BrowsReader: A System for Realizing a New Children's Reading Environment in a Library

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Abstract. This paper proposes a system for realizing a new children's reading environment in a library. Conventional libraries establish children's rooms for supporting children's activities of reading printed picture books. The collections there, however, are often biased in content and limited in number, and children are usually not satisfied with them. When the entire collection becomes large, it occurs that younger children cannot effectively search that collection. Similar search problems also exist in children's digital libraries. We have designed a system called Brows-Reader with the purpose of realizing a new environment, where children can browse in a large virtual bookshelf and can easily find the digitized and/or printed picture books that they are interested in. A user study was conducted to test the effectiveness of the system.

Keywords: Children's digital reading room, children's digital library, picture books, browsing interface.

1 Introduction

Picture books play an important role as textbooks for children. By reading stories and seeing pictures children can see an unknown world, improve their levels of imagination and expression, and learn the words and wording [3]. Conventional libraries, especially public libraries, arrange printed picture books in the bookshelves in their children's reading rooms or corners. The collections there, however, are often biased in content and limited in number, and cannot fully satisfy the children's needs. In addition, it is usually hard for children to read digitized versions of old picture books and newly published digitized picture books. When a library collects a large quantity of picture books, children would face the unfamiliar keyword-based index search different from the bookshelf browsing.

Some of these problems have been alleviated by realizing children's digital libraries on the Web, e.g., International Library of Children's Literature in the National Diet Library of Japan [8], and International Children's Digital Library created in Maryland University [7]. When utilizing digital libraries children are still required to input a keyword or click a category symbol in order to access to the desired digitized books, in spite of the difficulty that younger children cannot deal with keywords and categories very well [6]. They also have to trace

Fig. 1. An image of a children's digital reading room

the links to get to the desired picture books. Further they will not be able to read the printed versions as in a conventional library.

We here try to solve such various problems by formalizing a new reading environment, a children's digital reading room, where a table with a built-in touch display [14] and a personal computer installed with the proposed BrowsReader is placed in a conventional reading room as shown in Fig. 1. BrowsReader, a system to assist *a group of children as well as a single child* in book-finding and book-reading activities, consists of Bookshelf-Browser and Book-Reader. The main features of the activities in this room involve:

(1) Children can easily find the books of their interest from a large quantity of intermixed collections of digitized/printed picture books.
(2) Children can read both digitized and printed picture books with the same interface on the table.

For (1), Bookshelf-Browser that assists children to browse the titles/author-names and the front cover images of digitized/printed picture books, is designed with the consideration of the cognitive ability of younger children as to the use of keywords and categories. Although children start to become interested in characters from around 3 years old, they could not correctly spell words until 11. The vocabulary of younger children is not rich enough and the categories have not been well formed [1][11][12]. By using Bookshelf-Browser children can narrow a large index of the title/author-names to be browsed by incrementally inputting a character, and a large virtual bookshelf showing the front cover images by touching a bookcase of the bookshelf. For (2), Book-Reader together with Bookshelf-Browser is specifically designed for children so that they can read, with the same interface, the just found digitized picture book together with any other previously found books.

BrowsReader was evaluated by establishing a temporary children's digital reading room in a playground during the 2007 Children's Event at Oita University. The collection consisted of the digitized versions of 162 printed picture books. Total 111 children, ages from 2 to 13, visited the room with their friends and families. All the children could launch Book-Reader via Bookshelf-Browser

even though they had never learned how to use BrowsReader before. About a quarter of the children utilized the character input function. From the answers to the questionnaire, BrowsReader was shown to be interesting, useful, and easy to use even for younger children.

2   Design Policy

BrowsReader consists of Bookshelf-Browser accompanied by Book-Reader. The former is responsible for managing the primary and the secondary information of digitized picture books and the secondary information of printed books. The latter is mainly responsible for flipping the pages of digitized picture books. Digitized picture books as well as printed ones are read on a table with a touch display and a BrowsReader installed on a personal computer by page flipping.

2.1   Primary and Secondary Information

The primary information is about the digitized/printed picture books themselves, and the secondary information here is extracted from the primary information as to the bibliographic attributes "title" and "author." The secondary information functions as an index to the primary information for managing a large quantity of picture books. For adults there would be no problem in distinguishing and making use of the two kinds of information. For children, however, it would be difficult to make connections between the two [9].

