RFID Assistance System for Faster Book Search in Public Libraries

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Abstract

This paper presents a comprehensive overview and study of a proposed RFID Assistance System that uses existing technology and devices to enable faster book search, information overlay, and check out in a public library. The proposed system uses an interactive graphic interface contrary to the conventional alpha numeric character systems used in the Dewey Decimal or the Library of Congress system currently used in public libraries.

For the user study, we set up an analog version of the proposed system to compute accessibility as well as response times. The survey also lists responses to the usability of such a system for library search and check out.

Keywords

Handheld Devices and Mobile Computing, User Studies, Concept Design, User Interface Design

ACM Classification Keywords

H5.2. Information interfaces and presentation (e.g., HCI): User interfaces.

Introduction

Research of current Library of Congress or Dewey Decimal systems used in public libraries show that it is

often inconvenient for novice or occasional users to understand and use these systems. This usually arises due to unfamiliarity with the system and the time taken to find a book. Our proposal for improvement suggests the use of technology to decrease cognitive loads, thus making the library search easier. Such a system would not only help in faster book searches but could also be used to add additional layers of information for the particular book that would make the system more efficient for all stakeholders.

Thus, the proposed RFID assistance system is designed to provide assistance to library users to allow for faster books search as well as to augment these searches with additional layered information. Prior studies in the library confirm that it is a tedious process to search for books using current systems because they involve multiple steps. Our studies show that experienced users were able to find books quite easily but novice or first time users were often frustrated by the system. Perhaps this is because the current system affords users with a high cognitive load - 1) memorizing a relatively large alphanumeric code (e.g. NA1469 .H43 A4 2003); 2) having a relative knowledge of the library layout; 3) and an understanding of the coding. It can become even more of a frustrating experience if the book is misplaced or checked out (a common occurrence in most public libraries).

The new system proposes to use the existing database of the library and augment it with technology to provide assistance during the entire process of finding a book starting with the search until the check out. Not only will such a system minimize the time taken for the search but also will make the library system more efficient in terms of book management, book organization, security and database maintenance [1].

The system

In the proposed design, a PDA/Pocket PC device helps the user to search for books within the library database and also provides information about book and its location. RFID (Radio Frequency ID) placed on books and the ID cards of the user provide the PDA with information which can help to locate the book from within the library shelves. Proximity sensors on the shelves can detect the RFID on the user ID, enabling the user to locate the appropriate shelf [2].

Interaction Technique

To better explain how this design works lets create a scenario of an individual looking for a book in a public library. For the purpose of this study, let's call her Jill. Jill has just joined school. In her first week, she receives a research assignment that requires extensive use of the library. In her earlier school, she used an online catalogue to find books. Having found the details of the book on the computer, she would write down the name, title and alpha numeric information of the book on a piece of paper. Having all these information, she would then go to the library to find the book. However Jill found that 1) the system was not easy to comprehend especially the first few times she used it; 2) it was time consuming; 3) it's frustrating if the book is misplaced or has been checked out 4) or if she forgets the alphanumeric code or loses the piece of paper she has it on; 5) she has to go back and search the online catalogue once again if she wants a different book; 6) she has to wait in a queue to check out the book.
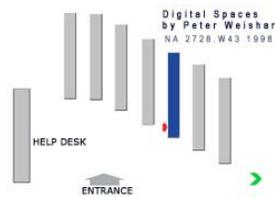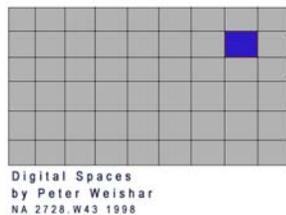
figure 1

figure 2

figure 3

figure 1. The PDA used in the user study. The image shown in the screen (enlarged in **figure 2**) shows the book racks in gray and the desired rack in blue. **figure 3.** Shows an elevation of a rack with blue marking the section on the shelf where the book is located.

Her current school however has adopted a new RFID assistance system for library search. Jill goes to the front desk and is handed a PDA after the front desk scans her RFID enabled student ID. On the PDA she uses a search engine linked to the library's database and using keywords, author name or title she is able to find the book she wants. When Jill is ready to get the book, the screen immediately shows her an easy to read graphic layout of the library with information about the floor and the location of the shelf holding her book. Jill follows the directions on the PDA leading to the correct shelf. As she nears the correct shelf, proximity sensors on the shelf detect her ID and a colored LED flashes on the rack. Once near the correct rack, the image on her PDA changes showing her the location of her book in relation to other books on the rack. Noting that the book is on the top right hand corner of the rack, Jill looks for a flashing LED under the book she was looking for. Having found her book, she may choose to look for another book, or check out. On the PDA she sees a tab recommending other books with the same key words or suggested by her professor. These recommended books can be located within the library using the same mechanism. This eliminates the time for Jill to go back to a computer to find the alphanumeric code of the book.

