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Real-Time AR Text Recognition Based Library Management System

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Abstract
Background/Objectives: Difficulties in managing books are increasing due to the quantitative and qualitative growth of libraries worldwide. In particular, since books are often not located in the designated bookshelf, the user and librarian often have difficulty finding certain books.

Methods/Statistical analysis: Therefore, this study proposed a real-time Augmented Reality (AR) based text recognition library management system using a smartphone in order to improve the efficiency of the user's book search and librarian's book management. The existing method of finding books by book classification number and AR text recognition based library management system implemented in this study was used to measure and compare the time taken to find a specific book. A Mann-Whitney U test, interview, and observation were all conducted for the analysis.

Findings: According to the analysis, the system did not improve the speed of finding books. The reason is that the text was not easily recognized over a long distance, and it was not easy to check the text recognition results of the smartphone while searching for a book with one's eyes.

Improvements/Applications: In future studies, we will develop a smart glasses based library management system to ensure that text recognition results show up at the user's point of view and will verify the effectiveness of it.

Keywords: *Library Management System, Text Recognition, Optical Character Reader, Augmented Reality, Smartphone.*

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1. Introduction

In the traditional library system, it is common to manage books by attaching a barcode to books [1,2]. However, the bar code system focuses only on the convenience of borrowing and returning books and has the disadvantage of only recognizing one book at a time. In addition, it is cumbersome to attach an anti-theft sensing chip separately to prevent theft.

In order to solve this double problem, a library system using RFID (Radio Frequency Identification) has emerged [3-7]. RFID is a technology that recognizes objects in a non-contact manner using radio frequencies and small IC chips, and can be used for the location and tracking of objects [8,9]. RFID is largely composed of tags (chips, transponders) attached to objects such as goods, readers that read them, codes for identifying embedded information, middleware, and more. Using a library management system using RFID, it is possible to recognize several books at once and to lend and return them, as well as to prevent theft [10,11].

However, RFID tagging must be done by hand, which requires a great deal of manpower and time.

The use of RFID makes the library management system much more efficient. However, there is still a problem in that the user must find the desired book by hand. In order to solve this problem, there have been studies on systems capable of determining the location of books in real-time using either ZigBee or Bluetooth. ZigBee is an international standard specification for low-speed short-range personal wireless communications aimed at low power usage and low costs based on IEEE 802.15.4. Bluetooth is a general term for short-range wireless communication technology, standards, and products to realize bidirectional short-range communication between portable devices at low cost without the complication of cables [12]. When the user approaches the book, the location of the book is displayed by lighting the LED of the bookshelf on which the book is located using the ZigBee or Bluetooth communication of the wireless terminal, thereby reducing the time and effort to obtain the book [13]. However, although this method can help locate books in real-time, the difficulty is in installing LED and ZigBee or Bluetooth on every bookshelf. This is not easy in terms of time and money. In addition, if the book is not located in the original designated place, it is difficult to find the desired book. People have to search for the book with their own eyes, which is especially difficult when the library is large.

In order to solve this overall problem and improve the efficiency of book management, this study proposes a real-time Augmented Reality (AR) text recognition based library management system. An Optical Character Reader (OCR) allows for the detection of text in images with automatic language identification [14], and many previous studies take advantage of OCR [15]. However, the OCR is generally used to recognize text after taking a picture using a smartphone. This method is not suitable for situations in which text is to be recognized by scanning an unspecified large space such as a library bookshelf in real time. Therefore, this study aims to develop a system that finds the book the user is looking for by scanning text on the screen displayed in real-time through the camera lens and to verify its effectiveness through the comparative experiment with the existing book search method.

2. Materials and Methods

2.1. Real-Time AR Text Recognition Based Library Management System Overview

As shown in Figure 1, a real-time AR text recognition based library management system using a smartphone was developed. It is a system that marks the book that the user is looking for on the screen of the smartphone in real-time through text recognition when a user searches a bookshelf with a camera of a smartphone to find a book.

