

### ABSTRACT

By analyzing and comparing several fingerprint matching methodologies, we found that every single method will have the advantage in providing security as well as, will face some bottleneck problems as drawback. This paper presents a survey on the improvement in each fingerprint matching algorithm. The experiments performed on real-world applications provides the result that any fingerprint matching algorithm which derived from the previous paper will have some 20% of enhancement in it. The drawbacks on each paper and the method to solve that will be discussed as a survey in this paper.

### INTRODUCTION

Due to the performance and low cost fingerprint based biometrics authentication systems are used for more than a century successfully. These fingerprint recognition systems are highly used by the forensic department for criminal investigation. Even though these systems play a major role in user identification, it has some challenging risks to face. But due to the unique property of the fingerprint (i.e) no two humans will have the same fingerprints, these systems exist in the security domain. Although these systems cannot be easily hacked or attacked by the intruders, there is some possibility to hack these systems. Fingerprint matching is difficult due to the following reasons. 1, Skin distortions 2, rotation 3, Errors in feature extraction. The devices based on fingerprint recognition systems are well-suited for many real time applications. When considering the performance these systems are fast and flexible. Nowadays many security devices are existing in the market, but the security provided by fingerprint recognition systems are stand-alone and reliable. These systems are highly reliable and best to use. The new security systems will try to solve the problems of the existing devices. Biometric fingerprint recognition systems are vulnerable to spoofing attacks. These systems play a major role in forensics and in civil applications. It has been proved that fingerprint based security systems are the most reliable method to use and has the high market shares. Even though it is the most reliable method it has been studied for many years that the performance of these systems is still lesser than the expectation. The fingerprints can be acquired both in online and as in off-line. Here a survey on all fingerprint matching methods has been discussed and the description of the benefits and drawbacks on each paper is listed.

### LATENT FINGERPRINT MATCHING

This paper [1] uses a robust alignment algorithm called "Descriptor based Hough transform" to align fingerprints and measures similarity between fingerprints by considering both minutiae and orientation field information for matching Latents. The speed of our matcher running in a pc with intel core2 quad CPU and windows XP OS is around 10 matches per second. No need of spending time in optimizing the code for speed. Multithread capabilities were not utilized. This matching could be much faster in C/C++ than in MATLAB because of the nature of the MATLAB descriptors.

### FINGERPRINT MATCHING USING PORES AND RIDGES

This paper [2] focuses on extracting level3 features (pores) because it is found that level3 features claimed to be permanent and unique for fingerprint matching algorithm. It includes the implementation of high resolution fingerprint sensors due to its accuracy.

Iterative closest point algorithm is employed for matching level3 features which provides consistent performance in high quality and low quality images. This method is informative and robust. Level3 features should only be used when the fingerprint image is of high quality.

### **A HYBRID MOBILE VISUAL SEARCH SYSTEM**

The main idea behind this paper[3] is that it combines the benefits of on-device and on-server database matching methods and efficient inter frame coding of a sequence of global signatures which are extracted from the viewfinder frames on the mobile device.

This hybrid system provides a fast local query on mobile. Our coding inter frame method reduces the uplink bitrate. Residual enhanced visual vector (REVV) is well-suited to building a memory efficient on-device MVS system. This system requires 50MB of RAM to store look images on mobile device. Low bitrate provides querying remote server over networks with low transfer rates.

### **COMPRESSED FINGERPRINT MATCHING**

This paper[4] is intended to use real-valued or binary random projections to effectively compress the FingerPrint. The method is concentrated to reduce the size of the camera fingerprints based on random Projections. The most common camera fingerprint is the PRNU (Photo response non-uniformity) of digital imaging sensor.

The proposed method effectively preserve the geometry of the database and reduce the dimension of the problem. This method provides higher compression ratios and improves scalability. Complexity in calculating random projections in million-pixel images but it can be solved by sensing matrices

### **TOUCHLESS MULTIVIEW FINGERPRINTS ACQUISITION AND MOSAICKING**

This paper[5] depicts a touchless multi view fingerprint capture device using multi camera mode with optimized This device parameters and it uses the mosaicking method to splice together the captured images of a finger to form a new image with a larger useful print area.

Since each finger has four samples in our method and it has high image quality and features are extracted correctly and transformation model estimation results also has the similar results as the proposed method discussed in this paper. The quality of the images cannot be guaranteed due to touchless imaging technique which leads to bad mosaicking results. The speed for image quality of device is much lower than that of touch based devices.

### **INCORPORATING RIDGE FEATURES WITH MINUTIAE**

This paper[6] shows fingerprint matching using extracting both the ridge and minutiae-feature. To extract features of ridge and minutiae the four elements are considered. They are ridge-count, ridge length, ridge curvature direction and ridge type.