2.2   BrowsReader

Fig. 2 illustrates the processing of the information in BrowsReader. With Bookshelf-Browser children can find books of their interest by browsing in the virtual bookshelf and/or the index. The virtual bookshelf showing the front cover
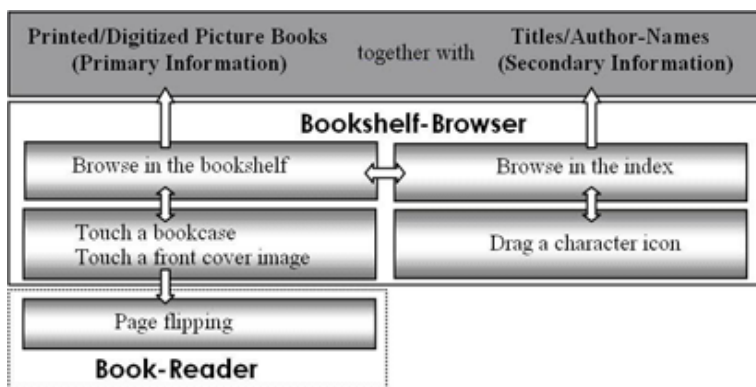

Fig. 2. Information processing in BrowsReader

images of digitized/printed picture books in the form of arranged bookcases is browsed in as seen in the real bookshelf browsing, and the index listing the titles and author-names as seen in the Keyword-in-Context index browsing. For easy browsing the bookshelf can be enlarged by touching a bookcase, and the index by dragging a character icon. To better help children understand the relationship between the primary information and the secondary information, the left and right parts of Bookshelf-Browser in Fig. 2 should be processed seamlessly, and the results be displayed promptly. Bookshelf-Browser is designed to do exactly this.

The front cover images of the books in the virtual bookshelf are intended to be treated as the primary information. The found digitized books can be read by just touching their cover images and flipping the following pages as if they were printed versions. Book-Reader, designed to be activated by Bookshelf-Browser, assists children in page flipping. When the touched image is for a printed book, children can find the book quickly from the real bookshelf based on the information from Bookshelf-Browser. On the table they can read both digitized and printed picture books together by page flipping.

The way of processing the information in a conventional children's reading room can be seen in the left part of Fig. 2, where the primary information is fully utilized. Children find the printed picture books by browsing in the bookshelves, pick them up, and then read them by flipping through the pages on a table. When the entire collection increases in size, children will have difficulty in searching it just by the primary information. A search system for processing the secondary information may help them in this case. This system, however, requires children to input keywords, a not easy task for younger children to do. Children who find books of their interest also need to go to the bookshelves to check the front covers to be certain they have got the right ones. In this environment, the primary information and the secondary information are processed separately, rendering it hard for children to make connections between the two.

In children's digital libraries, the processing of the two kinds of information is still separated even though the primary information is digitized. Children have to know and input keywords or category symbols before starting any search. The accesses to the primary information and the secondary information are independent. Besides, only the digitized picture books are available to read, no the printed versions.

3   Implementation Process

This section explains how Bookshelf-Browser and Book-Reader are implemented.

3.1   Bookshelf-Browser

The virtual bookshelf and the index are unified in Bookshelf-Browser. Children can browse in the bookshelf and in the index freely without noticing the difference. The bookshelf and the index, respectively, are enlarged by touching a bookcase and by dragging a character icon. The user's character input filters the
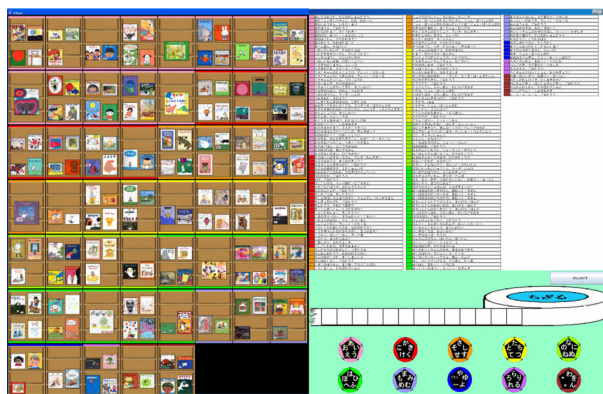
Fig. 3. Bookshelf-Browser

results to contain only the titles and author-names with the input character(s). The enlargements of the bookshelf and the index are synchronized such that when a part of the bookshelf (or the index) is enlarged its corresponding part of the index (or the bookshelf) becomes enlarged as well. This synchronization helps children relate the picture books to their titles/author-names in a visible way. Fig. 3 shows Bookshelf-Browser, where the bookshelf with 162 book cover images on the left and the index with input character icons on the right are displayed. The white ribbon-shaped paper on the middle right is prepared for displaying the history of the inputted characters.

