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LIBRARY AUTOMATION SYSTEM USING OCR AND BIOMETRICS

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***Abstract*—the project is synergism and implementation of two technologies OCR and Biometrics. Both these technologies merged to issue and return book in library system. For the purpose of identification of books OCR has been used and for recognizing the user to whom the book will be issued finger print as biometric has been used. OCR has enabled scanned documents to become more than just image files, turning into fully searchable documents with text content that is recognized by computers. The result is accurate, efficient information processing in less time.**

The images will be captured and stored using the camera. We claim that our system will provide fast and accurate character recognition and can be deployed in a vast range of applications.

I INTRODUCTION

THE project consists of two portions OCR and Biometrics. OCR portion of the project will be used for recognizing library tags and biometrics portion of the project will be used for person identification. Whenever any user had to issue or return any book the required book and finger print of the specific person will be entered and then our system will be responsible for issuing or returning the book.

We name our setup and technique as Library Automation system using OCR and Biometrics. Our focus on this project is to develop a system which would help both management and users. Management would have ease of issuing and returning books and users will have ease as time will be saved while issuing and returning books. In the current scenario of the project picture of the tag on book will be taken and cropped. The OCR portion will separate and recognize the character and then will match the complete word in the data base, the biometrics portion will recognize the user to whom the book will be issued by taking fingerprint and matching it with the templates already taken. At the end an entry in the data base will be made in front of the matched character in the database to which the book will be issued. Our system is as cheap any libraRY CAN BUY IT VERY EASILY. VERY little hardware and the system will become functional [2].

II. THEORY

Review Stage

Basically we aim to implement such a system that could be placed in any environment and start issuing and returning items. But we used library for testing purpose because both and biometrics can be applied easily in library system.

OCR and Biometrics alone can also be used in a variety of projects but are merged in this project to get the required results. Once the book has been identified using OCR and user has been recognized using biometrics all the results will be stored in database with date and time which has already been connected with our algorithm. And at the end receipt will be issued using printer which will show the date till the book has been issued to this specific user till this date. There are two potions of this project which will be discussed in the following topics.

Image Acquisition

Whenever the user inserts the book in the system the first and important step is to acquire the best quality image. For this purpose 10MP Logitech camera is used which is considered as one of the best camera for acquiring images.

Continuously first 50 frames are captured and then last frame is selected which allows the camera to have a better autofocus upon the entered book's tag. The reason beyond this is camera takes some time for focusing upon the subject i.e. book's tag, the last frame is selected which has best focus for future processing and then this image will be sent to our software which will then do processing to identify and recognize tag.

Preprocessing

Once the image has been acquired the next step is to do some preprocessing so that OCR technique can be applied on that image. For preprocessing different filter are used and then the results of these filters are compared. Morphological filters were giving best result in preprocessing. So, morphological filters have been used as preprocessing.

Cropping tag

Once preprocessing has been applied and the image is ready. The next step is to crop the location of the library tag from the image. For this purpose two techniques were applied Hough transform and region properties and the results were tested. Now we will discuss a little about Hough transform and region properties.

Hough Transform

Firstly this function was implemented for segmentation purpose, Hough transform is used to detect the straight line in an image, and it uses the parameter of equation of line i.e.

Rho = x*cos (ø) +y*sin (ø)

As the tag area of the image has a rectangular shape, so the property of the rectangle is used to detect the tag. Each of the lines is compared with other lines and thus the lines that have same length and theta are found. This results in the tag image [8].

This implementation was not able to provide with good results because this implementation requires very high preprocessing (of the image) and edges are not always sharp enough to be detected which causes for a false result shown in figure 1 and figure 2.

Figure 1

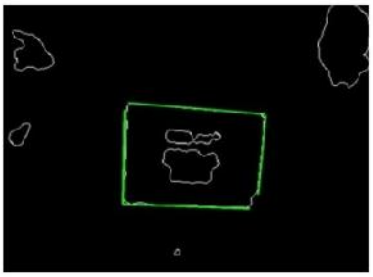

Figure 2

Region properties

Region properties is used to get the property of each connected area in the binary image, in which firstly edges of the image are detected then the most important part of this implementation is to subtract the edge detected by the previous image which remove the edges by making black lines there, then the min filter is applied to increase width of these black lines.

In region props property of connected objects found are

Area
Bounding box
Eccentricity
Extrema
Centroid

First of all the image is converted to binary image and different morphological operations are applied on this image such as shrinking of connected object and opening the binary image by structuring element in horizontal and vertical direction. Remove the area of connected object less than 6000 and then fill the holes between the connected object and the no. of connected objects are also found. Then this image is given to region properties to get different property of connected object. After the area open is used to delete the object less than 6000.

a) If no of connected component is 1, it will be selected as book tag (ROI) and cropped by bounding box parameters.

b) Else if connected component whose area is greater than 15000 and eccentricity is between 0.6 to 0.9 these component will be selected as ROI and cropped.

c) Else if the connected component which has centroid nears the center of image will be selected as ROI and cropped with the help of bounding box [6].

