

A COMPARATIVE STUDY OF FINGERPRINT MATCHING TECHNIQUES

CHAPTER 4 – Results and Discussion



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| ID | FULL NAME |
| 10736694 | Terence Ugo Nacciarone Quashie |
| 10729461 | Abdul-Aziz Abubakar Saddick |

Contents

[Summary of Data 1](#_Toc119240334)

[Table Categories 1](#_Toc119240335)

[Fingerprint Image 1](#_Toc119240336)

[Time Taken 1](#_Toc119240337)

[Match Score 1](#_Toc119240338)

[Verdict 1](#_Toc119240339)

[Sample Data 2](#_Toc119240340)

[Results And Discussion 3](#_Toc119240341)

[Matches 3](#_Toc119240342)

[Algorithm Run Time 4](#_Toc119240343)

[Cross Regional (CR) Cut Images 4](#_Toc119240344)

[Obliterated (OBL) Images 5](#_Toc119240345)

[Z Cut Images 6](#_Toc119240346)

# Summary of Data

The data was grouped into two (2) sections namely

1. SIFT RESULTS
2. MINUTIAE RESULTS

Each of these sections had the following information

1. Fingerprint Image
2. Match Score
3. Time Taken
4. Verdict

## Table Categories

### Fingerprint Image

This section shows the original fingerprint image paired against its altered version. Altered versions were further broken down into sub categories, namely

* CR (Cross Region Cut)
* OBL (Obliteration)
* Z-Cut

### Time Taken

Time Taken refers to the time for total completion of the algorithm; that is, from initialization to match score generation.

### Match Score

Match score refers to the number of matches that were produced when images in the sub altercation category were compared to the original image.

### Verdict

Verdict refers to the conclusion generated by each algorithm after it had completed its processing on both images. Each algorithm had different criteria for drawing a conclusion.

#### Scaled Invariant Feature Transformation (SIFT)

* If the number of matches were greater than 35 () the fingerprint images were considered a good a match with no impact on FAR or FRR
* If the number of matches were greater than 18 but less than 35 the fingerprint images were considered a good match but with a low score meaning it could increase FAR (False Acceptance Rate)
* If the number of matches were less than 18 then the conclusion is that fingerprints do not match

The table below summarizes the relationship between verdict and match score and its impact on False Acceptance Rate (FAR) and False Rejection Rate (FRR) for Scale Invariant Feature Transformation (SIFT)

|  |  |
| --- | --- |
| **Match Score** | **Verdict** |
| Greater than 35 | Good Match |
| Greater than 18 but less than 35 | Match but with low score |
| Less than 18 | No Match |

#### Minutiae Matching Algorithm

* If the match score was greater than 7 the fingerprint images were considered to be a good match
* If the match score was greater than 3 but less than 7 the images were considered match with low score and could increase FAR
* If the math score was less than 3 then the fingerprint images were not considered to be a match

The table below summarizes the relationship between the match score and verdict as well as its impact on FAR and FRR

|  |  |
| --- | --- |
| **Match Score** | **Verdict** |
| Greater than 7 | Good Match |
| Greater than 3 but less than 7 | Match but with low score |
| Less than 3 | No Match |

## Sample Data



# Results And Discussion

## Matches

After both algorithms run on the same data sample, the following results were generated as shown in the graph below:

From the graph above,

1. The percentage of good matches on SIFT were **41.78%** whereas Minutiae generated good matches on **28%** of the sample images
2. SIFT produced **37.56%** low matches on all matches. The effect it has on False Acceptance Rate and False Rejection Rate is as follows:
   * 1. Increase in False Rejection Rate
     2. Decrease in False Acceptance Rate

Minutiae produced **15.1%** low matches and samples provided. This has the following effect on False Acceptance Rate and False Rejection Rate

1. Increase in False Rejection Rate
2. Decrease in False Acceptance Rate
3. SIFT generated **20.67%** low matches on the images it was provided with, having the following effects on False Acceptance Rate and False Rejection Rate.
   * 1. Decrease in False Rejection Rate
     2. Decrease in False Acceptance Rate

Minutiae produced the most amount of no matches found with **58.59%** having the following effect on False Acceptance Rate and False Rejection Rate

* + - 1. Increase in False Rejection Rate
      2. Decrease in False Acceptance Rate

## Algorithm Run Time

### Cross Regional (CR) Cut Images

The time taken to process cross regional cuts on both algorithms is shown below in the graph

From this graph, the following observations can be made:

* The average time to process a fingerprint image with a cross regional (CR) cut using the SIFT algorithm increases as the number of images increase. The trendline equation is  
  ***y = 6E-08x + 5E-05***
* The time to process a fingerprint image with a cross regional (CR) cut on average using the Minutiae algorithm reduces as the number of images increase. The trendline equation is  
  ***y = -1E-09x + 1E-05***
* Using the trendlines above the time for various populations are shown in the table

|  |  |  |
| --- | --- | --- |
| Runtime CR | | |
| Number of Subjects | SIFT | Minutiae |
| 500 | 0.0000799999999999999 | 0.0000095 |
| 5000 | 0.00035 | 0.000005 |
| 50000 | 0.0030499999999999998 | 0.00004 |

### Obliterated (OBL) Images

From this graph, the following observations can be made:

* The average time to process a fingerprint image using the SIFT algorithm increases as the number of images increase. The trendline equation is ***y = 4E-08x + 6E-05***
* The time to process a fingerprint image on average using the Minutiae algorithm reduces as the number of images increase. The trendline equation is ***y = -7E-10x + 1E-05***

Using the trendlines above the time for various populations are shown in the table

|  |  |  |
| --- | --- | --- |
| Runtime OBL | | |
| Number of Subjects | SIFT | Minutiae |
| 500 | 0.00008 | 0.00000965 |
| 5000 | 0.00026000000000000003 | 0.0000065 |
| 50000 | 0.00206 | 0.0000249999999999999 |

### Z Cut Images

From this graph, the following observations can be made:

* The average time to process a fingerprint image using the SIFT algorithm increases as the number of images increase. The trendline equation is ***y = 6E-08x + 5E-05***
* The time to process a fingerprint image on average using the Minutiae algorithm reduces as the number of images increase. The trendline equation is ***y = -3E-09x + 1E-05***

Using the trendlines above the time for various populations are shown in the table

|  |  |  |
| --- | --- | --- |
| Runtime Z-Cut | | |
| Number of Subjects | SIFT | Minutiae |
| 500 | 0.0000799999999999999 | 0.0000085 |
| 5000 | 0.00035 | 0.00000499999 |
| 50000 | 0.0030499999999999998 | 0.00014 |

From the above data, the following observations can be made

* Scale Invariant Feature Transformation (SIFT) is more likely to accurately identify subjects with (some sort of distortion on their fingerprints) such as cuts, dust or skin-oil on the fingerprint or on the scanner. Minutiae is less likely to identify subjects with distortions or aberrations on their fingerprints.
* Minutiae based algorithm will run faster on larger datasets as compared to SIFT, however its accuracy is further reduced because of this.
* Both algorithms have good performance, running under 3 milli seconds on a database containing 500,000 sample fingerprint images.