The bookshelf is organized after arranging the books in the lexicographical order of the titles and clustering them into bookcases in fixed size. Each bookcase forms a unit for enlargement. The arrangement can be done as to an attribute, e.g., "author," "cover color," and "subject" other than "title," and its result corresponds to a simultaneous menu [4][5] for the employed attribute. When the "subject" is employed, consecutive bookcases store the images of the books with the similar categories. This makes it much easier for children to browse the books based on categories, even if they may not have enough knowledge about them.

The index called Character-String-in-Context index, devised as a sibling of the KWIC index, is made for listing the titles and author-names with the input character(s) in the middle of each string. The CSIC index is enlarged in font size just by dragging every input character icon. No enter-key is needed. The input character information is materialized in the CSIC index and in the white ribbon-shaped paper. Children with inadequate spelling skills can freely change the sequence of the input characters in the ribbon-shaped paper, and accordingly refashion the CSIC index. By this way children can manage the secondary information without pre-condition of having knowledge about keywords.[1]

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[1] BrowsReader works as an enhanced search system in a library when children input a keyword instead of a character. The CSIC index in this case works as one of the KWIC index as seen in the outputs of a search engine, e.g. Google [2].

3.2   Book-Reader

Book-Reader, which works cooperatively with Bookshelf-Browser, is a viewer to read digitized books in a way similar to read printed ones. Its main function is page flipping with three options: page-by-page reading, scan reading, and bulk reading. Other functions include graffiti and magnifying, by which children can enjoy reading with imagination. Book-Reader is automatically started when the front cover image of a digitized picture book is touched. The foreground in Fig. 4 shows two digitized picture books (which were on the bookshelf before having been touched) being read.

4   An Example of Utilizing BrowsReader

Fig. 4 shows an example situation of the utilization of BrowsReader. A child, who has imagined about "うさぎ (rabbit)," can find a book by dragging an icon for a character, e.g., 'さ,' that occurred in his/her mind, by browsing in the enlarged CSIC index or the enlarged bookshelf and then by checking the details of the front cover images in some bookcases. The books found can be read with his/her friends, where they together or one after another flip the pages by dragging the displayed images. In Fig. 4, another book about "うさぎ" which had been under reading is displayed behind the reading one.

Fig. 4. Utilization of BrowsReader

5   Usability Experiment

We conducted a user study to evaluate the usability of BrowsReader by establishing a temporary children's digital reading room in a playground during the 2007 Children's Event hosted at Oita University. All participated children could visit the room freely. Though some experiment under the controlled situation could

be performed, we adopted such a study in order not to bear unpredictable influence on the children's reading activities in the future. The collection consisted of the digitized versions of 162 printed picture books. A 30-inch (2560×1600 pixel resolution) display controlled by a personal computer with an Intel® Core^{TM}2 Duo CPU working under Windows XP was utilized to implement our prototype of BrowsReader.

We fixed several parameters on our prototype before we conducted the user study. Nine university students took part in this preliminary experiment. For Bookshelf-Browser, after examining how effective and easy the interesting books could be found while browsing in the bookshelf, it was decided that each bookcase was to have 4 books. In [5] it is mentioned that a character icon not smaller than 96×96 pixels in size would be desirable for a 30-inch display, but we set the size to be 64×64 so that total 50 input character icons could be displayed, and we grouped 5 icons together into a big soccer-ball icon whose size was at least 96×96 pixels. Any character could be inputted by touching a soccer-ball icon and then dragging the corresponding character icon. The size of each bookcase was at least 96×96 pixels.

For Book-Reader each book was displayed so that the font size of a character was at least 15 pt (which was decided by examining the above 162 picture books). The speed of page flipping was designed to be 1 page per second based on experience from preliminary experiment; but a faster speed was also set for smaller books. The pixel size of the icons for graffiti and magnifying was set to be at least 96×96.

5.1   Participants and Logged Data

Fig. 5 shows the environment for the user study. Two tables were prepared, where each display was put on a table though it should be fit in the center of a table top in a real environment. Total 111 children (ages 2-13) took part in the study (10:00 a.m.-15:00 p.m.) together with their friends and families. There were 16 kindergartners (ages 2-5), 68 lower graders (ages 6-9) and 27 higher graders (ages 10-13) from elementary schools. They did not know anything about BrowsReader before they came to the event. All the children were delighted to touch the bookcases/characters, to browse in the bookshelf/index, and to read the digitized picture books.

A logging system was utilized to record touch operations by the children for the statistical survey. A questionnaire for the children was also prepared.

5.2   Tasks and Results

The children were asked to use BrowsReader just as they pleased. University students would assist them only when they had problems. All the children launched Book-Reader via Bookshelf-Browser, and most of them were able to flip pages. After using BrowsReader, each of the children was interviewed in a casual conversation and requested to fill in the questionnaire shown in Table 1.

