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Experimental studies on software tools to enhance accessibility to information in digital libraries

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The digital library, widely recognized as an important application in global and national information infrastructures, is an integration of advanced information technologies. Activities related to the digital library and the information technology to enhance accessibility to information in the digital library are surveyed. The paper describes five experimental studies on software tools which are designed to enhance the accessibility of information: an online public access catalogue with a bookshelf-like user interface, a book selection assistance system for children's books, an information visualization of characteristics of children's books, an application of a collaboration support system to a reference work in a library, and a multi-lingual browser for WWW documents. The paper shows the need for an intuitive information access tool for novice users.

1. Introduction

The digital library has been widely recognized as an important application in global and national information infrastructures. Libraries have been equipped with information technology. Library information systems which have functions for online document retrieval and for housekeeping are quite common in all types of conventional libraries, i.e. university library, public library, special library and so on.

Information technology for libraries has progressed very rapidly with the expansion of the Internet and WWW. Project Mercury at Carnegie Mellon University (CMU) Library (started at the end of the 80s) has produced the Library Information System II which has functions to retrieve journal articles and to display them on a user terminal [14]. As shown in the next section, various digital library projects are in progress using the Internet and WWW as the common platform. Design of a library as a physical space is being affected by the WWW and the digital library. The Media Union at the University of Michigan, which is a new library building, provides users with a digital environment where they can retrieve information and browse documents via the campus LAN and the Internet as well as the conventional collections, and they can produce information and publish it via the networks.

Libraries, conventional or digital, are responsible for information access environments where users can access information electronically. Generally speaking, digital libraries have two types of collections, a collection of primary information and documents, and a collection of secondary (or meta) information. The primary information collection

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includes such materials as books, journals, pictures, and maps. The meta information collection includes catalog records, indexes, and so forth. These collections must be well-organized and seamlessly combined in order to make information access effective.

Thus, the digital library is an integration of a collection of various types of information and advanced information technologies, such as semantic information retrieval, multimedia communication, information visualization, and so on. This paper shows experimental studies from the viewpoint of the user interface and browsing technology that enhances accessibility to information in the digital library. In this paper, the authors firstly discuss the basic concepts of the digital library and show several technological aspects essential for enhancing accessibility and usability of information stored in the digital library. Then, they show five experimental studies done by the authors, which include an online public access catalog (OPAC) with a bookshelf-like interface, a book selection assistance system for children's books, a visualization method of characteristics of children's books, a collaboration system and its application to a reference work, and a multi-lingual browser for WWW documents.

2. Information technology to enhance information accessibility in digital libraries

2.1 *Approaches to digital libraries*

Many research and development projects exist for digital libraries. The following paragraphs briefly describe these activities.

2.1.1 *Historical collection.* National libraries such as the U.S. Library of Congress (LoC) [20], the French national library [7], and the National Diet Library (NDL) of Japan [5], have large-scale digitization programs for historical and rare materials. American Memory (AMem) of the National Digital Library Program at LoC is creating a digital collection of books, magazines, photographs, motion pictures, and sound records. AMem provides WWW-based access to the digital collection. Users can browse the directories of the collection, retrieve the materials and browse them with their own Web browsers.

2.1.2 *Academic journal articles on-line.* Those systems such as TULIP [19], JSTOR [18], Red Sage [21] and NACSIS-ELS [1], provides user with a collection of academic journal articles. The users can find the journal articles by retrieval on a bibliographic dataset and/or full text retrieval, and read page images of the articles with their local browser.

2.1.3 *Electronic texts.* Electronic text centres [22] provides users with electronic text databases. SGML is widely used to produce high quality electronic texts. The Interspace at UIUC [17] has an SGML-based collection consisting of articles from engineering and science journals and magazines.

2.2.4 *Non-textual materials.* There are various projects working on non-textual materials, i.e. maps, photographs, manuscripts, motion pictures, audio and visual records, human body, remotely sensed data, and so on. For example, the Alexandria digital library at UCSB is developing a large collection of spatially-referenced data [16],

the Informedia at CMU develops an interactive online digital library of audio and video information [15].

2.2.5 *Integrated information environment at university libraries.* The Internet is one of the core information resources for researchers and students in universities. This fact implies that university libraries will have to provide an integrated information environment where users can access both digital and non-digital (conventional) information resources. The Media Union at the University of Michigan provides users with the integrated space for digital and non-digital sources of information.