The proposed method gives additional information for fingerprint matching with little increment of template size. The method is invariant to any transform and it can be used in addition to conventional alignment free features in the fingerprint identification. This method needs to be improved for images with a small foreground area and those of low quality.

### **FINGERPRINT MATCHING BASED ON GPU**

This paper[7] presents a GPU fingerprint matching system which is based on MCC (Minutia cylinder code) and it is the best performing algorithm in terms of accuracy.

The speed up ratios are up to 100.8x with respect to a single thread CPU implementation. This system has no scaling issues. It can identify a fingerprint from large database processing up to 55700 fingerprints per second with single GPU. When GPU's are collaborated they have to exchange data to perform different operations which makes the calculation slower.

### **FINGERPRINT LIVELINESS DETECTION**

This paper[8] concentrates on differentiating fake and live fingerprint. Implementation of SURF and the PHOG method separately in order to detect the liveness of the fingerprint is unreliable. But the combination of SURF+PHOG method yields greater accuracy in terms of performance.

The experimental and theoretical results has proven that this method has low equal error rate(EER).Low level gradient features are used as feature extraction which is highly reliable.Increase in false acceptance rate and drop in false rejection rate lowers the equal error rate.

### EFFICIENT SENSOR FINGERPRINT MATCHING

This paper[9] is focused on improving the computational efficiency of source identification techniques which is PRNU noise based sensor fingerprint matching method.

The detection accuracy of this method is very high with false positives and negatives in the order of  $10^{-6}$  or less.It aims to reduce the number of matchings hat have to be performed when searching a large database.It includes efficient retrieval of a fingerprint using binary search tree method.The main memory operations like loading of a fingerprint data takes high amount of time.Compression is not very effective and it takes upto 50MB of space even after compression.

### EXEMPLAR PRINTS FOR LATENT FINGERPRINT MATCHING

[10] uses feedback in matching stage to refine the features extracted from the latent fingerprint image.This This paper paper gives the information that matching latent images based on initially extracted set of features without any prior information and is prone to error. So it integrates top-down flow to matching to use exemplar mate to refine features in order to improve the accuracy.

The proposed method in this paper refines the latent features and improves the rank 1 identification and accuracy is improved to 3.5%.This method uses a local ridge orientation to extract features at multiple peak points in frequency representation of the latent image which results in computational complexity.

| S.N<br>O | TITLE  | DESCRIPTION   | ADVANTAGES  | DISADVANTAGE<br>S   | FUTURE WORK   |
|----------|--|---|---|---|---|
| 1.       | Latent fingerprint matching                        | This paper[1] uses a robust alignment algorithm called “Descriptor based Hough transform” to align fingerprints and measures similarity between fingerprints by considering both minutiae and orientation field information for matching Latents.                   | <ul style="list-style-type: none"> <li>❖ The speed of our matcher running in a pc with intel core2 quad CPU and windows XP OS is around 10 matches per second.</li> <li>❖ No need of spending time in optimizing the code for speed.</li> </ul> | <ul style="list-style-type: none"> <li>❖ Multithread capabilities were not utilized.</li> <li>❖ This matching could be much faster in C/C++ than in MATLAB because of the nature of the MATLAB descriptors .</li> </ul> | Improving multithreading capabilities.                |
| 2.       | <b>FINGERPRINT MATCHING USING PORES AND RIDGES</b> | This paper[2] focuses on extracting level3 features(pores) because it is found that level3 features claimed to be permanent and unique for fingerprint matching algorithm.It includes the implementation of high resolution fingerprint sensors due to its accuracy | <ul style="list-style-type: none"> <li>❖ Iterative closest point algorithm is employed for matching level3 features</li> </ul>  | <ul style="list-style-type: none"> <li>❖ Level3 features should only be used when the fingerprint image is of high quality.</li> </ul>  | Extract level 3 features for images with low quality. |

