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8—23 A Library System for Small-scale Library

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Abstract

In this paper, we explain a library system for small-scale libraries. This system uses books and face images for administration of lending and returning books. Users can borrow books by facing the front of the camera, presenting the book, and clicking the "Borrow" button. When returning books, users are required to click the "Return" button in the same way as on borrowing. The librarian can check the state of lending and returning on the Web browser. In the identification of books, a four directional feature that is in low resolution was used. To identify similar books, the feature which is cut the around part of book image, is used to distinguish these books. Face identification is used for easy administration. In this paper, we show that the four directional feature and cut feature are effective for book discrimination in experiments. The availability of face recognition for the system is also shown.

1. Introduction

In small-scale libraries, for example laboratories', there are many books while the users are relatively limited. Users in the library administer the lending and the returning of books. It is an easy way of administration, but it is very vague that nobody can know who borrowed and lent book.

In our research, we constructed a library system using the cover images of books and face images of users[1]. Our library system doesn't need the work of issuing ID cards to every user and putting ID seals on every book. The operations of our library system are very simple.

2. Overview of system

An overview of the library system is shown in Fig.1. The system consists of an image scanner for capturing a book image, a camera for capturing the user's face image, a computer for administration of the lending and the returning of books, and the Web browser, which is the human interface, on a monitor. Because the Web browser is adopted for the human interface, it doesn't depend on any operation systems.

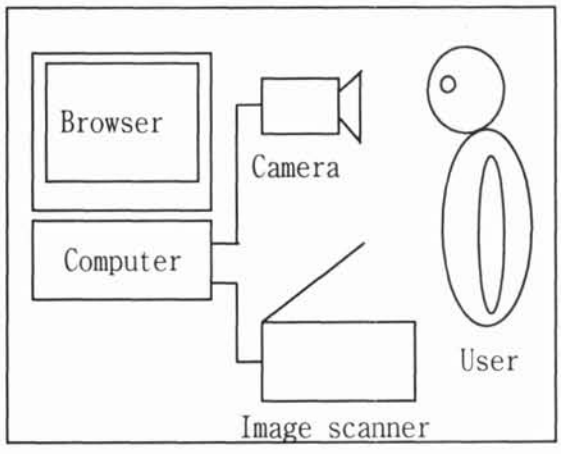


Fig. 1 Overview of system

2.1. Lending process

A user has to face the front of the camera and present a book to be borrowed. When the user clicks the "Borrow" button on the Web browser, the system captures the cover image of this book using the image scanner while the system counts down. A face image of the user is taken at the finish of the count down. Fig.2 shows a screen shot during the lending. The system shows the images taken for the user on the Web browser.

Lending data, which contains the obtained images, features and other information, is recorded on a lending list.

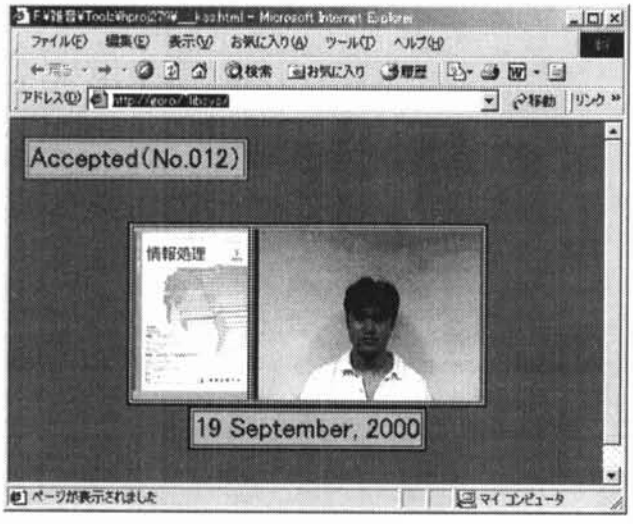


Fig. 2 Lending acceptation

2.2. Returning process

A user has to face the front of the camera and present the borrowed book in the same way as the lending process. The user clicks the "Return" button, and the system obtains an image of the user's face and a cover image of the book.

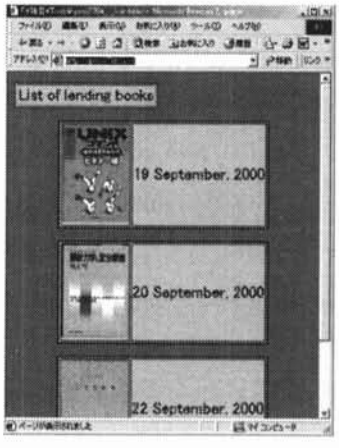
The system refers to the lending list using the images. The similarities between the presented book and all borrowed books are calculated. If there are several similar books, the system shows candidates and the user selects the book to be returned. A returned book is recorded on a returned list with the lending data. If the system accepts these images, the return process is completed.

The user returns the books to the same bookshelf from where it was borrowed.