Digital libraries are a repository of various types of digital information, and, in addition, they must provide users with an integrated environment to access information effectively. Crucial points for effective information access in the digital library learned from conventional library information systems (LISs) and WWW as follows:

- User interface functions of conventional LISs is poor, since LISs have been developed in a character-based environment.
- Meta information schemes for conventional LISs such as OPACs do not make sufficient use of graphical and multimedia oriented functions for information access that are quite helpful for users.
- The current Internet environment is very poor for information access and browsing of documents written in languages other than English.
- Functions to seamlessly navigate users to appropriate documents which may be digital or non-digital are essential.
- Since librarians are an important information resource in a library, users connected to the digital library via networks will want to ask reference questions to the librarian.

These points are mainly concerned with user interface technology. The technologies which help a user intuitively understand the information presented to them, e.g. information visualization and computer supported collaborative work, will be effective to improve information accessibility in the digital library. The next section discusses several aspects of information technology that enhance the accessibility to information in the digital library based on these points.

2.2 *Information technology to enhance accessibility to information*

2.2.1 *Library Metaphor and OPAC.* The library metaphor is important for designing user interfaces of information access support tools. The following paragraph describes the typical behaviour of a user in a conventional library.

Consider a user in a typical library. He would search for a book using an OPAC terminal, find a book and go to a bookshelf designated by the OPAC. Then, he would locate the book on the bookshelf and pick it up to browse it. In some cases, he would find another book on the bookshelf which is more suitable to his requirements than the retrieved one. In the case he cannot find any book suitable to his requirements at the bookshelf, he would go back to the OPAC terminal or consult with the reference librarian concerning such problems.

Conventional OPACs have been built for character terminals. They have a command

line-based user interface and/or a screen-based user interface. New user interfaces of OPACs on WWW are a kind of the screen-based interface, which indicates to users the parameters required for retrieval and displays retrieval results as a sequence of bibliographic data. Multi-window-based graphical user interface technology is helpful for OPAC users since they can keep the result of each retrieval in a window and see multiple windows at the same time to compare their retrieval results.

2.2.2 *Use of metadata and navigational tools.* Metadata, which is 'Data about data' or 'Information about information', is the most important component of digital libraries, because information retrieval tools and user interfaces depend heavily on the organization of metadata. Visualization of metadata is the crucial point in creating tools which help users find information in a large information space.

It is not easy for novice users to select appropriate terms and phrases for information retrieval. In this case, the thesaurus, which defines a space of terms and phrases that are semantically controlled, is the important information resource that produces effective retrieval requests. For example, the Interspace at UIUC has a visualization tool of the INSPEC thesaurus [3]. Galaxy [6], a user interface for finding news articles, provides a visualized space of terms and phrases where a user can move around looking for these terms and phrases to find a document.

Metadata defines a set of aspects that defines data. A set of data can be seen from multiple aspects, e.g. sorted by author name, sorted by category, and so on. Morohashi *et al.* [4] describe an information retrieval system with an information visualization function to show a set of data from multiple points of view.

2.2.3 *Browsing documents.* The systems supporting online academic journal articles provide users with functions to search academic journal articles and browse them on user terminals. SGML-based electronic text systems also have similar functions for retrieval and browsing. The functions for accessing and browsing documents must combine seamlessly for users to be able to go back and forth between the retrieval and browsing functions.

2.2.4 *Collaboration support.* Library users ask various kinds of questions at a reference desk in a library. Thus, the librarian is an important information and knowledge resource. The library is a place not only for studying alone but also for doing group work. Collaboration support systems are useful for a user who needs a librarian's assistance or is doing group work in the library environment.

2.2.5 *Internationalization and multi-lingual functions.* A library is inherently multi-lingual. Even a small library in a small town has holdings written in foreign languages and/or classic languages, and therefore every library information system must be able to handle multi-lingual data. Digital libraries are vital for the worldwide sharing of information and knowledge. However, an applicable multi-lingual computing environment has not been developed for conventional computer systems and the Internet. The WWW browsers, such as Netscape Navigator, are de facto standard user interfaces for information access via the Internet. Those browsers, however, have localized implementations in each place around the world, e.g. Japanization in Japan.