Fig. 5. An experimental environment

Table 1. Questions in the questionnaire

No.	Question
Q1	Are you happy when you used it?
Q2	Did you read a book when you used it?
Q3	Did you use it with others together?
Q4	Would you like to use it again?
Q5	Do you often go to a library?

About Browsing: Fig. 6 shows the results about browsing derived from the logged information, where gray, black, and white bars are for kindergarteners, lower graders, and higher graders, respectively (The similar bars are used in the following figures). Most children still found the books via the browsing of the primary information; but there were about 15% to 30% of them used mainly the secondary information to find the books. The children in higher school grades preferred to use primary information when browsing. The reason is that they are more used to read printed picture books. Before the study, we were uncertain about how many children could handle the CSIC index browsing. The result turns out that it worked fairly well when displaying the index together with the bookshelf.

About character input: Even the kindergartners and the lower graders tried to input a character as shown in Fig. 7. They often input a part of their names or some known characters. The results of the study show the kindergartners and the lower grader students were more likely to input characters than the higher grader students. This result, which seemingly contradicts to the discussion in [12] where category symbol input is recommended, shows some rationale about preparing the character input for searching the picture books.

About Reading: Page flipping was rather popular among the kindergartners as shown in Fig. 8. The kindergartners liked page flipping, which matches the findings in [12]. However, all children rarely used the magnifying. This fact shows
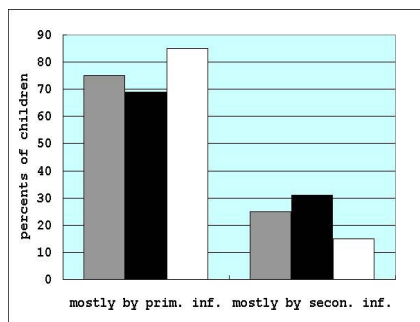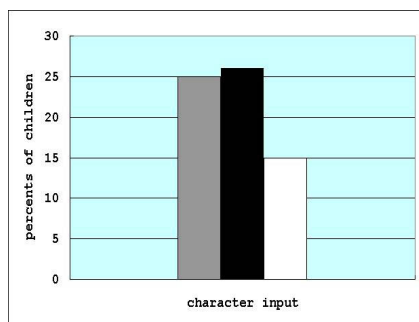
Fig. 6. Statistics as to browsing

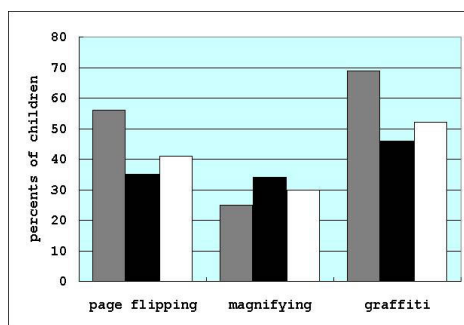**Fig. 7.** Statistics as to character input

Fig. 8. Percents of children who used different functions in Book-Reader

the pertinence of the display size of the books. Also, many children, especially the kindergartners, preferred to write graffiti, which matches the finding in [13]. Because graffiti is not allowed in a printed picture book in a conventional library, this added function favors the use of the children's digital reading room.

About the questionnaire: According to the statistics of the questionnaire in Table 2, BrowsReader was said to be interesting, useful, and easy to use. For question 1, one child returned the negative answer "there is no my favorite book."

Table 2. Percents of positive answers

No.	kindergartners	lower graders	higher graders	average
Q1	100	98.5	100	99.5
Q2	81.3	89.7	96.3	89.1
Q3	81.3	32.4	29.6	50.3
Q4	93.8	94.1	100	96.0
Q5	75.0	75.0	66.7	72.2

This might be due to the fact that there were only 162 books prepared in this study. Half of the children enjoyed reading with others. Even children who did not often go to a library liked to use BrowsReader and wanted to use it again.

6   Conclusion

A new children's reading environment is suggested by settling tables, for which touch displays and BrowsReader installed personal computers are set up, in a conventional children's room in a library. A child there can enjoy with his/her friends or family by finding the interesting books from a large quantity of digitized/printed books, and by reading the just found books together with any other previously found books. The effectiveness of BrowsReader was also shown in the user study.

The 30-inch screen utilized here can display up to about 500 front cover images each of which is distinguishable from the others without enlargement. Many conventional children's reading rooms, however, stores more than 10,000 printed picture books. We plan to evaluate BrowsReader for a collection of 10,000 to 20,000 picture books, and then set it in the children's reading corner of Oita University library for the future usability tests.

Though a display was placed on a table in the user study, it should be fit in the center of a table. Such an arrangement will be realized by adopting the research findings in [14], and/or by employing an emerging device seen in [10].

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