the type of gestures. For example, only some simple and basic gestures are used, such as swiping up, down, left, and right, tapping, and long press. In addition, we unified the definition of all gestures, making it possible that a gesture can have same control sense, even in different pages. Voice feedback is also synchronized with the gestures. The results of the operation are automatically spoken, aside from providing operational guides.

In order to realize the reading function of the client App, we built several functional modules on the B-Reader client App, including the information transmission and reception (ITR) module, the audio processing and recording (APR) module, the information integration and display (IID) module, the navigation indexing (NI) module, the annotation setting (AS) module, as well as the gesture recognition (GR) module. The ITR module is responsible for sending out a user's query request and resolving the book data received from the cloud database according to the pre-defined protocol. It then restores the data into unified data format used in the B-Reader's internal system, establishes the local database, and provides follow-up data display and playback use. The ITR module is responsible for the output of the book data and for selecting appropriate modules and devices according to the required output format. If it is a synthetic voice, then after conversion by the voice synthesis module it is played through the audio device, while text data would be displayed through the screen. It can also use multiple modes at the same time to achieve the effect that the voice and text can be displayed synchronously. The APR module is mainly to achieve a simple recording function. It is used to record some extra messages, such as notes on book contents and key tips. The NI module is in charge of parsing the architectural level of the book content and establishing the index database of paragraphs, chapters, sections, pages, graphs, tables, and so on. At the same time, a navigation index list and index address query are provided, thus helping to achieve the functions of content searching, directly jumping to any point, and bookmark setting. The AS module records the label position within books, such as start position, end position, and section length. It provides an annotation list and annotation query and helps to achieve the annotation function. The NI module and the AS module can be applied to both text and audio data. The GR module receives and identifies a user's gestures and triggers and manipulates the process of each reading function.

The B-Reader cloud database connects the existing external databases of books for the blind. It is used to inquire the book information, download the book files, and perform content parsing as well as format conversion. In order to construct the B-Reader cloud database, we have respectively developed the book information inquiry (BII) module, the book data compilation (BDC) module, the book data Archiving (BDA) module and book content parsing and capture (BCPC) module to achieve the scheduled functions of the cloud database. The BII module is responsible for connecting the external databases and conducting remote queries to obtain the information about books, such as title, author, and other general information, as well as type, format, and other conversion information. The information is useful for follow-up access, download, and conversion of book data. The BDC module downloads the books in the external database in accordance with the query results. According to the type, format, and other conversion information, the module decides upon the processing strategies, such as transferring format, capturing text, capturing graphics, or directly archiving, to aggregate different sources of book data into a unified data category. The BDC module also retains the structure of the original book and presenting it as the

pre-defined format, so as to make it convenient for the B-Reader cloud database and the client App to exchange and transfer book data. In order to facilitate data transfer, the BDA module follows the pre-defined protocol to archive the data to be transmitted. Because the book data may be in plain text format, which can be easily copied, it must be encrypted to protect the copyright before the archiving. The BCPC module is one of the most important function modules in the B-Reader cloud database. The BCPC module is responsible for parsing the original E-books and capturing the text content and structure information in order to achieve the goal of automatically generating accessible E-books for the visually impaired. The cloud database is the important core of the B-Reader system as it integrates external resources, parses E-book content, and enhances the automation degree of the production of accessible books for the blind. Under the operation of the cloud database, E-books in different formats are all converted into data of a unified category. The client App only needs to access and process a single data category, without concern for the original format and details of the book. Hence, it can be dedicated to providing users with more convenient reading services and functions.

Conclusion

In this paper, we proposed the B-Reader system, which is an assistive system for the visually impaired in reading. The B-Reader system provides book inquiries, reading, and several assistive functions. The B-Reader's client App runs on a smartphone or tablet computer. It is operated by intuitive gestures, while giving feedback through the synthetic voice. In addition, the cloud database connects the external book databases, obtains and collects the book resources, automatically parses the book content, transfers the format, and supports the realization of the main functions of the B-Reader system.

After using the B-Reader system, the reading types of the visually impaired will be greatly changed, due to its fairly high mobility and convenience. Moreover, the proposed B-Reader system properly resolves various reading problems, such as a lack of supply of books for the blind, slow production, and a lack of an appropriate E-book reading system that the visually impaired faced in the past.

Acknowledgment

The authors would like to thank the National Science Council of the Republic of China, Taiwan, for financially supporting this research under Grants [MOST 108-2221-E-040 -008 -, MOST 105-2218-E-126-001 and MOST 105-2221-E-040-007].

References

Hersh, M. & Johnson, M. A. (2008). Assistive Technology for Visually Impaired and Blind People. Springer Publishing Company.

Budelli, J. (2010). OCR helping the Visually Impaired. Retrieved September, 2019, from http://community.aiim.org/blogs/joe-budelli/2010/09/08/ocr-helping-the-visually-impaired-.

Sivan, S. & Darsan, G. (2016). Computer Vision based Assistive Technology for Blind and Visually Impaired People. The Proceedings of the 7th International Conference on Computing Communication and Networking Technologies.

World Blind Union. (2017). Brief On WIPO Treaty. Retrieved June, 2017, from http://www.worldblindunion.org/English/our-work/our-priorities/Pages/Brief-On-WIPO-Treaty.aspx.

W3C. (2017). Understanding Conformance | Understanding WCAG 2.0. Retrieved June, 2017, from https://www.w3.org/TR/UNDERSTANDING-WCAG20/conformance.html.

World Blind Union. (2018). Marrakesh Treaty to Facilitate Access to Published Works for Persons Who Are Blind, Visually Impaired or Otherwise Print Disabled. Retrieved June, 2018, from http://www.wipo.int/treaties/en/ip/marrakesh/#wipo-int.

Wikipedia. (2019). Universal design. Retrieved June, 2019, from https://en.wikipedia.org/wiki/Universal_design.

Contact email: fang@pu.edu.tw