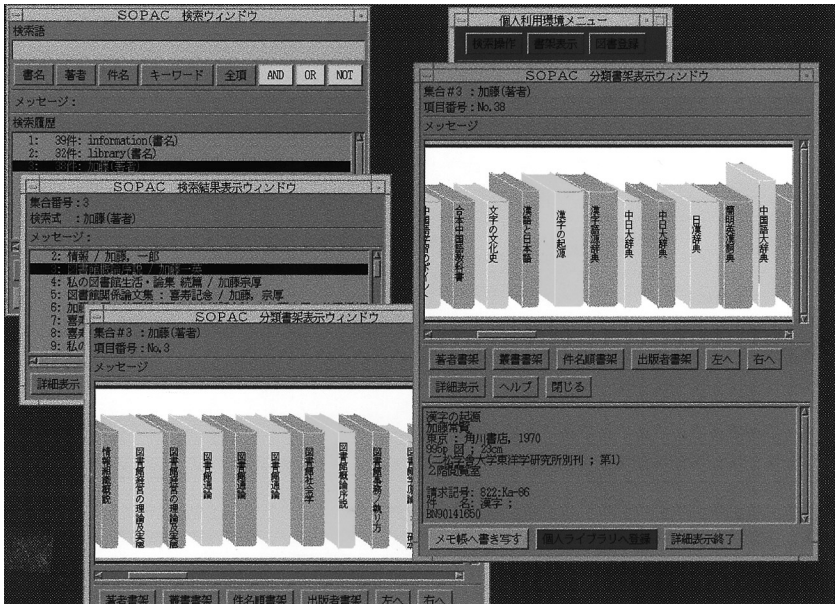

Figure 1. A Snapshot of the SOPAC GUI.

3. Experimental studies

Based on the discussions above, this section shows five experimental systems which are designed to enhance accessibility to information in the digital library:

- an OPAC with a bookshelf-like interface,
- a book selection assistance system for children's books,
- an information visualization tool for characteristics of children's books,
- a collaboration support system and its application to a reference work, and
- a multi-lingual browser for WWW documents which requires no multi-lingual fonts in a user environment.

3.1 *OPAC with bookshelf-like interface*

An OPAC is an essential aid for users to find documents in a library, a bookshelf is a nice place to browse the library collection. From these considerations, the authors developed an OPAC, named SOPAC, which has a bookshelf-like interface for bridging the gap between OPACs and bookshelves [11].

3.1.1 *SOPAC–OPAC with bookshelf-like interface.* SOPAC has been implemented based on the client–server model on a UNIX workstation which has the Motif GUI environment. The database of SOPAC is copied from the database used by the OPAC running in ULIS.

Users communicate with SOPAC via multiple windows. A snapshot of the SOPAC GUI is shown in Fig. 1. This GUI includes the following windows:

Figure 2. Bookshelf window.

- Retrieval Command Window—accepts retrieval commands as well as set operations AND, OR, and DIFF for intersection, union, and difference operations on retrieval data.
- Result Window—displays retrieved data. Users can get detailed bibliographic data of a member of the list on the Detailed Information Sub-window.
- Memopad Window—for user annotation.
- Bookshelf Window—browse a portion of the bookshelf by designating a book on a result window. A bookshelf image of the designated book and its neighbouring books is displayed. The order of the book images is primarily determined by the call numbers of the books.
- Detailed Information Sub-window—all of the bibliographic information of a book which is selected on a result window or a bookshelf window.

Users can browse a bookshelf by clicking the Display Bookshelf button to open the window shown in Fig. 2. SOPAC displays a bookshelf with the book highlighted on the Retrieval Window and placed in the centre. The order of books is the same as that on a physical bookshelf. The order is determined by the unique identification number given to each book and users can scroll the bookshelf horizontally.

Each book image is a push-button to request detailed bibliographic information, which is displayed on a Detailed Information Sub-window attached below the bookshelf window. The shape of a book image is determined by the bibliographic description of

the book, i.e. height and number of pages. The book title is presented from top to bottom and can be vertically scrolled.

3.1.2 *Discussions.* From the experience on SOPAC, we learned the following points:

- This kind of OPAC has potential to work as a 'virtualized library' if it has active information such as 'this book is checked out' and 'in bindery'.
- It has potential to create a 'personalized collection' if it has a function to re-organize bookshelves in accordance with semantical requests from users.
- The multi-window interface is user-friendly. However, a WWW-based interface is required for remote users off campus and for those who have no Motif environment.

3.2. *Image-based user assistance for children's book selection*

The authors had developed a knowledge-based system to assist book selection for children using multimedia [8,10,12]. The system described here is implemented on WWW using Java based on the knowledge-base of the previous system. [This system has been developed as a part of the children's digital library at NDL.]

Children's books include picture books for infants and novels for elementary school students (first through sixth grade). The picture books are mainly stories. The key points of the system design are as follows:

- Classification: books are classified in each of the categories, i.e. background, leading character, impression, and subject. Vocabulary in each classification category is controlled and has a limited number of terms because every term is represented as a component image in the images for user interaction.
- Image Intensive User Interface: graphic images are primarily used for user interaction since young users may not read written messages. Narration is accompanied with the image.
- Navigation: a user does not input any textual retrieval command but instead selects a favorite place (background) and a favorite person/animal (leading character) displayed on the screen. This feature is intended to draw user's interests.