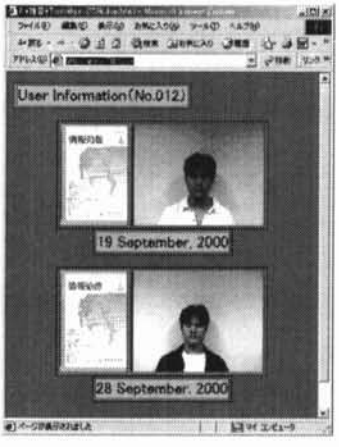
2.3. Administration

The librarian can check the state of lending and returning on the Web browser. A list of the cover images of the books is shown on the Web browser, as shown in Fig.3(a). The librarian can get the information of the user as shown in Fig.3(b) by clicking the cover image. The librarian periodically checks if any books are overdue by searching the list. If the librarian finds overdue books, then the librarian makes contact with the user.

This way, users and the librarian can use our library system with easy operations.



(a) List of cover images



(b) Information of user

Fig. 3 Administration on the browser

3. Book identification

In our system, the administration of the lending and returning processes uses the cover images of books[2]. First, the system makes a rough classification using information such as size and weight. Next, the system makes the identification using low resolution features.

3.1. Segmentation of book area

We use an A3 size image scanner for scanning the cover image of the book. A scanned image is shown in Fig.4(a).

First, the book area is segmented from the input image using a Hough transform as shown in Fig.4(b).

The size of the book obtained by the previous process is useful for the rough classification. Another rough classification is made by the color information. The RGB color histogram is extracted from the book image.

3.2. Low resolution feature

The main component of book recognition is the low resolution feature. The low resolution feature has a good performance and a fast processing speed.

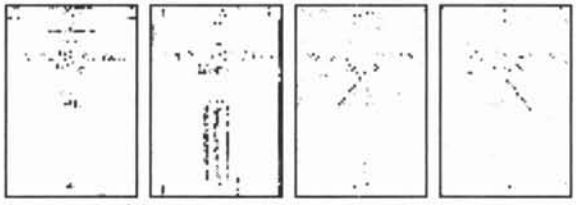
We compared two features: the edge feature and the four directional feature[3].

The edge image is extracted from the cover image. The edge feature is the edge image in decreased resolution.

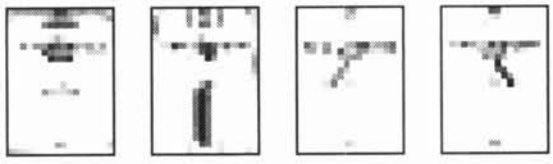
Horizontal, vertical, upper right and upper left edge patterns are extracted from the book image. Fig.4(c) is an example of a four directional pattern of a book image. The four directional feature is four directional pattern in decreased resolution as shown in Fig.4(d).

The resolution of features is 16×22 pixels, because the ratio of the horizontal to the vertical of many books is 1 to $\sqrt{2}$. The resolution was obtained by basic experiments.

(a) Scanned image (b) Segmented image



(c) Four directional pattern



(d) Four directional feature

Fig. 4 Feature extraction

The correlation between a book to be lent and a book being returned is obtained by eq. (1).

$$C=\frac{\sum_{n=1}^{N}F_L(n)F_R(n)}{\sqrt{\sum_{n=1}^{N}\{F_L(n)\}^2}\sqrt{\sum_{n=1}^{N}\{F_R(n)\}^2}} \qquad (1)$$

$F_L(n)$ and $F_R(n)$ are the feature of the lent and returned book, and N is a dimension of the feature. In the edge feature, dimension N is $16\times22=352$. In the four directional feature, dimension N is $16\times22\times4=1048$.

3.3. Cut feature

When we experimented on the library system, we noticed a problem of the results of some subsets.

They were books of a series and the results were very inaccurate. We researched them and suspected that there was some noise around the cover images of the books. Accordingly, we compared the method of using the image cut around the edges to the method of using the whole image. The cut area that was obtained by basic experiments is 25 pixels.

4. Experiments of book identification

4.1. Experimental data

Experimental data consist of the images of 210 books. These were captured by the image scanner. Every book is captured two times; an image when lent and an image when retuned. These images are RGB color, A3 size and 75 dpi. The data includes three types of books as shown in table 1. Subset 1 contains 90 books of various kinds. Subset 2 contains 80 books from the series, but these are not very similar. Subset 3 contains 40 books, which looks similar, but are different in a small area, for example, date or volume number, as shown in Fig.5.

4.2. Experimental results

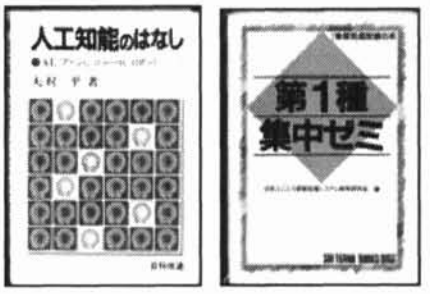
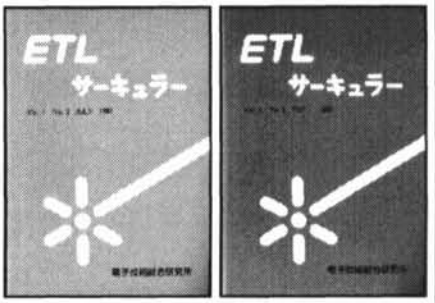
We compared three features for the identification of the books. Rough classification was not used in this experiment.