The system developed in this study basically follows the search method of a general library book search app system. When a user searches for a book, it provides the location of the bookshelf on which the book is located based on the data stored in the database. As shown in Figure 1, when the user arrives at the bookshelf, he or she activates a camera that supports text recognition technology to find the book. Looking at the bookshelf with the camera, the text recognition system recognizes the book the user wants based on the input text. When the book user want is recognized, the location of the book is displayed as a visual object on the camera screen using AR technology. The system compares the recognized book title with the lost book data in the database to see if there is a lost book. If a lost book is found, information about the current location is stored in a database so that the librarian can access the lost book information.

Figure 2 shows the system diagram for an Android, Node js server, and Google Mobile OCR. When the server receives the title of the book the

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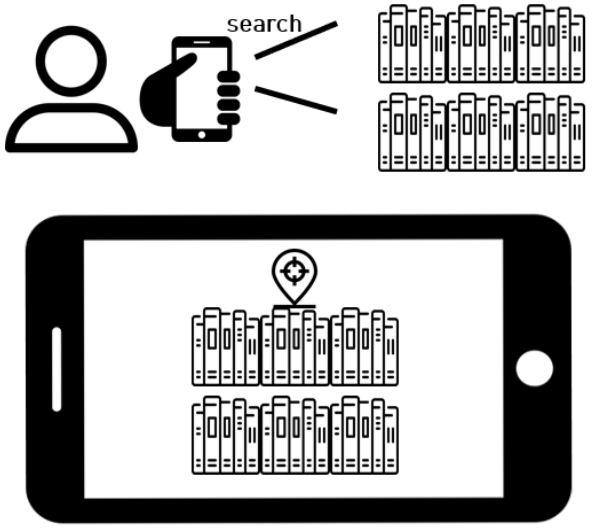

Figure 1. Real-Time AR Text Recognition Based Library Management System Using a Smartphone.

user wants to find, it accesses the database and retrieves the data of the book. Based on the imported data, the book location information is provided to the user. When a user arrives at the bookshelf where the book is located and activates the text-recognition camera, the application requests text recognition from Google Mobile Vision.

When Google Mobile Vision receives a request for text recognition, it recognizes the text in the image displayed by the camera and sends the recognized text value and coordinate information to the node js server. At this time, the node js server checks whether the text information sent from Google Mobile Vision includes the text of the book that the user wants to find and the text of the lost book. If the text of the book that the user wants exists, the text information is sent to the Android, and the Android receives the position coordinate information of the text and displays it as a rectangular object on the screen based on the coordinate information. If the text of the lost book exists, the location information where the text is found is stored in the database so that the lost book can be found.

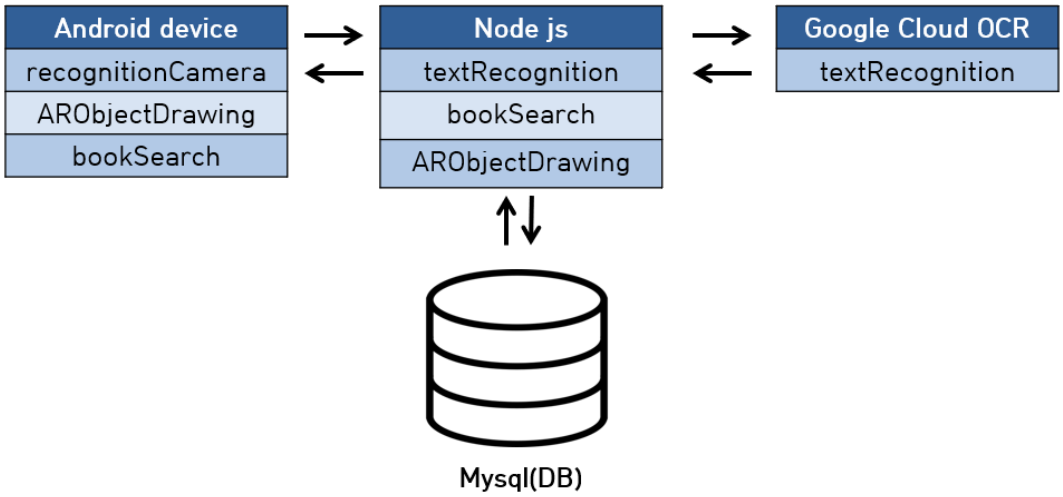

Figure 2. System Diagram.

