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Fingerprint recognition

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FINGERPRINT RECOGNITION

Introduction

Biometrics is a technology that can identify a person based on their physical characteristics. Fingerprint identification and recognition is a biometric method that finds wide application in different types of applications due to its accuracy and reliability. The main goal of this project is to develop a system that will be able to recognize if 2 prints come from the same person or not. For this purpose, images are first collected from a public dataset. Then digital image processing techniques are applied over the same images in order to improve their quality. After the image is preprocessed, the so-called critical points which are later compared according to their Hamming distance.

(Example of an image of a print of a plate in different positions)

Data set

The dataset I used is called FVC2002[1] and is published by the University of Bologna. There are 4 different datasets on the site, but for this project I used the DB1 dataset.

Binarization

Binarization of the image allows us to clean the image from unnecessary noise and helps us to make the contrast between the "wrinkled" surface of the print and the rest of the lines.

Otsu's Threshold

Otsu Threshold will automatically select the best generic threshold for the image to get good contrast between foreground and background information. This is because the image contains a bimodal distribution of pixel values. For that image, we can roughly take the value in the middle of the histogram peaks as the threshold. (for non-bimodal images, the binary will not be correct.) Otsu allows us to avoid using a fixed blank value, thereby making the system more general for any recording device. Threshold result can be seen below.

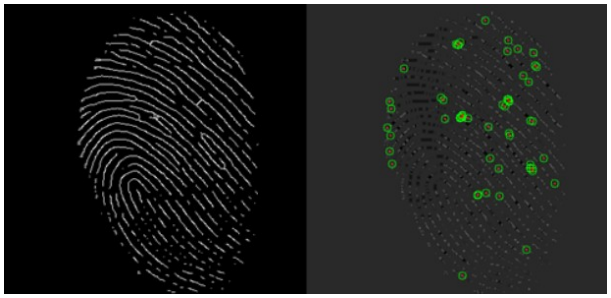
Image skeletonization

In order to improve the process of finding critical points on the print, it is good to skeletonize the image itself. This creates more unique and stronger critical points. The skeletonization is based on the Zhang-Suen algorithm.[2]

(The result before and after skeletonization)

Looking for critical points (minutiae points)

Once the skeletal image is obtained, the next step would be to find the crossing points of the ridges of the impression, which are then called minutiae points. This can be done using a critical point detector, which requires a large change in local contrast. Such is the Harris Corner detector[3]. Because the Harris Corner detector is capable of detecting strong corners and edges, this is ideal for the fingerprint problem, where the most important minima are short edges and bifurcations, the positions where edges converge. The critical points found are shown in the figure.



Defining a formal descriptor

Once the list of critical points is obtained, a formal descriptor of the local region around that point should be created so that it can be uniquely identified among other critical points. Since the orientation of the print can vary (it is not a fixed position), we need a descriptor that is robust to such small differences. One of the most commonly used descriptors for this purpose is the ORB descriptor.

Using this method we can obtain a descriptor for each critical point and form a matrix of such descriptors that identifies the print.

Comparing prints

Once the descriptor matrices for two fingerprints are obtained, an algorithm is needed to compare them. The simplest way is to search with the so-called brute force along the hamming distance between descriptors from 2 different points. This way we will get a score that indicates how similar the 2 fingerprints are. By setting a threshold it can be determined whether the fingerprints are the same or not.

Another way is to compare the original fingerprint with all the fingerprints found in our fingerprint database and choose the one with the best score of all – in order to identify the input fingerprint.

Conclusion

With this project, a fingerprint recognition system was developed, which is based on the method of finding critical points. These points are then used to find formal descriptors of the region around them, forming a matrix that identifies the footprint itself. I tested the system on the FCV2002 DB1 dataset to determine if it successfully recognized the fingerprints.

References

[1]http://bias.csr.unibo.it/fvc2002/databases.asp

[2]TY Zhang and CY Yuen. "A Fast Parallel Algorithm for Thinning Digital Patterns". Communications of the ACM. Vol. 27 1984

[3]Harris, Chris, and Mike Stephens. "A combined corner and edge detector." Alvey vision conference. Vol. 15. 1988