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|    |   |   | <p>which provides consistent performance in high quality and low quality images.</p> <ul style="list-style-type: none"> <li>❖ This method is informative and robust.</li> </ul>   |  |  |
| 3. | <b>A HYBRID MOBILE VISUAL SEARCH SYSTEM</b> | The main idea behind this paper[3] is that it combines the benefits of on-device and on-server database matching methods and efficient inter frame coding of a sequence of global signatures which are extracted from the viewfinder frames on the mobile device.   | <ul style="list-style-type: none"> <li>❖ This hybrid system provides a fast local query on mobile.</li> <li>❖ Our coding inter frame method reduces the uplink bitrate.</li> <li>❖ Residual enhanced visual vector(REVV) is well-suited to building a memory efficient on-device MVS system.</li> </ul> | <ul style="list-style-type: none"> <li>❖ This system requires 50MB of RAM to store look images on mobile device.</li> <li>❖ Low bitrates provides querying remote server over networks with low transfer rates.</li> </ul> | Reducing the storage space for images.                           |
| 4. | <b>COMPRESSED FINGERPRINT MATCHING</b>      | This paper[4] is intended to use real-valued or binary random projections to effectively compress the FingerPrint. The method is concentrated to reduce the size of the camera fingerprints based on random Projections. The most common camera fingerprint is the PRNU(Photo response non-uniformity) of digital imaging sensor. | <ul style="list-style-type: none"> <li>❖ The proposed method effectively preserve the geometry of the database and reduce the dimension of the problem.</li> <li>❖ This method provides</li> </ul>  | <ul style="list-style-type: none"> <li>❖ Complexity in calculating random projections in million-pixel images but it can be solved by sensing matrices.</li> </ul>   | Reducing the difficulties in calculating the random projections. |

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|    |  |   | higher compression ratios and improves scalability.   |   |  |
| 5. | <b>TOUCHLESS MULTIVIEW FINGERPRINTS ACQUISITION AND MOSAICKING</b> | This paper[5] depicts a touchless multi view fingerprint capture device using multi camera mode with optimized device parameters and it uses the mosaicking method is to splice together the captured images of a finger to form a new image with a larger useful print area. | Since each finger has four sample in our method and it has high image quality and features are extracted correctly and transformation model estimation results also has the similar results as the proposed method discussed in this paper.   | <ul style="list-style-type: none"> <li>❖ The quality of the images cannot be guaranteed due to touchless imaging technique which leads to bad mosaicking results.</li> <li>❖ The speed for image quality of device is much lower than that of touch based devices.</li> </ul> | To improve the performance of the method to assure quality of the images.      |
| 6. | <b>INCORPORATING RIDGE FEATURES WITH MINUTIAE</b>                  | This paper[6] shows fingerprint matching using extracting both the ridge and minutiae-feature. To extract features of ridge and minutiae the four elements is considered. They are ridge-count, ridgelength, ridge curvature direction and ridge type.                        | <ul style="list-style-type: none"> <li>❖ The proposed method gives additional information for fingerprint matching with little increment of template size.</li> <li>❖ The method is invariant to any transform and it can be used in addition to conventional alignment free</li> </ul> | This method needs to be improved for images with a small foreground are and those of low quality  | Extracting ridge and minutiae for images of low quality with high reliability. |

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|    |  |   | features in the fingerprint identification.  |   |  |
| 7. | <b>FINGERPRINT MATCHING BASED ON GPU</b> | This paper[7] presents a GPU fingerprint matching system which is based on MCC(Minutia cylinder code)and it is the best performing algorithm in terms of accuracy.  | <ul style="list-style-type: none"> <li>❖</li> <li>❖</li> <li>❖ The speed up ratios is up to 100.8x with respect to a single thread CPU implementation.</li> <li>❖ This system has no scaling issues.</li> <li>❖ It can identify a fingerprint from large database processing up to 55700 fingerprints per second with single GPU.</li> </ul> | When GPU'S are collaborated they have to exchange data to perform different operations which makes the calculation slower                           | Reducing the hindrance when many GPU'S are combined. |
| 8. | <b>FINGERPRINT LIVELINESS DETECTION</b>  | This paper[8]concentrates on differentiating fake and live finger print. Implementation of SURF and the PHOG method separately in order to detect the liveness of the fingerprint is un reliable.But the combination of SURF+PHOG method yields greater accuracy in terms of performance. | <ul style="list-style-type: none"> <li>❖ The experimental and theoretical results has proven that this method has low equal error rate(EER).</li> <li>❖ Low level gradient features are used as feature extraction which is</li> </ul>   | <ul style="list-style-type: none"> <li>❖ Increase in false acceptance rate and drop in false rejection rate lowers the equal error rate.</li> </ul> | To maintain constant equal error rate(EER).          |

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| 10. | <b>LATENT FINGERPRINT MATCHING AND EXEMPLAR PRINTS</b> | This paper[10] uses feedback in matching stage to refine the features extracted from the latent fingerprint image. This paper gives the information that matching latent images based on initially extracted set of features without any prior information and is prone to error. So it integrates top-down flow to matching to use exemplar mate to refine features in order to improve the accuracy. | ❖ It improves the rank-1 identification and accuracy is improved around 3.5%. | ❖ Frequency representation of the latent image results in computational complexity . | To have a method to extract features at multiple peak. |
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## REFERENCES

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