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Figure 3 shows the ER diagram of the system proposed in this paper. The user table that can identify a user has userID, userPW, and userName attributes. The primary key is userID. The book table has the following properties: bookNum, title, author, bookImg, ocrText, quantity. The primary key is bookNum. The ocrText attribute is a text keyword that will be recognized in order to find the book the user wants when using the text recognition camera feature. In the lend table, there is a 1: N relationship between the user table and the book table. Similarly, the lost book table has a 1: N relationship between the user table and the book table. In the lost book table, scanResult is a property for saving the location when the lost book is scanned while the user is using the text recognition camera function.

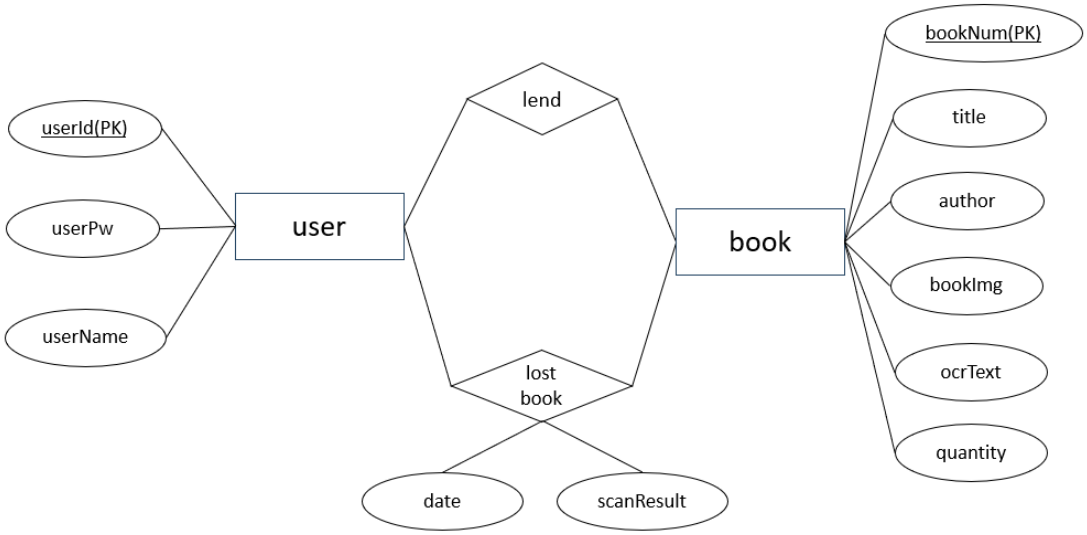

Figure 3. ER Diagram

2.2. Experiment

• Experiment procedure and participants

After establishing the research hypothesis that the time required to find a specific book using an AR text recognition based library management system using a smartphone will be faster and more satisfying than the traditional method of searching for a book by book classification number, and then verifying this hypothesis, two homogenous groups were created to experience the systems. The time taken to find a book was measured and surveys and interviews were conducted. The first group found books using the AR text recognition based library management system, and the second group found books using book classification numbers.

University students (20 to 25 years old), who frequently use libraries, were selected for the experiment. The experiment was conducted at a university in Busan, South Korea on January 15 to 17, 2020. After explaining the experiment to an unspecified number of students who visited the library, the experiment was conducted on students who agreed to participate in the experiment. A total of 21 students participated in the experiment, and they visited the library at least once a week and borrowed about one book every two to three weeks. A total of 11 students (4 males, 7 females) participated in the book search test using the AR text recognition based library management system, and 10 students (3 males, 7 females) participated in the test group searching for books by book classification numbers. It took 5 to 10 minutes for each student to participate in the experiment, and the interview took about 2 to 5 minutes.