Deciding to check out, she collects all books she has found and moves towards the front desk. She could use her PDA to check out the books; but Jill decides to use a self checkout counter, not unlike the one in her neighborhood supermarket. The counter is placed next to the front desk. She uses her student ID to check out [3] the books at this counter and returns her PDA to the front desk. Having completed her first visit to the
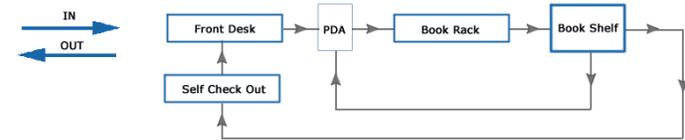

figure 4. This figure shows a multi cyclic process from the book search to the check out.

library in less time than it would have taken at her last school, Jill leaves to work on her assignment.

How the System Works
To locate a book in a library, a database of information has to be stored about that book - Call numbers, ISBN number, title, author's name, abstract, key words. Such information about the book can be used by the described search engine to find the book. This information can be located on the library database accessible through a wireless network in the vicinity of the library. Alternatively, RFID tags on the book itself act like barcodes that transmit information – these tags can store multi-layered information about a particular book accessible by a search device - a PDA or cell phones or any other similar device with the appropriate software. Once the search device attaches itself to a book, it can track and locate the book by locating the RFID information from database or by sensing proximity.

An alternate design (if a search device is not a viable option) is to have printed graphic directions that will lead the user to the desired book's location. Since there might be more than one user using the system simultaneously, color coding (or graphic coding for color blind) will minimize confusion. Although the design of such an interface was considered to be out of

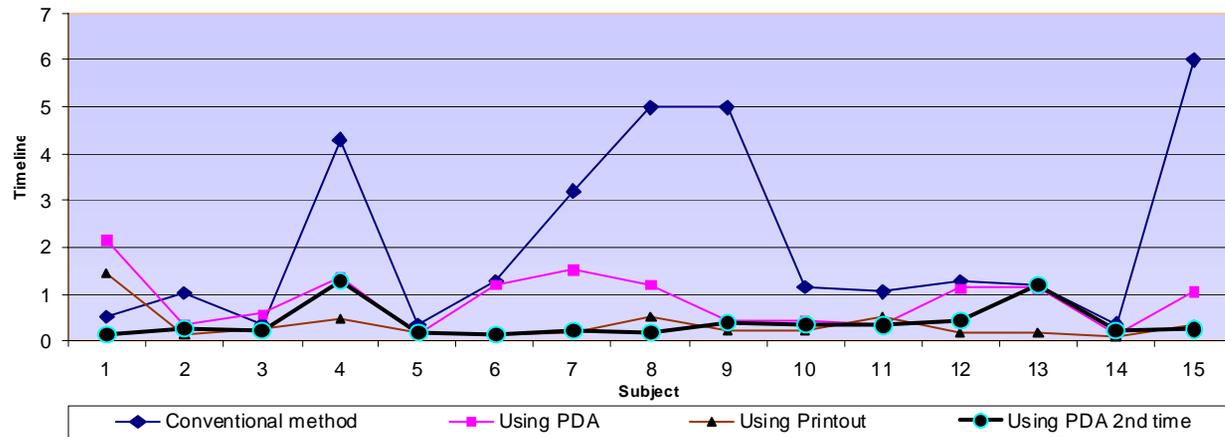**Chart Showing Participant Data (n=17)**

figure 5. This graph is a result of the user study with n=17. In this study the participants were asked to search for books in three different menthods. First the participant was asked to find a book using the conventional library congress system of book search. The diamond points show how much time each subject took to find a book using the first method. In the second method (square points) the subject was asked to find another book using a PDA and a graphical interface with color coding. In the third method (triangular points), the same graphical interface was used but instead of the PDA, a paper print out was used. In the 4th study (circular points) PDA was used once again to adjust for the learning curve of the subject.

Note: Two participants' data is not included in the graph since they could not locate the books using either method.

the scope of this study, it was acknowledged as an important possibility of further research.

User Study
To analyze the design, a comprehensive user study was designed and conducted in the Bob and Kathy Luke library of College of Architecture, Art, and Design at Mississippi State University. The participants included all stakeholders – faculty members of the school, students as well as library staff (n=17). To verify our claim that the new system will take lesser time than the conventional alphanumeric system, we developed the aforementioned interfaces on a PDA. Owing to constraints of a larger space, the study was conducted in a small library. We believe that the study can be extrapolated to a larger system with similar results.