Table 2 shows the ratio of the correct book decided by the highest correlation. Using the edge feature, the results of subsets 1 and 2 were good, but results of subset 3 which are books of a series were poor. The four directional feature improved the result of subset 3 and total, but the low resolution feature has a limit of discrimination of books of a series.

Cut feature, which involves cutting around the edges of the cover image before extracting the edge feature or the four directional feature, shows good results. These results show that there is some noise around the cover images of the books and by cutting them, the cut feature method can discriminate between similar books of a series. The cut feature doesn't influence the results of subsets 1 and 2.

While identification of similar books of a series is difficult, the correct book is among the books with higher similarity. The system is designed that the user can select the correct books from the books with higher similarity.

Table 1 Experimental data

Subset 1	
Subset 2	
Subset 3	

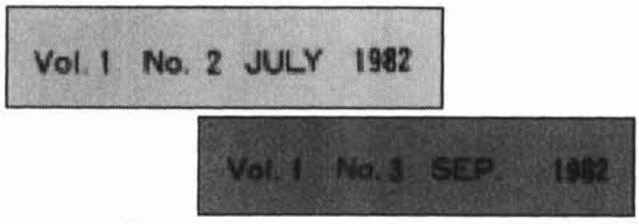


Fig. 5 Difference in small area

Table 2 Experimental results

	Subset 1	Subset 2	Subset 3	Total
Edge	100	100	80.0	96.2
Four direct.	100	100	82.5	96.7
Cut	100	100	97.5	99.5

Numerals are ratio of correct answer (%)

5. Face recognition

When the librarian finds a book that is overdue or some problems happen, the librarian needs to make contact with the users. If the librarian knows all users' faces and addresses, that is easy. If he or she doesn't, the librarian must look for them. In this case, the users need to register their faces and addresses. The users register their information by capturing their faces for 15 seconds and inputting their addresses. The librarian can find the information of a user by clicking the face image contained in the lending data or the returning data.

If a face image is clicked, the system refers to all images of registered faces and calculates the similarities between the clicked image and them. The system shows the face images with their information sorted by similarity. The librarian searches for the information wanted in the face images.

The recognition of a face is very important to identify a person. Several schemes for face recognition have been reported[4][5][6].

5.1. Segmentation face area

We used the R−B value for segmentation of the face region. The method of segmentation is shown in Fig.6.

First, the system searches the region of skin color by the R−B value and decides the width of the face region. Next, the system decides the height of the face region by eq. (2).

$$Height = Width \times 1.2 \qquad (2)$$

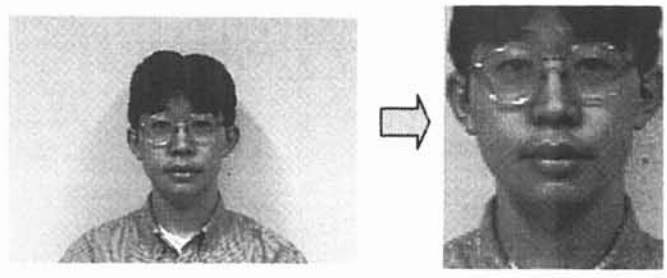


Fig. 6 Face segmentation

6. Experiments of face identification

We experimented on the case that someone had a book that was overdue and the librarian wanted to make contact with the user.

6.1. Experimental data

Experimental data consist of face images of 14 persons. Every person is captured two times; an image for registration and an image for the lending. They were captured for 15 seconds and the system obtained 200 frames of the face image. These images are RGB color and 320×240 pixels. The background is simple and the direction of the face is fixed.

6.2. Experimental results

We use the four directional feature for the identification of the face image.

Table 3 shows the order in the identification. If the system identifies correctly, the order is 1. The results show that the ratio of correct identification is 85.7%. While the face identification is difficult as compared with the book identification, the performance is usable enough for the system that the librarian searches for the information of the user.

Table 3 Experimental results

Person	Order	Person	Order
A	1	H	1
B	1	I	7
C	1	J	1
D	1	K	1
E	1	L	1
F	1	M	9
G	1	N	1

7. Conclusion

We explained a library system using the cover images of books and the face images of users for administration of lending and returning books. The users can use the system with easy operation, and the librarian doesn't always need to be there. The librarian periodically checks if the borrowed book is overdue. The librarian can get the information of the users by clicking the face images of the users. Our system is useful in the small-scale libraries such as laboratories'.

In the experiments of book identification, the edge feature and the four directional feature were compared. It was shown that the four directional feature had good performance. To identify the books of a series, the cut feature was effective. In the experiments of face identification, the ratio of correct identification is 85.7%. It is enough for the system with the librarian's support.

Acknowledgement

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Reference

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