

A Novel Library System

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Abstract

In this paper, we propose a novel library system using images of the books and borrower's face. The images of books to be lent are recorded in the lending list. The images of books being returned are identified from a list of lent books by processing the images of the book and the users face. To obtain high performance, we use features extracted from low resolution book cover images to identify the book. We use partial feature to distinguish books of series. We also developed a system which used world wide web technology to get a user-friendly interface. The experiments showed this system to be possible.

1 Introduction

A library system needs to handle borrowing and returning of books, magazines, etc. With the advent of computer technology, a library system using computers has come true. The words "electronic library" are known to a wide public[1].

Administration at existing libraries is as follows. The librarians affix a sticker to every book. This sticker is written as an ID code, such as a bar code. Then, an ID card is issued to every user. For borrowing and returning, a librarian records the ID code of the book and the ID card which is shown by the user. This is borrowing and returning based on an ID card, not the user. If a third party impersonates a borrower using the same card, the system does not know who is borrowing and returning the book.

There are many tasks involved in introducing a conventional administration system to an existing library, such as affixing the ID stickers to every book, and issuing ID cards to every user.

A conventional administration system is used at large scale libraries, because this system always needs a librarian in charge of borrowing and returning. Moreover, almost all library systems are based on the test. However, today's media has not only the test, but also

includes image, audio and video. It is necessary to make a new library system for multimedia.

In this paper, we introduce a novel library system using images of books and borrower's face for a small scale library, such as the reference room of a laboratory in a university. This system does not need to affix ID stickers to the every book, nor issue ID cards for every user. It also does not always need a librarian. The system can automate the administration of borrowing and returning in cooperation with the user.

For classification, the images of the book covers have been used[2]. Dr. Hull has presented the similarity of document image for document analysis[3]. Our system uses the cover image to administer the borrowing and returning. The images of lent books are recorded on the lending list. A returned book is identified from a list of lent books by processing an image of the book cover and comparing it to books that have been lent. The identification method uses low resolution features. Therefore, the processing speed is fast. This system uses a correlation for similarity of cover images.

The distinction of similar books, such as books of series, is difficult. For example, the difference between these books is only a volume number. In this case, one solution is reading a volume number using character recognition. Character extraction methods from book cover image have been presented[4],[5]. The four directional feature has been presented for character recognition[6]. The characters of the book covers include designed fonts and symbols. These diversities of the book covers are disadvantages for segmentation and recognition of the characters, but these are advantages for our method that uses partial features.

For distinguishing among the serial books, we use the partial feature method which does not use character recognition. First, the partial images are segmented from book images. The similarity between each partial images of lent books and returned books are calculated. If some parts have low similarity, these parts have important information which enable it to be distinguished from similar books. The obtained parts have important information which can identify the details of a serial

book.

The recognition of a face is very important for identifying the person[7]. Several schemes for face recognition have been reported[8],[9],[10],[11]. In our system, human identification is an auxiliary measure of the administration because a substitute person can return the books. However, this system can administrate the borrowing of books and the users, because the images of books and the borrow's face are recorded at the same time. Recording the face images hopefully gives users more motivation to return the books. If they are returned late, a librarian confirms the lent books and users on a browser.

We also developed a system which used HTTP protocol to get client-server model. So this system can be applied to different platforms. Further we also adopted a touch screen to obtain a user-friendly interface.

2 A Library System

Overview of the user friendly library system is shown at figure 1. This system consists of a camera or an image scanner that captures a book image, a camera that captures the user's face image, a computer that administrates the lending and the returning using image processing, and a browser on a monitor. If possible, it also contains input devices for secondary information such as weight and size of book. Figure 2 shows the opening screen of the library system.

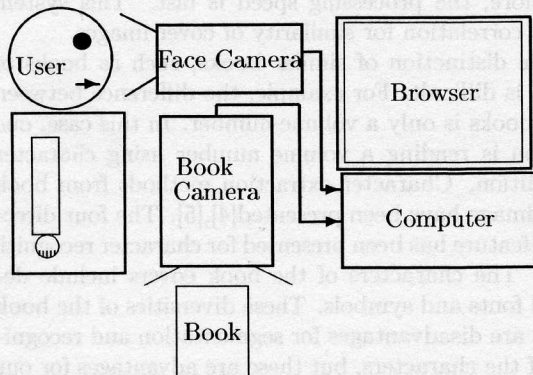


Figure 1: A Novel Library System.