Classification of the books in each category is given by adult readers. The number of vocabulary in each category is limited since the number of image components displayable on a screen is limited and the book selection process must not be long. Table 1 shows the categories and the vocabulary.

Figure 3 is a book selection flow for picture books. (Note: these images are included in the children's digital library at NDL.)

Step 1: The system (S) shows an image that includes all of the primary backgrounds. A user (U) selects a favorite place in the image.
Step 2: S shows a secondary background image, and U selects a favorite place in the image.
Step 3: S shows icons of leading characters on the selected backgrounds, and U selects one.
Step 4: S retrieves books from the database and shows a list of cover pages and titles. U selects a favorite one.
Step 5: S shows a set of information about the selected book, which includes a large cover page, a set of bibliographic data, and a brief introduction of the book.

Table 1. *Categories and vocabulary*

Picture books	
Categories:	
Background	
primary	secondary
sea	
town	downtown, home, school, zoo
countryside	mountains, village, wood
castle	
vehicles	
Leading characters	
boy, girl, gentleman, lady, dog, cat, elephant, king, mouse, rabbit, hippo, train, fox, cow, monkey, duck, princess, house, vegetable, doll, crab, hedgehog, grandparent	
Novels	
Categories:	
Subject:	
friendship, animals, love, war, growth, nature, humor, adventure, life	
Impression	
bright, warm-hearted, wonder, lively, sad, imagination, serious, refreshing, powerful, thrilling, gentle, funny	
Backgrounds	
primary	secondary
sea	island, boat
mountain	woods, villages, river
town	school, home
Characters	
boy, girl, animal, chair, doll, thief, father, mother, grandfather, grandmother, pirate, dwarfs, witch, gentleman, lady, mermaid, teacher, fairy	

In the case of the novel selection, a user firstly selects an impression or a subject, and continues these steps. The selection history is displayed on the screen as a series of iconized images of each step. The user can select one of the icons to jump back to a certain point, e.g. from step 4 to step 2. Texts displayed for the picture book selection are mainly written in Hirakana. [Hirakana is a set of Japanese phonetic characters. Kanji means Chinese characters used in Japan. Children first learn Hirakana at kindergartens and elementary schools.] Words written in Kanji are accompanied with Hirakanas for children who do not know Kanji.

The user interface is developed on WWW using Java applets for sound messages and animation control. The bibliographic records and introductory statements are encoded in SGML. The system currently has about 300 titles including both children's novels and picture books.

3.3 *Visual representation of characteristics of children's books—a statistical approach [13]*

Library users, who are not looking for a specific book, often walk around the bookshelves to find something interesting; for example, a happy story of boys and girls, a family

