A COMPARATIVE STUDY OF FINGERPRINT MATCHING ALGORITHMS

Presented by

Terence Ugo Nacciarone Quashie - 10736694
Abdul-Aziz Abubakar Saddick - 10729461

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INTRODUCTION

In 1983 when the Home Ministry Office, UK, concluded that no two individuals can have the same fingerprints, it set in motion a series of events that led to the widespread use of fingerprint pattern systems, known as the AFIS (Automatic Fingerprint Identification Systems). These systems are actively used by law enforcement agencies all over the world today. In fact, these fingerprint matching systems have become so successful in criminal investigations that the term fingerprint has become synonymous with the word inherent characteristic or unique characteristic

LITERARY REVIEW

1. The success of fingerprint identification systems spurred a wide spiral of its application geared towards civilization application such as biometric authentication. This widespread is known as the “Second Generation”.

2. The “Second Generation” has spearheaded the race for efficient fingerprint matching algorithms. With the most popular algorithm being Minutiae

3. Minutiae works by locating local landmarks where fingerprint ridges either terminate or bifurcate (Minutiae Points) and then match minutiae relative placements between a given fingerprint sample and the stored template

4. Minutiae is not always accurate as it struggles when given poor quality images.

LITERARY REVIEW

5 This short-coming of the Minutiae-based system meant that there was need to extend characteristic feature matching beyond minutiae points. For this, techniques such as the Scale Invariant Feature Transformation (SIFT) was introduced, an object matching algorithm.

6 SIFT works by constructing a scale space from which descriptors are extracted and used in the matching process.

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PROBLEM STATEMENT

There is a need to develop a fingerprint matching system where the underlying sensing, representation and matching technologies extend beyond minutiae points

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PROJECT IMPACT

1. identification of specific advantages of each technique to further advice the appropriate selection of a technique to fit a specific purpose;

2. Indication of aspects of each technique which can be twerked to improve performance

3. Identification of the limitations of each technique to further understand the output/outcome of using a particular technique in designing bio-metric applications

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AIMS

AIM 1

Identify a suitable algorithm that extends the capabilities of Minutiae

AIM 2

Implement both algorithms (SIFT & Minutiae)

AIM 3

Characterize the efficiency of each algorithm

AIM 4

Test matching capabilities of both algorithms using fingerprint samples

AIM 5

Draw conclusions from results gathered

OBJECTIVE 1

Multiple papers will be consulted and referenced to properly discuss a suitable algorithm that extends the capabilities of Minutiae

OBJECTIVE 2

Both algorithms would be implemented using the Python Programing Language

OBJECTIVE 3

A GUI (Graphical User Interface) would be built to observe the processes involved in both algorithms

OBJECTIVE 4

Generate data from the GUI for analysis purposes

OBJECTIVE 5

Run both algorithms on a standardized dataset of fingerprint images and collect necessary information to compare both algorithms

OBJECTIVES

SCOPE

This research falls under the computer vision scope as it uses various techniques and libraries such as gaussian blurring and OpenCV2 respectively.

METHODOLOGY

RESEARCH DESIGN

This design method of the research combines various techniques to seek answers to "What's" and "How's"

- "What are fingerprint matching algorithms?"
- "How do these fingerprint matching algorithms work?"
- "How are they implemented?"
- "Which algorithm is more accurate?"
- "What are the times each algorithm takes to finish?"

DATASET

Fingerprint Set	Real	Altered Easy	Altered Medium	Altered Hard
Dimension	96 x 103	96 x 103	96 x 103	96 x 103
Image Type	Bitmap (.BMP)	Bitmap (.BMP)	Bitmap (.BMP)	Bitmap (.BMP)
Image Size (KB)	38.7	10.7	10.7	10.7
Number of images	6,000	17,931	17,067	14,272

IMPLEMENTATION

PHASE 1

Implement both algorithms using the python programming language using various libraires such as