2.1 Lending Process

A user pushes the function button first, and then, faces the front of camera, and presents a book to be borrowed. A system captures a cover image of this book

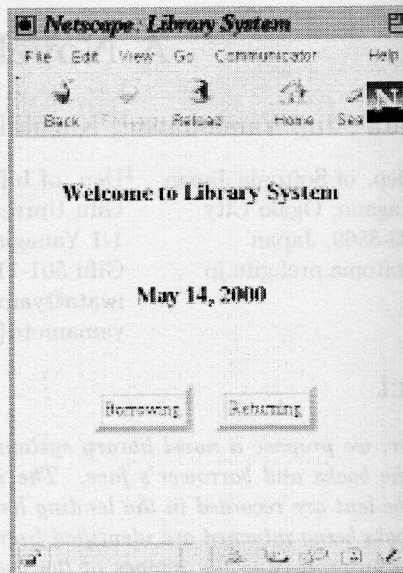


Figure 2: Opening Screen.

using a camera or an image scanner. If possible, the system gets information such as the size and weight of the book. A face image of the user is captured at the same time. Figure 3 shows a screen capture when the lending is accepted. The system shows the captured images for the user on the browser.

The low resolution features and the partial feature are extracted from the cover image. These features are used for the identification of the books and users when the book is returned. The partial features are used for identification

The obtained images, features and other information are recorded on a lending list, such as Figure 4.

2.2 Returning Process

A user faces the front of the camera and presents the borrowed book in the same way as in the lending process. If a system accepts these images, the return process is completed.

The system refers to a lending list using the images. Rough classification uses the sizes and the weights. The similarities between a presented book and all lending books are calculated. If there are several similar books, the system compares them using detailed partial features.

Next, the system identifies the person returning the book and compares the image with the image of the person who borrowed the book. If a substitute returns the book, face identification is failed. In the case of

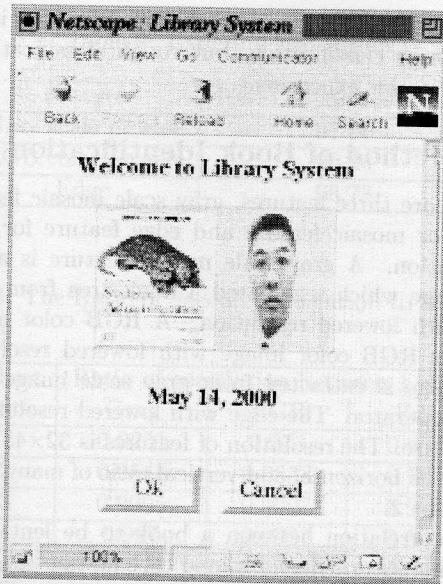


Figure 3: A Lending Acceptance.

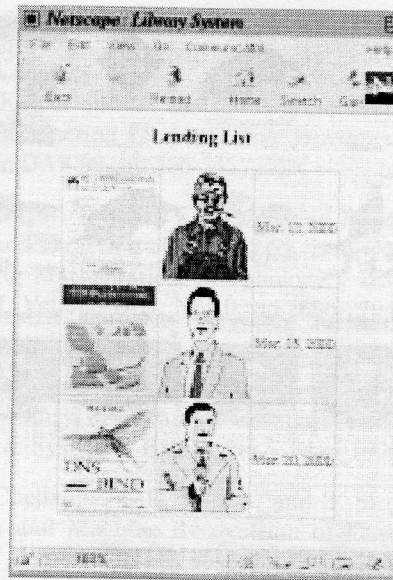


Figure 4: A Lending List.

substitute returning, the substitute input a name of a person who is borrowing.

Of course, the borrower returns the books to the same bookshelf from where it was borrowed.

2.3 Administration Process

The librarian can check the state of lending and returning on the browser. To administrate lending, the browser shows the books to be lent with the user's face images. The librarian can check the delayed return by searching the images which are sorted by lending date. If the return is late, the librarian can tell using a face image.

If multiple copies of the same book are lent and only one is returned, the system can use the face images to find out who has and has not returned their books. If a substitute person returns the book, this system can be also known who is returning through a substitute.

Returning the books to the bookshelf is the user's duty. The user arrange books on a bookshelf the same as when borrowed.

3 Book Identification

In this system, the administration of lending and returning uses the cover images of books, not the ID stickers. First, a system does the rough classification using information such as size and weight. Next, the system identifies the book using low resolution features. I will

explain about comparison of some feature extraction method, and discuss a suitable method for the identification of the books.

3.1 Experimental Data

Experimental data are the cover images of 82 books. These are captured by an image scanner. Every book is captured two times, an image of lending and an image of returning. These images are RGB color, A4 size and 75 dpi. The upper left of an image matches the upper left of the books. The data include four types of books as shown in table 1. Subset 1 shows a variety of books. Subset 2 shows the series of books whose color and shape are different. Subset 3 shows a series of book whose colors are similar, but the written characters on the covers are very different. Subset 4 shows a series which is similar and different is small areas, such as volume number. Figure 5 shows the sample books.