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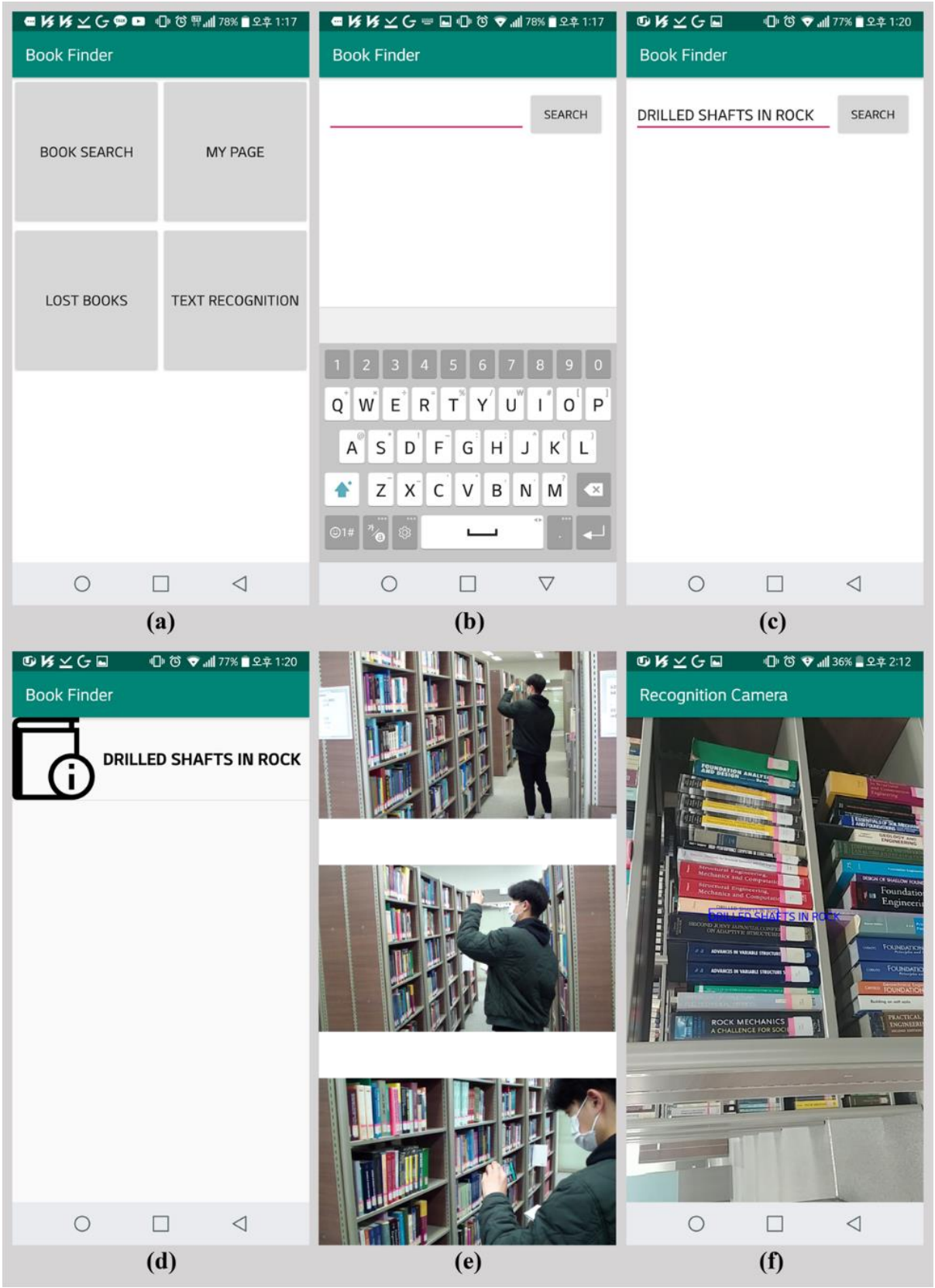

