A Correlation based finger print verification system
PROJECT REPORT

Submitted By Group 1 of Lab Group - B2

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1 Introduction

In this era of technology, security has become one of the main concern for every people. To solve this issue everyone wants to have an unique identity which can secure their personal information. Finger print verification is one of the trusted security system.
Every finger print has an unique pattern. This pattern can be used for security purpose. After finger print verification one can get access to his personal information.This can protect many high level of information of both personal and national.

2 Problem Description

Finger print verification is one of the most secure way to preserve personal and national information. In this project, we tried to build a system that can verify finger print using correlation algorithm. We have used two models to verify finger prints and compare which model gives more accuracy.

3 Dataset Description

Description of the dataset is briefly discussed below.

- The dataset contains images of different finger prints and each have unique identification. Th dataset is obtained from [1].
- Dataset contains 50 images of finger prints.
- Image type is BMP or bitmap images file. This type of image file stores two-dimensional digital images of both monochrome or single color composed images and color images.
- Used dataset is stored in here.

4 Description of the Models

We have used two different approaches of correlation algorithm to verify finger prints and find the most matched finger print region. In both Models we have pre-processed the images to remove any unnecessary information.

4.1 Model 1

Model 1 is the first approach of correlation algorithm. In this model, we have matched the template with pre-processed images for verification. Block diagram of this model is given below.
After loading the input image, we pre-processed and verified the image.

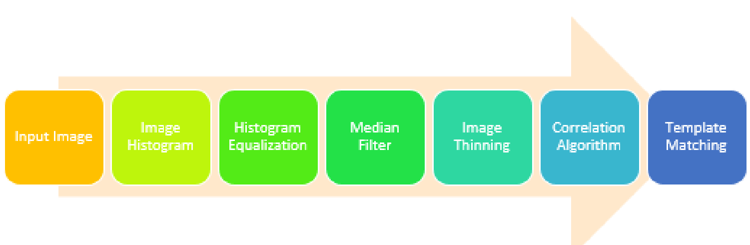

Figure 1: Block Diagram of Model 1

4.1.1 Pre-Processing

- Image Histogram: Histogram is the graphical representation of the intensity value of an image which represents the number of pixels in each intensity value. X-axis of the graph represents intensity and Y-axis represents number of pixels.

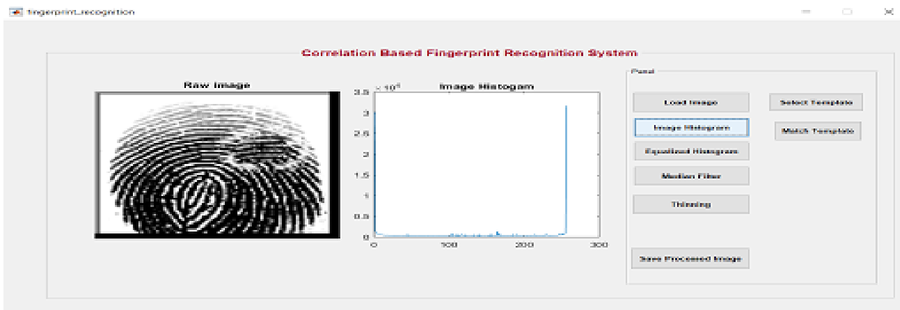

Figure 2: Image Histogram

- Histogram Equalization: Histogram equalization is a computer based image processing technique used to improve the contrast. This technique was done by spreading out most frequent intensity value and stretching out the intensity range of the image.A graph is shown below for equalized histogram.

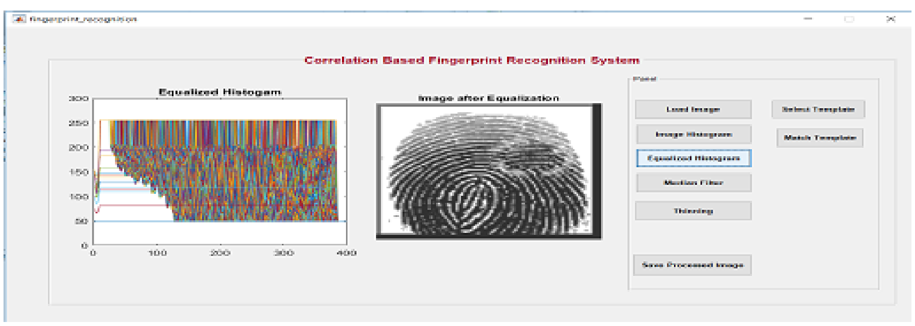

Figure 3: Equalized Histogram Image

- Median Filter: To reduce noise and preserve edges median filter is used. It mainly reduces "salt and pepper" noise. After histogram equalization we get an improved contrast image but the noises were not reduced. Median filter is used to get the noise free image.