In the study two set of questionnaires were prepared and the subject was asked to answer one set before the study and one after the study. Once the first questionnaire was completed, the participant was asked to search for four pre-determined books from the library. The participant was asked to search for the first book using the conventional system. Both the search time (time to find the book on the computer/card catalogue) and the response time (time to find the location of the book) were noted.
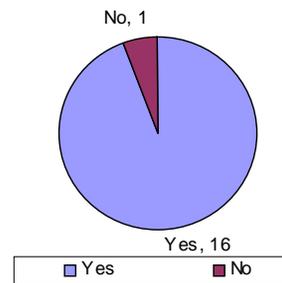
In the second search the participant was asked to find another book, this time using the search interface on the PDA. Once the search was complete, a location map was provided on the PDA screen showing the location of the specified book in the library. For pragmatic reasons,

Important Results of user study (n=17)

Has this new system made it easier for you to find books in the library?
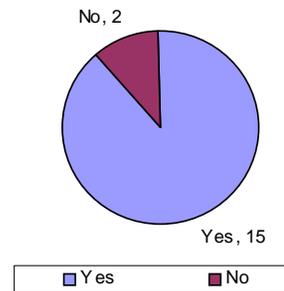
Did the color coding help you to locate books better than the current system?

Have you used a PDA or Pocket PC before?

No, 2

Yes, 15

| ■ Yes | ■ No |

No, 1

Yes, 16

| ■ Yes | ■ No |

Sometime 6%

Daily 31%

Once 13%

Never 50%

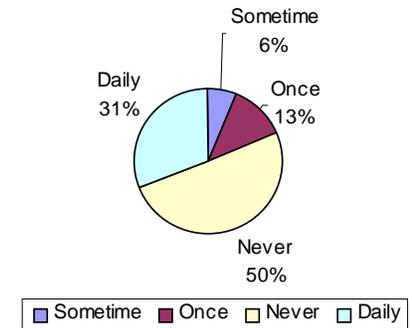| ■ Sometime | ■ Once | □ Never | □ Daily |

figure 6. Graphs showing tabulation of important questions from the questionnaires.

1. 2 out of 17 subjects could not find the book using the conventional system nor the new system.
2. The conventional system took more time even for experienced users. 15 out of 17 users said that the new system made it easier for them to find books in the library.
3. The time taken by using color (graphic) coding was much lesser than that by the conventional system. 16 out of 17 participants said that color (graphic) coding helped them locate a book better. In the study it was also noted that three users who never used the library before could not find the book using the conventional method but could easily find the book with the new system.
4. Time taken when PDA was used for the second time was much lesser as expected. Results show that even in the first book search the participants took lesser time than the conventional method to find the book. Moreover when the participant was asked to search for another book using PDA, it was found that it took much lesser time than the first search indicating a low learning curve.
5. As mentioned in the paper, two interfaces were used. In the first case participants used a PDA and in the second case a print out of the same graphic interface was provided. Although we assumed that the tangible nature of paper would make it easier for participants to find a book, a surprising 11 out of 17 participants preferred the PDA to the paper.

LEDs on shelves were substituted with color paper tags displaying similar information. Once again, both search and response times were noted. In the third test instead of the PDA interface, a print out of the map was handed out to the participant showing the location of the book - using similar color coding.

In order to compute the learning curve of the system; we conducted a fourth test in which once again the PDA interface was used. At the end of the study, the participants were asked to answer the second questionnaire.

In this study we also argued on using cell phones instead of a PDA. In our survey we found that most

users accepted the fact that everybody uses a cell phone so it is a good idea to use

cell phone instead of PDA. However we feel that a smaller screen size and other interface issues could raise usability concerns.

Real World Solutions
Current RFID systems in libraries [4] are used for logistics, inventory, and internal categorization. However, none of these libraries employ a search method that is linked to this database. Our proposal suggests using RFID technology and combining it with a graphical interactive mechanism that will be available to the patrons of the library. Such a system has inherent difficulties - it means more than just an

inventory change for most libraries. An overhaul of the whole library is not just an expensive affair but also requires a fairly well maintained database that is available to the public (or patrons of the system). Hence, in order for the developmental model proposed in this paper to become a reality, it will take more than just an effort from designers and usability scientists. It means a change in the business model of how libraries operate.

Conclusion

From the user study it was evident that the new system took less time and was much easier to use in comparison to the conventional system (see figure 7 for detailed results). Moreover, the interface afforded additional layers of information that we found was useful to the user - helping in better or augmented searches. The system could in theory minimize the number of book losses and could help in managing the library with decreased work force.

However we acknowledge that the study is not complete. Many assumptions and deviations were made during the study. Although most of these deviations are comparable to the designed solution, it would be interesting to see if the result holds up during a test of the complete system. The current study has been presented to the much larger Mitchell Memorial library at Mississippi State University and we are currently discussing the possibilities of implementing the whole or parts of the system for further study and development.

Acknowledgements

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