Figure 4. The Process of Finding A Specific Book Using the AR Text Recognition Based Library Management System, (a) System main screen, (b) book search page, (c) Entering the book title, (d) List of books searched by the user, (e) Finding a book while looking at the bookshelf with the camera, (f) Camera screen with book title displayed as a blue square object

The process of finding a specific book using the AR text recognition based library management system is shown in Figure 4. When the user runs the Book Finder, the system main screen appears as shown in Figure 4 (a). BOOK SEARCH, MYPAGR, LOST BOOKS, and TEXT RECOGNITION buttons are located in the center. If the user touches the BOOK SEARCH button, the SEARCH page to enter a book title appears as shown in Figure 4 (b). When the user inputs the title of the book to search for as shown in Figure 4 (c) and then presses the SEARCH button, the list of books searched by the user is displayed as shown in Figure 4 (d). Touching the list activates the camera that recognizes the text of the book title. When the user moves while looking at the bookshelf with the camera as shown in Figure 4 (e), the application recognizes the text of the book title entered by the user and displays it as a blue square object as shown in Figure 4 (f).

• Measures

The time taken to find a book was measured and recorded, and the interview was conducted after the experiment. Since the sample size of the group was relatively small and did not satisfy the normality, a Mann-Whitney U test, which is a nonparametric statistical method, was used for the statistical analysis. The interview was used as a reference for interpreting the statistical analysis.

3. Results and Discussion

The time it takes for a group using the AR text recognition based library management system to find books was compared to that of the group looking for a book using the book classification number. No significant result was obtained (Mann-Whitney U = 47.00, Wilcoxon = 102.00, $p>0.05$) (Table 1). As shown in the box plots in Figure 5, however, we found that the interquartile range of the group using the AR text recognition based library management system is slightly wider and higher than that of the group searching for a book by book classification number, and the maximum value is much larger. These results indicate that although the overall results were not significant, some students using the AR text recognition based library management system took longer to find a book.

There are two reasons for this result. First, there is a limitation in that the text recognition system is not easily recognized over a long distance and instead works best when the user comes close to the book they are looking for. As a result of observing the experiment process, most of the participants approached the bookshelf and slowly scanned the bookshelf with their smartphones, which tended to slow down the search. Second, when looking for a book while looking at the bookshelf with their eyes, the user tended not to recognize it well even when the book searched for was displayed on the smartphone. Some students did not easily see the smartphone while looking for a book with their eyes throughout the experiment. Students who focused on the results of the recognition of the text on the smartphone were slow to find the approximate location of the book because they focused only on the recognition of the text. As a result, it was judged that no significant difference was found between the two groups; instead, some students in the group using the AR text recognition based library management system took longer to find books for these two reasons. Most experiment participants expressed their wish that the text could be recognized at a longer distance and described it is inconvenient to find text on their phone while searching for a book. Therefore in future research it is necessary to supplement the method of improving the text recognition performance, and it is necessary to develop the system using smart glasses so that the text is recognized at the user's point of view.

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Table 1: Results of the Mann-Whitney U test analysis for the time taken to find a book

Variable	Type of Book Finding	N	Mean Rank	Sum of Rank	Mann-Whitney U	Wilcoxon W	Z	P
Time taken to find a book	AR text recognition based library management system	11	11.73	129.00	47.00	102.00	-0.564	0.57
	Book classification number	10	10.20	102.00				