Figure 4: After Applying Median Filter

- Image Thinning: Thinning is a morphological operation used in the binarized image to reduce foreground pixel for a skeleton of the image. In this model, thinning is used as the last step for image pre-processing. In this step we get a skeleton image which can be easily matched with template. Threshold is applied to make the binary image.

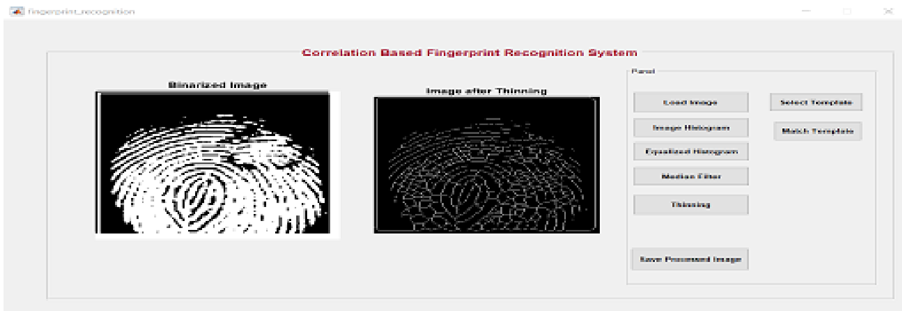

Figure 5: Image Thinning

4.1.2 Verification

Correlation is building relation of two images. To measure the similarity of two images or template match we have used normalized cross correlation or normxcorr2. It takes two values, matches them and gives the output region that matches. Template that we are using to match the original image must be smaller than the pre-processed image. Otherwise template normalization cannot be done.
In this algorithm, First we have calculated cross correlation in the frequency domain depending on size of image. The template is placed above the pre-processed image and slides throw the image to get the co-efficient. Then we computed sum by pre-computing running sums. Use local sums to normalize the cross-correlation to get correlation coefficients.
After algorithm we get a region of coefficient where algorithm found any match. That region is marked with blue box. If we get total match than the the whole image is marked with blue box.

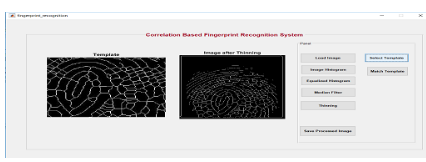

Figure 6: Before Correlation

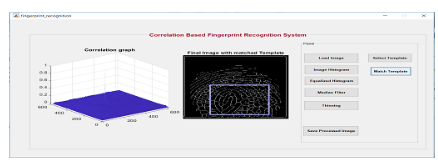

Figure 7: Matched Area

4.2 Model 2

This is the second approach of this project. We have applied another method to verify finger print. In Model 2, we have used correlation algorithm in frequency domain. The block diagram for Model 2 is given below.

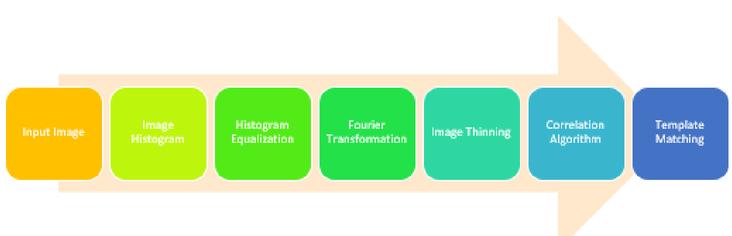

Figure 8: Block Diagram for Model 2

4.2.1 Pre-Processing

- Image Histogram: We plotted histogram of the image and got the same graph like Model 1.

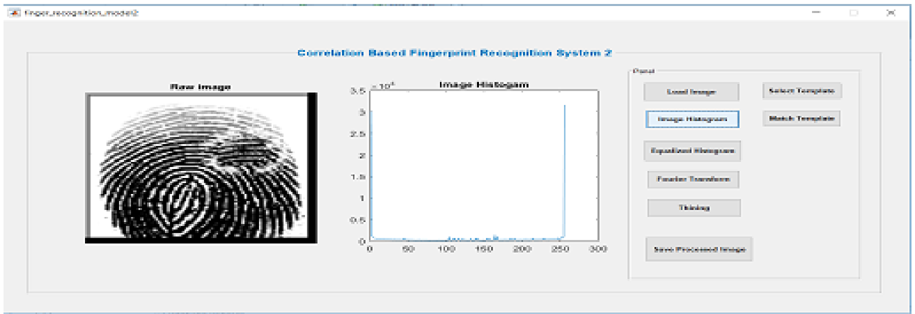

Figure 9: Histogram

- Histogram Equalization: In Model 2 we have used Contrast Limited Adaptive Histogram Equalization (CLAHE). In this technique we have worked with each neighbourhood for contrast limiting. Transformation function is derived from this contrast limiting procedure. This particular equalization function is used to prevent over amplification of noise which is better than normal histogram equalization.