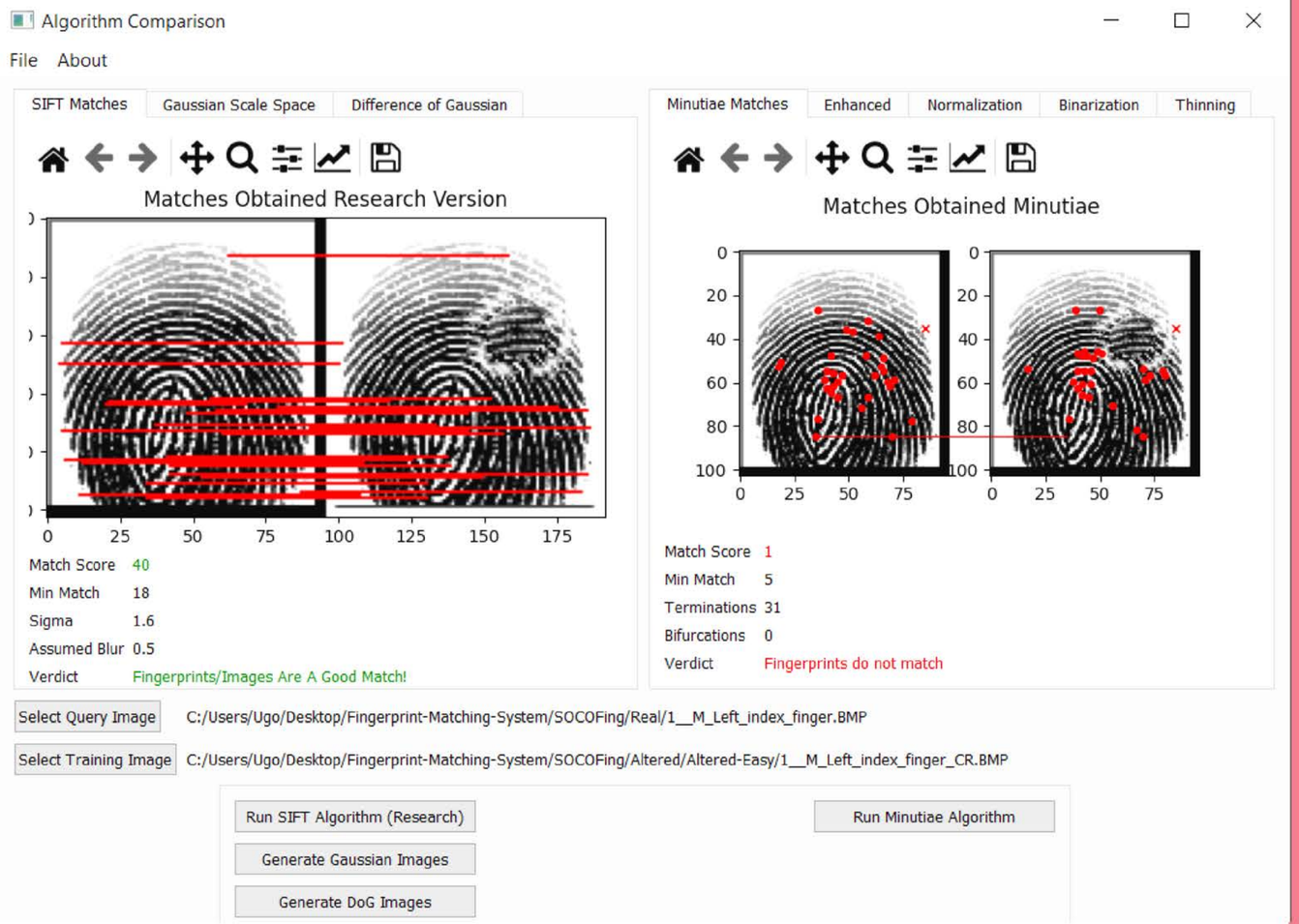
- NumPy
- OpenCV2
- Matplotlib

PHASE 2

Build a GUI (Graphical User Interface) using the PQYT5 library to show the processes of each algorithm