*p<0.05; **p<0.01

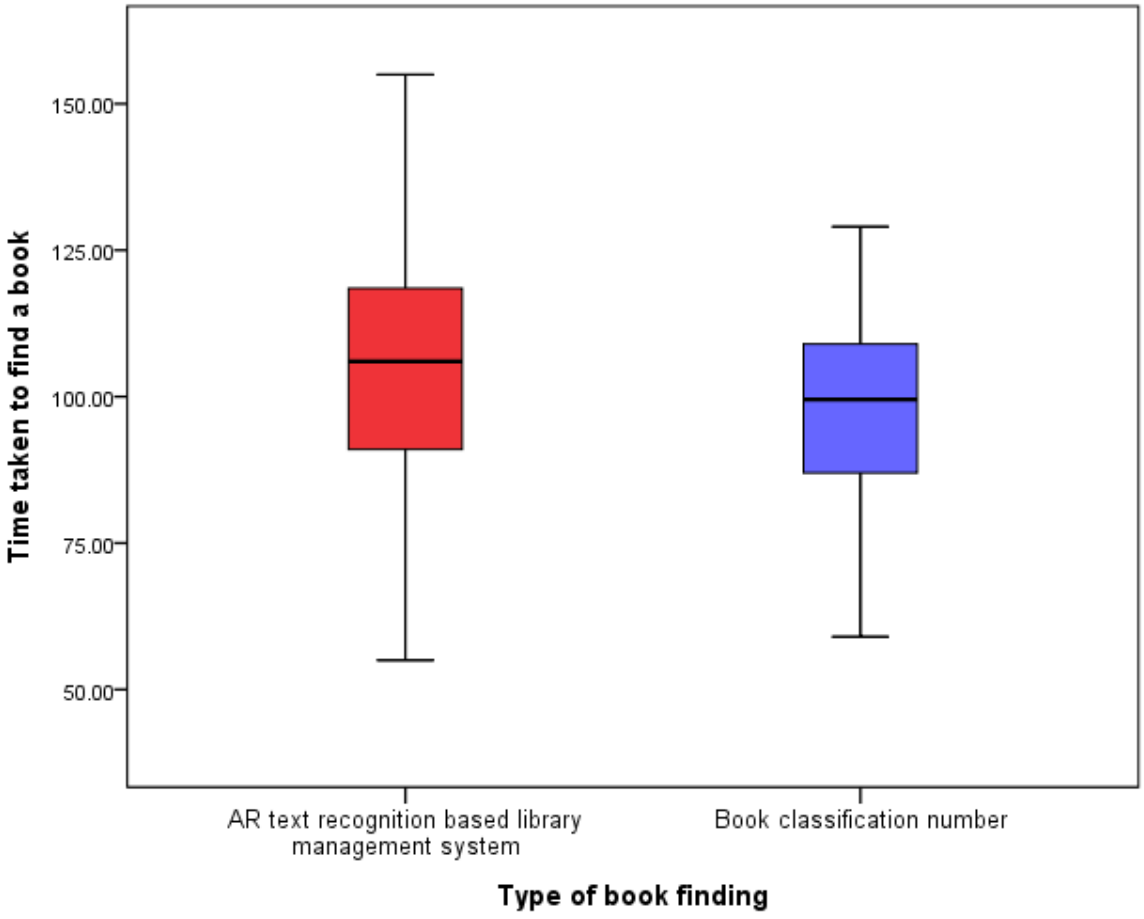

Figure 5. Comparison of Boxplots for the time taken to find a book

4. Conclusion

In this study, we proposed an AR text recognition based library management system to improve the efficiency of library users' book searches and librarian's book management. In order to verify the effectiveness, we implemented a smartphone-based text recognition library management system and conducted a comparative experiment. As a result of the experiment, there was no significant difference between the method using the AR text recognition technology system and the method of finding the book through the existing method. This result is because the text recognition performance is not excellent, and also because the text is recognized using a smart phone. That is, when the user's eyes look at the bookshelf and the

smartphone recognizes the text, the user tends not to easily recognize what is happening. Therefore, in future research we will improve the text recognition performance and develop a real-time AR text recognition library management system using smart glasses that recognize text at the point of view of the user so as to verify the effectiveness of it.

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