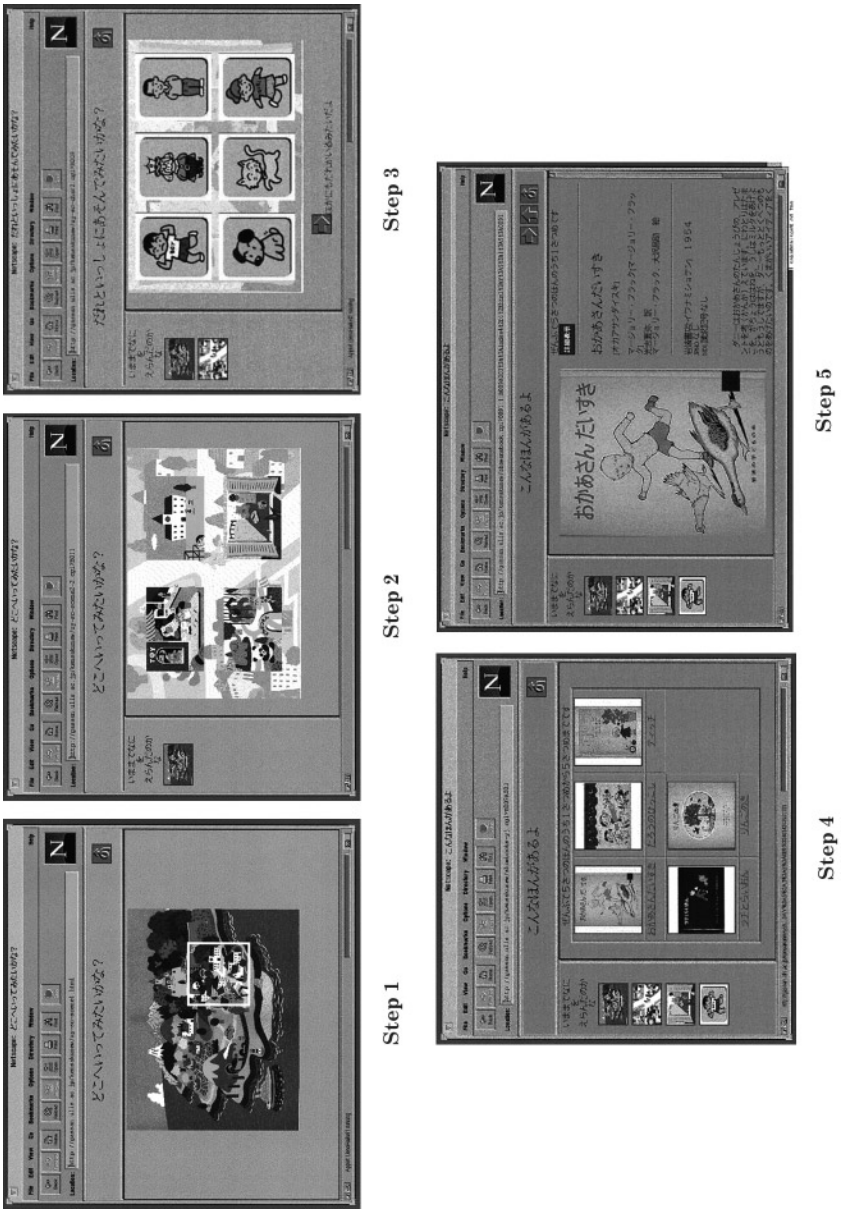

Figure 3. A book selection flow for picture books.

Table 2. *Developmental tasks*

1.	Brightness, cheerfulness
2.	Humor
3.	Patience, perseverance
4.	Basic rules for daily life
5.	Independence
6.	Love for family
7.	Love for others
8.	Respect for others
9.	Imagination
10.	Curiosity

story during a war, and so on. A book list which includes a list of introductory statements accompanied with bibliographic records of books is helpful. Since a book list has a large volume of information, a user has to search books based on their requirements in the list. However, this requirement would be hard to express for the user. For this type of user, intuitiveness is the most important aspect, since the book selection assistant system has to draw their interest or help them find their favorite topics.

This section shows an information visualization of characteristics of children's books based on the principal component analysis. The data used in this experiment is obtained by evaluation of children's books by a reviewer from the viewpoint that a book contributes for the development of a child in every category of the developmental tasks listed in Table 2. A reviewer of a book gives one of the scores, A = strong, B = medium, C = weak, for each category. This evaluation is done on 100 books.

Each book is represented as a 10-dimensional vector, $<x_i> = (x_{i1}, \ldots, x_{i10})$, where each element is a score of every category of the developmental tasks. Figure 4 shows the two dimensional representation of the result of principal component analysis carried out on the 100 book vectors. The x- and y-axis are the first and the second principal component, respectively. The following paragraph is the detail of the analysis.

An element x_{ij} of a book vector, $<x_i> = (x_{i1}, \ldots, x_{i10})$, is one of the values, 1.0, 0.5, and 0.0, which corresponds to the scores A, B, and C, respectively. The jth components of all of the book vectors are normalized so that their mean and variance are 0 and 1, where $j = 1, \ldots, 10$. The plane created by the first and second principal components obtained by the analysis is called the development task plane. A 10-dimensional vector called a task vector, $<y_j>$, is given to represent a developmental task category. A task vector $<y_j>$ is $(0, \ldots, 1, \ldots, 0)$ where all elements except jth element is 0, and jth element is 1. 10 task vectors $<y_j>$, $j = 1, \ldots, 10$, are projected to the developmental task plane. Every vector, $<x_i>$ and $<y_j>$, is presented as a dot on the developmental task plane, which is called a book point and a developmental task point, respectively.

Suppose a parent wants to make their child read a book which is good for developing a sense of humour. There are two alternatives to get a list of books. One is to click on the developmental task point for humour (point #2 in Fig. 4). The system displays the task plane which shows only the task dots and book dots of the books scored A in the humour category. The other way is to click in one of the rectangles, in this case the

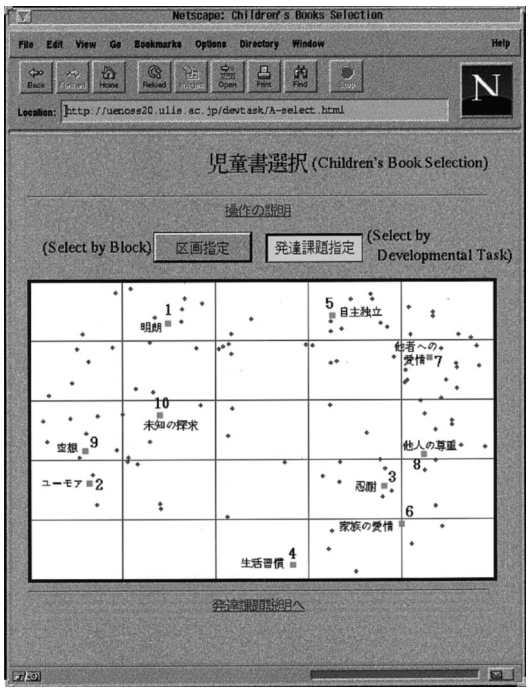

Figure 4. The two dimensional visual representation of book characteristics based upon principal component analysis.