PHASE 3

Collect necessary data from information displayed in GUI and analyze accordingly



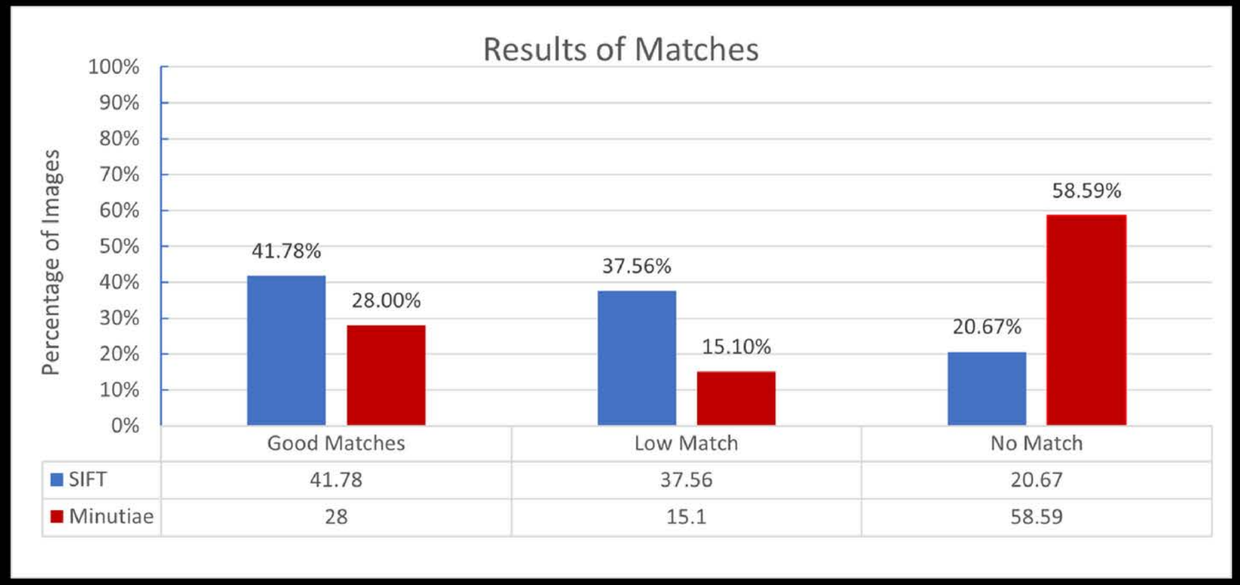
Fingerprint image	Alteration Type	Match Score (SIFT)	Time (SIFT)	Verdict (SIFT)	Match Score (Minutiae)	Time (Minutiae)	Verdict (Minutiae)
1_Left_index_finger.BMP 1_Left_index_finger_CR.BMP	Easy	40	6.85421E-05	Fingerprints Are A Good Match!	1	1.23717E-05	Fingerprints do not matc
1_Left_index_finger.BMP 1_Left_index_finger_Obl.BMP	Easy	44	6.68273E-05	Fingerprints Are A Good Match!	1	1.23392E-05	Fingerprints do not matc
1_Left_index_finger.BMP 1_Left_index_finger_Zcut.BMP	Easy	46	6.52769E-05	Fingerprints Are A Good Match!	8	1.24693E-05	Fingerprints Are A Good Ma
1_Left_little_finger.BMP 1_Left_little_finger_CR.BMP	Easy	31	6.58313E-05	Fingerprints Match With A Low Score!	0	1.23379E-05	Fingerprints do not matc
1_Left_little_finger.BMP 1_Left_little_finger_Obl.BMP	Easy	35	6.8484E-05	Fingerprints Match With A Low Score!	0	1.24996E-05	Fingerprints do not matc
1_Left_little_finger.BMP 1_Left_little_finger_Obl.BMP	Medium	27	6.77754E-05	Fingerprints Match With A Low Score!	0	1.2379E-05	Fingerprints do not matc
1_Left_little_finger.BMP 1_Left_little_finger_Zcut.BMP	Medium	30	6.11174E-05	Fingerprints Match With A Low Score!	0	1.22169E-05	Fingerprints do not matc
1_Left_middle_finger.BMP 1_Left_middle_finger_CR.BMP	Medium	20	5.32277E-05	Fingerprints Match With A Low Score!	0	1.33997E-05	Fingerprints do not matc
1_Left_middle_finger.BMP 1_Left_middle_finger_Obl.BMP	Medium	27	5.79226E-05	Fingerprints Match With A Low Score!	3	1.33751E-05	Fingerprints Match With A Really L
1_Left_middle_finger.BMP							