Character Enhancement

Character segmentation involves the following steps,

1) Character Enhancement

2) Finding area of text
3) Extracting character
4) Template matching

Character Enhancement

For character enhancement median filter is applied on the image for broken character and then is converted into the binary image.

Finding area of text

To find the area of text, from the bottom of image, each row is scanned and sum of each row is calculated, as text area have some white pixels, its sum is greater than threshold, the first row whose sum is greater than threshold to the row which has zero sums is extracted. It is the area of text as in figure 3(a), 3(b).

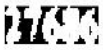

Fig 3(a) fig 3(b)

Extracting Character

One thing that all tags have common in our case is that they all have 5 characters. So for cropping the characters first in the text area thinning is applied and then if all the five characters are separated each character is separated by scanning each column and sum of each column is calculated, as a character has some particular area of black pixel and then space between the character has white pixel, hence a character is separated by cropping it from one region of threshold till the other and the white pixels are sparred and then next character is cropped similarly.

If two or more characters are merged, then the characters are cropped by using a predefine threshold value. Image is divided in two parts merge and the other. The same technique as discussed above is applied on the other part in which no characters are merging together and threshold is applied to the merge part.

Temple matching and templates

A template data base is created for each character from A-Z and from 1-9 for further matching. Each character is matched with the templates of characters and the character is decided which has maximum correlation.

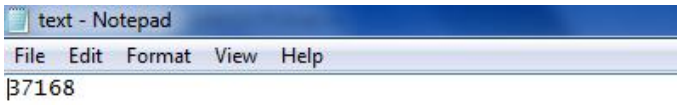

Fig 4

Extracted template

Storing result in Database

Once the data from book tag is recognized the final step is to store result in database, which is very important, as if the data is not stored properly in data base all the hard work of finding book tag is in vain. A number of databases are available it was very difficult to select a database, but after significant research and testing POSTRESSQL was chosen for storing results. There were number of reason behind choosing POSTGRES some of them are as follows,

1) POSTGRES SQL is open source database;
2) Connection with MATLAB can easily be made
3) It is believed that POSTGRES SQL can store unlimited records,

For storing the result in database, a query was used for sending all the identified results as OCR and fingerprint. Database check whether the book entered is already saved in database or not. If the book is not already saved in the database then database will make an entry of issued with current date. And if the book is already saved in the database the database will make an entry of return with the current database.

Printing the Receipt

Finally a chit is printed with the name of the book, to which the book is issued, issue date; last date till the book is issued. User can have the chit for record maintain or for any further use.

Biometrics

There are a number of biometrics traits that can be used for person's identification some of them are as follows:

1) Iris recognition
2) Face recognition
3) Hand and finger geometry
4) Vein geometry
5) Voice recognition
6) Signature
7) Fingerprint

We use fingerprint as biometrics because it provides accurate and efficient results as in figure 5.

Fig 5 Original Fingerprint Image

Our task in this portion was to use minutia information (x, y axis position of minutia) and transform this information in specific format that can be used for minutia matching on real time shown in figure 6.

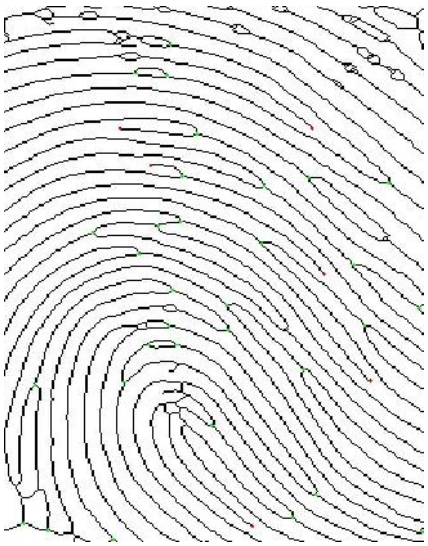

Fig 6 Minutia Extracted Image

For complete identification, we divide biometric portion into two parts

Creating a database
Minutia matching

Creating Database

A new technique is used for storing person fingerprint information. For this purpose first step in implementation is to separate minutia in bifurcation and termination, for each bifurcation and termination x, y axis position is known. Next step is to take one bifurcation point and find distance from this bifurcation to all bifurcation and termination one by one, which means that to create a table for one bifurcation point which contain its x, y position and distance from all bifurcation and termination and type of all bifurcation and termination (logical 1 for bifurcation and 0 for termination) [9],[10,11].

Distance is calculated by

$$d = \sqrt{(x2 - x1)^2 + (y2 - y1)^2}$$

Rotation Invariant

The purpose of calculating angle between each minutia to all other minutia is to make system rotation invariant for minutia matching or fingerprint matching. Fingerprint system can identify any fingerprint which is rotated at any angle.