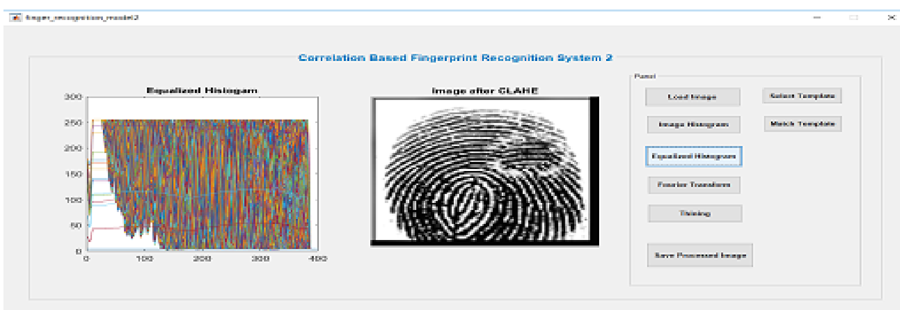

Figure 10: Equalized Histogram Image

- Fourier Transformation: Fourier transformation is an image processing tool. We have used this function to decompose an image into its sine and cosine components. Fourier works in frequency domain and gives enhanced image. We have used this function to filter the image.
  First we have applied Fast Fourier Transformation. It is an efficient implementation of DFT. It is used to convert an image from the spatial domain to the frequency domain.

$$F(x) = \sum_{n=0}^{N-1} f(n) e^{-j2\pi(x\frac{n}{N})}$$

Figure 11: Equation for Fast Fourier Transformation

Then we used Inverse Fourier Transformation in the frequency domain to get the result of the convolution. This function can be obtained by substituting a known function into the second equation opposite and integrating.

$$f(n) = \frac{1}{N}\sum_{n=0}^{N-1} F(x) e^{j2\pi(x\frac{n}{N})}$$

Figure 12: Equation for Inverse Fourier Transformation

After fast and inverse Fourier we get an enhanced image and use it as in our next step of pre-processing.

Figure 13: Applying Fourier

- Image Thinning: Thinning is a morphological operation used in the binarized image to reduce foreground pixel to get edge of the image. In this model, thinning is also used as the last step for image pre-processing. In this step we get a skeleton image which can be easily matched with template. Adaptive Threshold is applied to make the binary image.

Figure 14:

4.3 Verification

We have used cross correlation algorithm to get matching area and found the area. In model 2, we applied cross correlation algorithm in frequency domain.
The cross-correlation between two image is equal to the product of Fourier transform of one image multiplied by complex conjugate of Fourier transform of another image. After doing this, when we take the ifft of the product image, we get a peak which indicates the shift between two images.
Then when we get any match area with template, the area of the the image is shown. Full image and the template image goes blue. There is no box and graph in Model 2 for template matched area. But this Model cut the whole area which it finds similar with template.

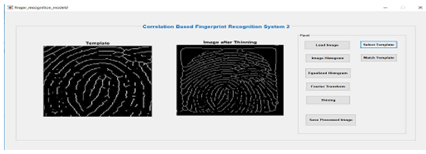

Figure 15: Before Correlation

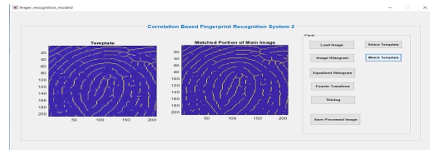

Figure 16: Matched Area

5 Comparison of the Models

We have worked with two models, the first one was done in spatial domain while the second one is done in Fourier domain. For template matching we have cropped some portion of the processed images from both of the models and checked if they match properly or not. Both of the model match with their respective cropped portions with 100 percent accuracy. While the second model can even do better by matching the cropped images processed from model 1 whereas, the first model fails to do that. Here is a diagram which proves the comparison:

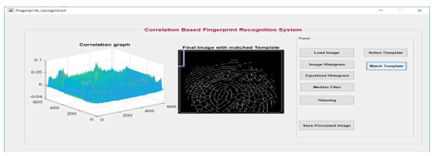

Figure 17: Model 1

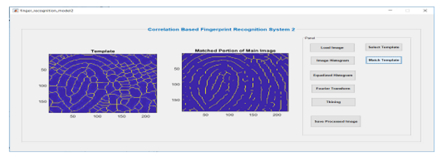

Figure 18: Model 2

6 Discussion

From the comparison we can see that Model 2 works better than Model 1. We got 100 percent accuracy for both of the model but for template matching, Model 2 is better. As we can verify Model 1's image in Model 2 but Model 2's image can not be verify by Model 2's.

7 Some Related Work

[2] and [3] are 2 related work which we have studied for this project.

References

[1] https://www.kaggle.com/ruizgara/socofing.

[2] https://www.researchgate.net/publication/228638061$_{A}correlationbased_{f}ingerprint_{v}erification_{s}ystem$.

[3] https://link.springer.com/chapter/10.1007/978 3-540-74549-5$_{7}$5.