Table 1: Subsets of Experimental Data

Subset	Books	Contents
1	25	Various books
2	17	Series of books Color & Shape are different
3	26	Series of books Color is similar Characters are different
4	14	Series of books Difference is only volume numbers

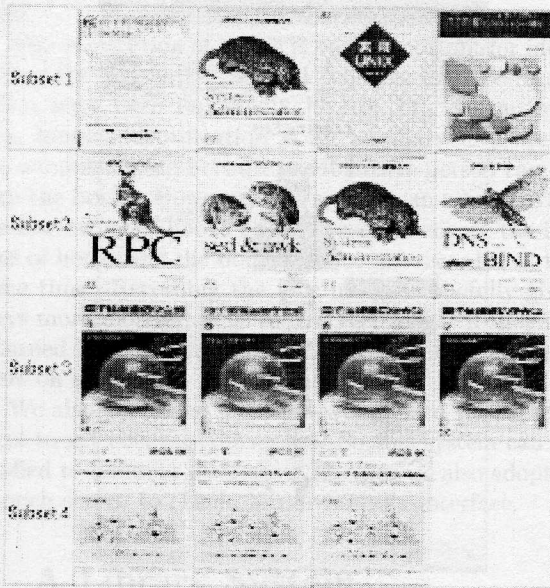


Figure 5: The Sample Books.

3.2 Segmentation And Rough Classification

The segmentation of book area from input image is the histograms of edge. It is defined that an input image is $I(x, y)$ and its size is (x_s, y_s) . A histogram of vertical neighbor subtraction, $H_v(y)$, is obtained by equation (1).

$$H_v(y) = \sum_{x=1}^{x_s} |I(x, y) - I(x, y + 1)| \quad (1)$$

A histogram of horizontal neighbor subtraction, $H_h(x)$ is also obtained by equation (2).

$$H_h(x) = \sum_{y=1}^{y_s} |I(x, y) - I(x + 1, y)| \quad (2)$$

A program traces these histograms from the bottom and right. If $H_h(x')$ and $H_v(y')$ are larger than threshold Th_v and Th_h , segmentation at x' and y' . The threshold Th_v and Th_h are obtained by equation (1) and (2).

$$Th_v = c_1 \max_{y=y_s-1-c_2}^{y_s-1} H_v(y) \quad (3)$$

$$Th_h = c_1 \max_{x=x_s-1-c_2}^{x_s-1} H_h(x) \quad (4)$$

For this experiment, we used $c_1 = 2.0$ and $c_2 = 40$.

The above obtains the size of the book which is useful for rough classification, but rough classification is not used in this experiment.

3.3 Method of Book Identification

We compare three features, gray scale mosaic feature, RGB color mosaic feature and edge feature for book identification. A gray scale mosaic feature is a gray scale image which segmented a book area from input image with lowered resolution. A RGB color mosaic feature is RGB color image with lowered resolution. Edge image is extracted from gray scale image using Prewitt operator. The edge with lowered resolution is edge feature. The resolution of features is 32×45 pixel, because the horizontal and vertical ratio of many books is 1 to root 2.

The correlation between a book to be lent and a book being returned is obtained by equation (5).

$$C = \frac{\sum_{n=1}^N F_l(n) F_r(n)}{\sqrt{\sum_{n=1}^N F_l^2(n)} \sqrt{\sum_{n=1}^N F_r^2(n)}} \quad (5)$$

where $F_l(n)$ and $F_r(n)$ are each feature of a book to be lent and a book being returned, and N is a dimension of feature. In gray scale mosaic feature and edge feature, dimension N is $32 \times 45 = 1440$. In RGB color mosaic feature, dimension N is $32 \times 45 \times 3 = 4320$.

3.4 Experimental Result

We compare three features for identification of the books. Table 2 shows a ratio that correct book has highest correlation. Using RGB color mosaic features are the worst result, and using edge features are the best. Table 3 shows the averages of the ratio of the second correlation to the first correlation. This table shows that edge feature is better than gray scale mosaic feature and RGB color mosaic feature, because the difference using the edge feature of second and first is clear. In the case of subset 3 and 4 using the edge feature, the second correlation is near the first correlation.

4 Conclusion

We proposed a new library system that needs neither ID stickers, nor ID cards. The administration only used image processing. The results of our experiment showed the potential of a system without ID stickers and ID cards.

Table 2: Experimental Result

Feature	Ratio of correct answer
Gray scale mosaic	97.56
RGB color mosaic	96.34
Edge	98.78

Table 3: The Ratio of Second Correlation to First Correlation

Subset Data	Ratio of correlation between 1 and 2		
	Gray	RGB	Edge
1	0.9251	0.973	0.6548
2	0.9548	0.9853	0.7613
3	0.9995	0.9997	0.9582
4	0.997	0.9987	0.9612
Total	0.9671	0.9884	0.8254

Since we developed this system using HTTP protocol, the system can not only be applied to various different platforms, but also get client-server model. The librarians can check the lending list through internet. Since we adopted a touch screen and opening screen, the beginners can easily use this user friendly library system interface.

Our feature work is improving the user interface used when a person other than the original borrower returns a book. For book identification, we will use various data which assume lending and returning. We will examine a suitable method of identification of a series of books.

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