rectangle where the humour point is placed. The system shows a list of books included in the rectangle.

3.4 *Collaboration support system for library users*

3.4.1 *Overview.* A librarian is an important information and knowledge resource in a library. The authors experimented with an application of a collaboration support system (CSS) for a reference work by a librarian. The task is for a librarian to teach a user how to use a GUI-based OPAC via the CSS [11].

The principal tools of the CSS, which provides the communication path between the librarian and the user, are the TV-phone and the shared virtual display:

- TV-phone: the TV-phone displays real time video pictures taken by a video camera at the workstation. The captured image is digitized and transferred through the LAN. Sound communication is half-duplex, requiring a talk control panel to switch talking direction.
- Shared Virtual Display (SVD): SVD is a window which realizes a virtual display where multiple windows are displayed and input/output operations are performed on them. The participants share the virtual display where the user can see every operation by the librarian, and *vice versa*. This feature is crucial in order to enhance the quality of communication between the participants; that is, a participant needs

to view all operations performed on the terminal of the other participant (for example mouse movement, mouse clicking, etc.).

3.4.2 *Experiment and evaluation.* The following is the scenario of the instruction:

1. The librarian (L) explains a retrieval window.
2. L shows a simple retrieval operation to the user (U).
3. L shows and explains the result window where the retrieved result is displayed.
4. L copies the contents of the result window into a Memopad window, and explains its usage.
5. L explains and shows an example of a composite retrieval which implies AND, OR, and NOT operation.
6. L shows the result.
7. L explains the operation to terminate the OPAC.
8. U does a simple retrieval and displays its result with assistance by L.
9. U uses a scratch window with assistance by L.
10. U does a composite retrieval and displays its result with assistance by L.
11. L asks U whether U has any questions about the usage.
12. L tells U to do practice until U is satisfied.
13. U says Good-bye.

(Note: The OPAC has a retrieval window to input retrieval commands, result windows to display retrieval results, and scratch windows to make personal annotations.)

Thirty users performed the task in the scenario given above using two remotely placed workstations (CSS instruction). They were asked to fill out a questionnaire shown below before and after the experiment. For comparison, four users received instruction in the same task from an instructor sitting next to the user in front of a workstation (in-person instruction).

Questionnaire (Definitely Yes: 5—Definitely No: 1)

[Q.1] Are you familiar with using keyboard and mouse?
[Q.2] Was the talk button easy to use?
[Q.3] Was it easy for you to hear the librarian?
[Q.4] Did you smoothly communicate with the librarian via TV-phone?
[Q.5] Was it easy to understand the instructions pointed out by the mouse cursor?
[Q.6] Was it easy to follow the librarian's operations?
[Q.7] Did the librarian understand what you said through TV-phone?
[Q.8] Do you like to learn about the OPAC via this collaboration support system better than learning about the OPAC beside the librarian using one terminal?
[Q.9] Did TV-phone and SVD work together well?
[Q.10] Do you think this kind of system is advantageous under a LAN environment?

All of the participants were students of ULIS. About 20% were novice users of workstations, not familiar with a mouse or GUI-based applications. All students had learned information retrieval with the ULIS-OPAC on a main-frame with a character user interface. Not all of the students had learned the OPAC used in this experiment.

Responses to the questionnaire on usability of the system are summarized in Table

Table 3. *Responses to the questionnaire*

Question	5	4	3	2	1	Total
Q.1	6	10	8	2	4	30
Q.2	7	10	8	4	1	30
Q.3	1	5	8	14	2	30
Q.4	5	8	7	10	0	30
Q.5	16	12	1	1	0	30
Q.6	15	11	2	2	0	30
Q.7	12	10	6	2	0	30
Q.8	7	7	13	3	0	30
Q.9	8	16	5	1	0	30
Q.10	16	10	4	0	0	30

Table 4. *Minutes for instruction by librarian using the collaboration support system*

Minutes	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Persons	1	0	2	0	5	2	4	4	4	2	3	2	0	0	0	1

Table 5. *Minutes for in-person instruction*

Minutes	10	11
Persons	2	2

3. Response to the system was mostly positive, and criticism was due mainly to the low quality of the TV-phone, such as poor sound, image size and frame rate, and half-duplex communication. Since such criticism was mainly of the performance rather than structure, these problems can be solved in future high performance networks and computers.