Summary

Calculation of binary image which contain minutia information in binary for single person is a complex process, which needs to be summarize, it involve following step

1. Select one bifurcation and find its distance from each bifurcation and termination.

2. Sort this distance in ascending order and select minimum five.

3. Find one angle for these five points to make system rotation invariant.

4. Transform this five row table to single row and place angle at last.

5. Transform this row to binary which is 48 bit long.

6. Repeat this process for all bifurcation to create a binary image (no of bifurcation*48).

7. Create a database by same procedure (1-6) for all people.

The purpose of this transformation is to make minutia matching very fast and real time compatible.

Minutia Matching

When a person enters his/her fingerprint binary image is created by same procedure as defined in creating a database. For matching of this image (entered image) to any binary image (2d binary image congaing minutia information) in database to identify person, the procedure is as follow

Find a hamming distance from one row of input

fingerprint to all rows of one image in database

Find minimum hamming distance and divide by total no of rows of image in database.

Repeat process 1-2 for all rows of input image, and sum all these calculated distance and divide by total no of rows in input image and place result in table.

Repeat process 1-3 for all images in database and store result in database.

Find the minimum index of this table created in process 4 and that index will be require person no and from this index found the name from database [1] [3] [5].

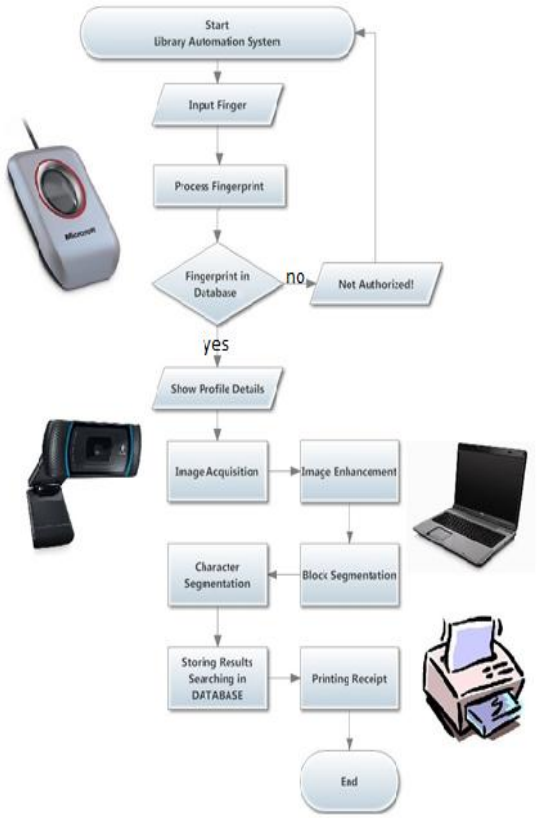

Fig 7 System Overview

The above figure 7 clearly shows working of the system.

Controlled environment

Controlled environment is needed for the capturing of image. Controlled environment includes light, background and placing of the camera which helped to achieve best results. For this purpose specific box shaped hardware is made using cardboard which has an entrance for the book on one side of it and on the other side camera is placed focusing on the tag of the book and on the top a light source i.e. a very low power light bulb (energy saver) is used. Advantages of making a controlled environment are precise light, better focus on region of interest and are to eliminate extra and unnecessary information from the background [4].

Some of its limitations are

- Too thick book cannot enter into database.
- Book should be placed at proper position for recognition
- Book should remain static while capturing image
- Finger print should be placed properly

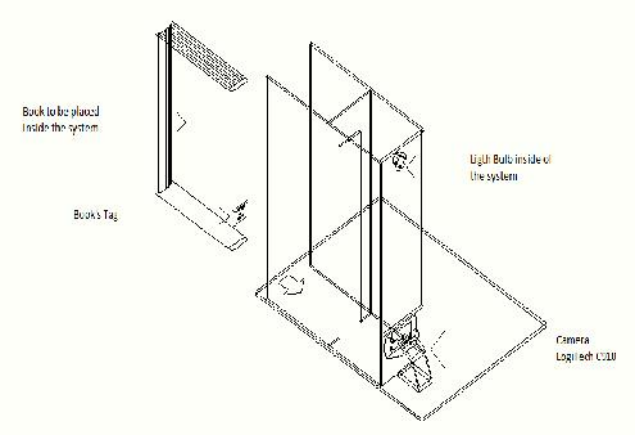

Fig 8 AutoCAD design of Hardware

Computer system

Computer system is a basic need upon which our code is to run and here we have not moved upon expensive DSP kits rather we have used a computer system instead which is easily available

Printer

Printer is used for issuing receipt for the user so that user may show it at the exit of the library gate and take the book out of the library.

CONCLUSION

We have tested this project on 500 books of our library from which 400 are successfully recognize .Result depends on the position of numeric tag, size of book, clear tag, lightning condition and position of camera and time given to camera for autofocus, results can be improved by using better camera with less auto focus and processing time can also be improved by better camera. It take almost 1.5 minute from capturing to reorganization of book, most of the time elapsed in acquisition of image.

Fig 9(a) Original Image

Fig 9(b) Enhanced Image

Image in binary after applying morphological operation and removing area less than 15000

Fig 10 Cropped Tags

Fig 11

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