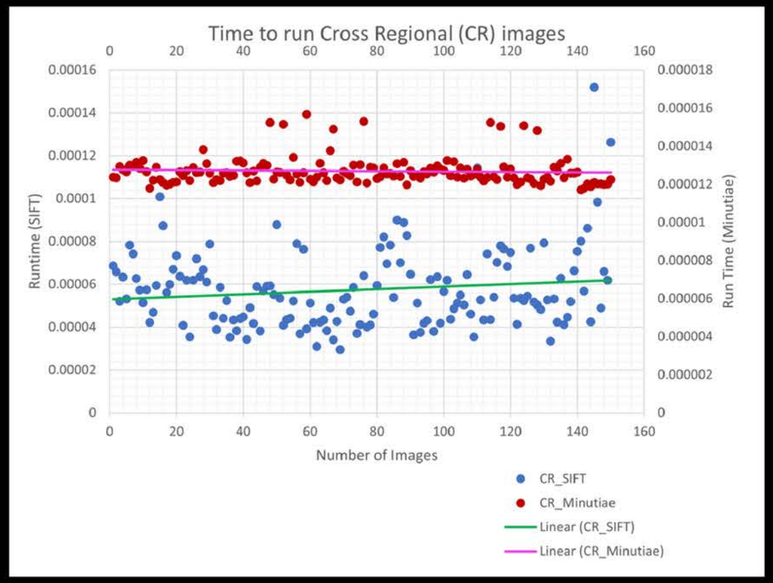
RESULTS

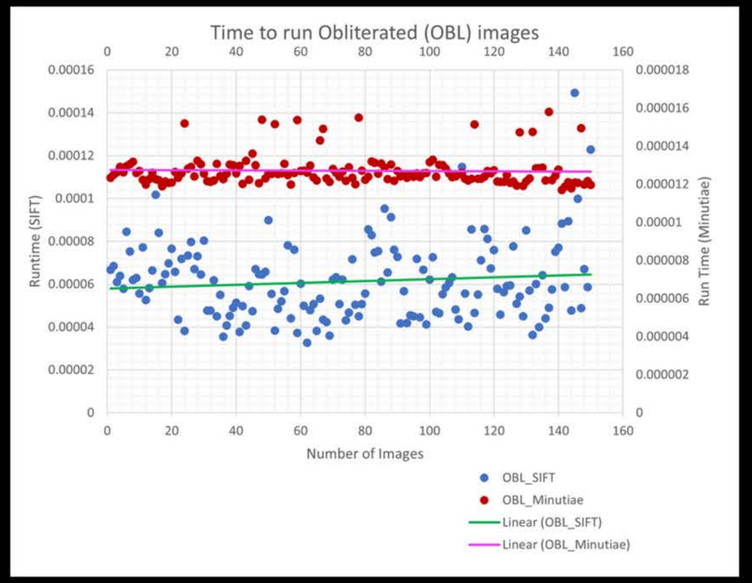
Results were collected from information provided by the GUI after running on multiple sets of fingerprint images with their respective altered versions.

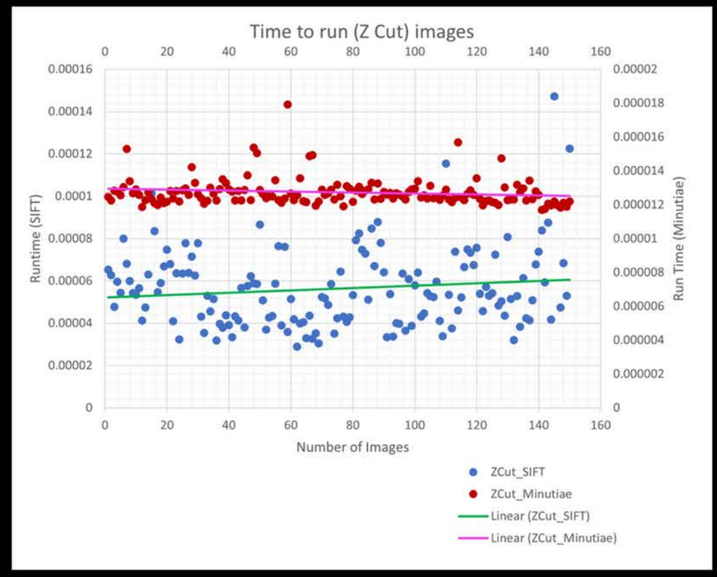
The results were then compiled into an excel sheet. The data was analyzed and trendlines were found. From this, conclusions were drawn

RESULTS


Results of Matches
Percentage of Images
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
41.78%
28.00%
37.56%
15.10%
20.67%
58.59%
Good Matches
Low Match
No Match
SIFT
41.78
37.56
20.67
Minutiae
28
15.1
58.59


Time to run Cross Regional (CR) images
Runtime (SIFT)
Run Time (Minutiae)
Number of Images
CR_SIFT
CR_Minutiae
Linear (CR_SIFT)
Linear (CR_Minutiae)


Time to run Obliterated (OBL) images
Runtime (SIFT)
Run Time (Minutiae)
Number of Images
OBL_SIFT
OBL_Minutiae
Linear (OBL_SIFT)
Linear (OBL_Minutiae)


Time to run (Z Cut) images
Runtime (SIFT)
Run Time (Minutiae)
Number of Images
ZCut_SIFT
ZCut_Minutiae
Linear (ZCut_SIFT)
Linear (ZCut_Minutiae)

CONCLUSION

Both algorithms can be implemented using the python programming language as well as their processes visualized

Scale Invariant Feature Transformation (SIFT) is more likely to identify subjects with distortions on their fingerprints such as cuts compared to Minutiae

Both algorithms have good performance, running under 3 milli seconds on a database containing 500,000 sample fingerprint images

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THANK YOU!

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