Instruction time required using the network CSS is summarized in Table 4, and using in-person instruction in Table 5. The average instruction times of the CSS and the in-person groups are 16.8 and 10.5 minutes, respectively. The fastest and slowest times of the CSS group are 10 and 25 minutes, respectively. The instruction times of 26 CSS users (87%) are between 14 to 21 minutes, and the median is 17 minutes. The instruction time of the CSS group has a wide range compared with the four students of the in-person group.

We attribute the difference between the two groups to the fact that the CSS students had to learn two systems, the OPAC and the CSS, since the experiment was the first experience to use the CSS for all of them, and some were novice users of workstations.

We feel that the difference in instruction times between the two groups is reasonable and acceptable, because all users learned to use the OPAC without going to the librarian's desk at a cost of only 7 additional minutes.

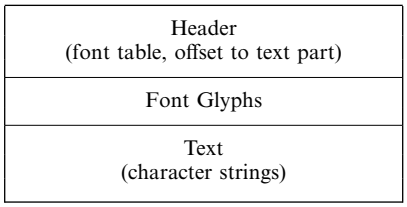

Figure 5. Scheme of the MHTML Document.

3.5 *Multilingual document browser*

A multi-lingual browsing environment is an important tool for making information in a digital library accessible worldwide. This section presents a multi-lingual HTML document browser which does not require built-in fonts for multi-lingual documents. An experimental application of this technology to an OPAC is also given in this section.

3.5.1 *Technological barriers for multi-lingual document exchange on WWW.* The following are some of the problems involved with the internationalization of the WWW:

- Conventional operating systems are not designed for multiple character code sets.
- Even if the international standard code sets for multi-lingual documents like ISO-10646-1 (Unicode) and ISO-2022-JP-2 are accepted, finding and installing fonts for the code sets presents both technical and economical problems.
- Some minor and ancient languages will never be included in any standard code sets. Rare characters or newly created characters may be added to a standard character set.

The primary function for multi-lingual documents is a browsing function from the viewpoint of the digital library. The problems above led the authors to design a multi-lingual document viewer which requires no multi-lingual font sets in a client environment. The simplest way to display a document containing unknown characters on a remote computer terminal is to send a bitmap image of the document to the terminal, which is created page by page, line by line or character by character. However, this image-based method involves very heavy overhead for transferring the documents. In our method, called Multi-lingual HTML (MHTML), a gateway server located between a WWW server and a client transforms a document into a package containing the text string of the document and the minimum set of font glyphs for the string, and sends the package to the client. Comparison between the image-based methods and ours and technological details of the MHTML document viewer are described by Sakaguchi *et al.* [9].

3.5.2 *Multi-lingual HTML document viewer.* Figure 5 shows the scheme of the MHTML document, which contains the header, a sequence of character strings encoded based on the MHTML encoding scheme, and the minimum set of font glyphs to make the characters visible on the terminal.

The MHTML document viewer is composed of the MHTML gateway (MG) and an applet for displaying MHTML documents running on a client's WWW browser. MG receives a request message with a URL from the client directly or via the applet to get

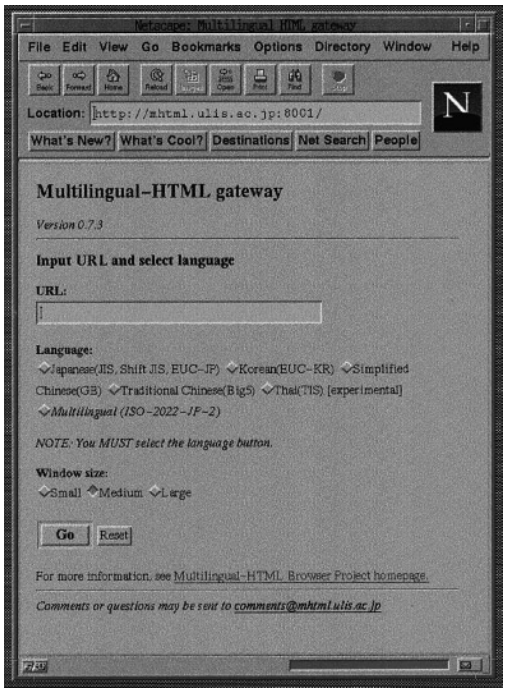

Figure 6. Snapshot of gateway page.

a document, gets the requested document, transforms it into MHTML form, and sends it to the applet. Figure 6 shows the gateway page where a user can input a URL and a language of a requested document. This page is also invoked when the user clicks on an anchor in the document displayed on the applet. In this case, the URL window is filled with the URL of the requested document. Figure 7 shows a multi-lingual document displayed by the applet.

3.5.3 *MHTML-based user interface for OPAC.* The authors have experimentally implemented a user interface for OPAC using the MHTML technology [2]. A user can input a retrieval word in Roma-ji from a retrieval window, which is Roman representation of Japanese, or in English. If the word is input in English and a toggle button on the retrieval window to use an English–Japanese dictionary is ON, Japanese terms for the English word are shown on an external MHTML viewer and the user selects an appropriate one from the viewer. Retrieval results are also shown on the external MHTML viewers. Figure 8 shows a snapshot on a user terminal which includes the retrieval window and MHTML viewers showing Japanese terms translated from an English word and retrieval results. This system is helpful for a user who wants to use a Japanese OPAC from foreign terminals. It also has the advantage to display special characters on a remote terminal which are not included in the standard character code set at the terminal. [These special characters are usually displayable only on terminals where the font glyphs for the characters are locally defined.]

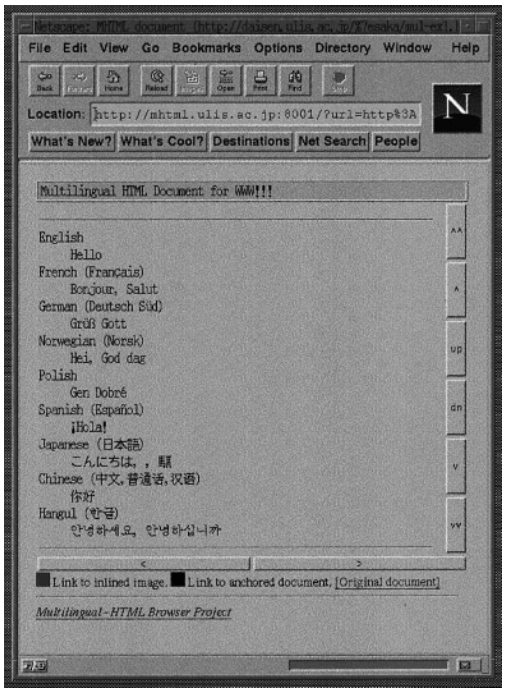

Figure 7. A multi-lingual document displayed on the applet.

Figure 8. Snapshot of display.

4. Concluding remarks

Through the rapid expansion of the information network on the Web, the Internet community is becoming larger and larger and various types of new users are joining the Internet community. Conventional libraries have been serving their holdings and information to various users. Digital libraries will have to serve these constituents as well. The digital libaries will have sophisticated tools for information retrieval and digital collection management. The authors believe that accessibility to information in the digital library is greatly enhanced by user interface tools which are intuitively understandable and usable for novice users.

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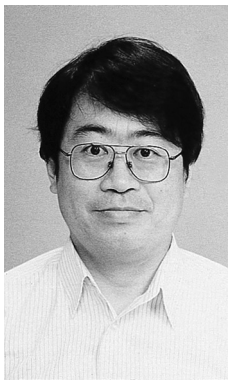
17. Illinois Digital Library Initiative Project, http://www.grainger.uiuc.edu/dli/
18. Start JSTOR, http://index.umdl.umich.edu/jstor/
19. TULIP at Michigan, http://tulipsrvr.engin.umich.edu/tulip/
20. Library of Congress World Wide Web (LC Web) Home Page, http:/lcweb.loc.gov/homepage/lchp.html
21. The Red Sage Home Page, http://redsage.ucsf.edu/
22. Directory of Electronic Text Centers, http://www.ceth.rutgers.edu/info/ectrdir.html



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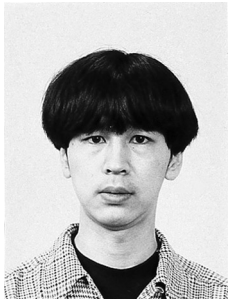

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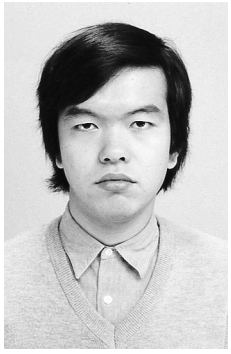

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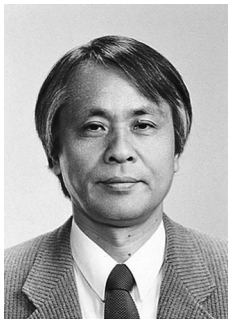

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