# Fingerprint Matching Using Digital Image Processing

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## ABSTRACT

*Biometric systems operate on behavioral and physiological biometric parameters to identify an individual. Every fingerprint has unique features and its recognizing system mainly works on local ridge feature such as ridge endings, minutiae, core point, delta, etc. However, fingerprint images get degraded and corrupted due to variations in skin and impression conditions. The more critical step in fingerprint matching is to reliably extract minutiae from the input fingerprint images. This paper presents a review of a number of techniques present in the literature for matching fingerprints.*

**Keyword:** *Fingerprint Images, Minutiae Extraction, Ridge Endings, Ridge Bifurcation, Fingerprint Recognition.*

## 1. INTRODUCTION

Biometrics is the science of recognizing uniqueness of humans based upon one or more intrinsic physical or behavioral traits. Biometric systems operate on behavioral and physiological biometric parameters to identify an individual. The behavioral biometric parameter includes signature, gait, speech and keystroke, which are keep changing with age and environment. However physiological characteristics such as face, fingerprint, palm print and iris remain the same throughout the life time of an individual. The biometric system can be used as verification mode or identification mode depending on the requirement of an application. The verification mode validates the individual's feature by matching against an existing database and the identification mode recognizes individuals among number of fingerprints. The quality of the fingerprint image is of critical importance therefore a good quality fingerprint must contain at least 25 to 80 minutiae. It is quite difficult to extract reliably minutia from poor quality fingerprint impressions which are due to very dry fingers and fingers mutilated by scars, scratches due to accidents, injuries or non-uniform contact with the fingerprint capture device. Fingerprint identification is commonly employed in forensic science to aid criminal investigations etc. A fingerprint is a unique pattern of ridges and valleys on the surface of a finger of an individual. False accept rate (FAR) specifies the performance of a bio-metric system. There should be a decision boundary which minimizes the false reject rate(FRR)for the specified

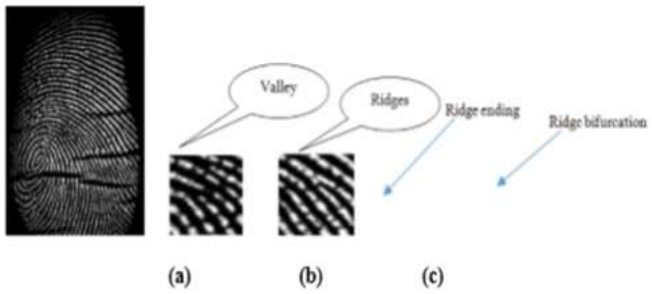


**Fig1. Basic Finger Print Image (b) Ridge Ending (c) Ridge Bifurcation**

Effects of a system are not straightforward and the simplification of block diagrams is required. The signal flow graph (SFG) developed by Mason, which is based on a representation of a system by line segments, is used to simplify block diagrams. When using the SFG method, the cause-and-effect relationships are normally obtained by

applying `Mason's gain formula'. Applying the formula however involves a relatively complex process such as identifying the nodes, the various paths (forward/loop, touching/non-touching) and calculating the corresponding path gains. Block diagrams can also be simplified using the rules of `block diagram algebra'. This too is a relatively complex process where up to 33 rules were introduced that may need to be applied. In this paper, a novel concept, the concept of main/branch stream and the corresponding shifting rule are introduced to simplify the complexity of the rules in the simplification of block diagrams using the block diagram algebra. A brief review of the block diagram basics is presented in part A of section II. The current practice in the simplification of block diagrams and the proposed alternative approach in the simplification of block diagrams using the novel main/branch stream concepts and the corresponding shifting rule are described in part B and C of section II respectively. Two illustrative examples are given in section III, which is followed by the conclusion.

**FINGERPRINT FEATURES**

Fingerprint features can be classified into three classes [7, 29]. Level 1 feature gives macro level details of the ridge flow, Level 2 feature gives minutiae points which are discriminative enough for recognition, and Level 3 feature gives pores of the fingerprint which complement the uniqueness of Level 2 feature.

**GLOBAL RIDGE PATTERN**

There are two types of ridge flows: the pseudo-parallel ridge flows and high-curvature ridge flows which are located around the core point and/or delta point(s). This representation relies on the ridge structure, global landmarks and ridge pattern characteristics. The commonly used global fingerprint features are:

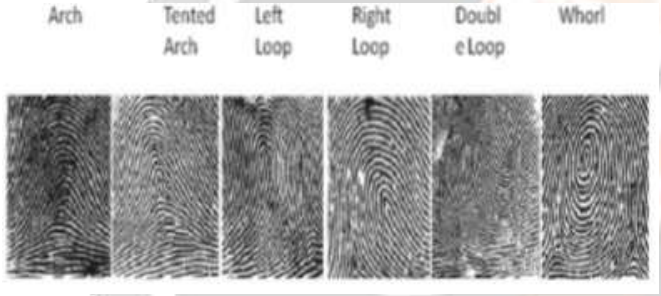


**Fig 2. Global Finger Print Ridge Pattern**

Techniques for Fingerprint Matching

- Minutia based
- Pattern matching
- Correlation based
- Image based Minutiae Based Matching

Techniques based on minutia represent the fingerprint by its local features, like terminations (ridge ending) and bifurcations. Two fingerprints match if and only if their minutiae points match with each other. This technique is treated as backbone of fingerprint recognition products. One of the example can be found in proposed algorithm of in which minutiae are extracted and then an affine transformation model is applied between the points and solved it using Ransac algorithm. Philippe Parra [2], proposed algorithm based on Fingerprint Recognition using Minutia Score Matching method work well as compare to Fingerprint Recognition Fuzzy Neural Network (FRFNN). Anil Jain et.al[20], has proposed novel hybrid method which is combination of texture based and minutia based matching technique which leads to substantial improvement in performance in overall matching performance as shown in graph below(fig 6) which shows that performance of hybrid method is more than only minutiae based.

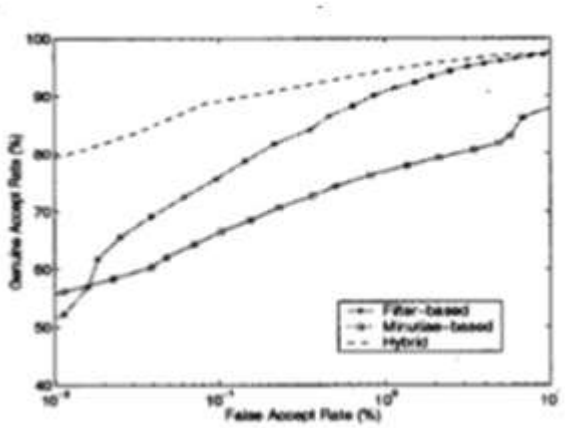

**Fig 3. ROC curve comparing the performance of hybrid technique with minutiae based approach**

**PATTERN BASED MATCHING:**

This technique also known as Ridge Feature Based Techniques. It is suffering from disadvantages such as being sensitive to proper placement of finger and the need of large storage for templates. Correlation Based matching. Result based on this principal is rarely accepted because of several reasons such as Non-linear distortion, Skin condition and finger pressure cause image brightness, contrast variation, and the technique is computationally very expensive. Image Based matching: Image based matching techniques try to match based on the global features of a whole fingerprint image showed that reinforcement learning for minutia detection. Arivazhagan has proposed method based on Gabor wavelet and co-occurrence matrices to obtain fingerprint code for fingerprint verification has proposed method based on the statistical descriptor for the characterization of co-occurrence matrices and for the result analysis Rate Estimation and statistical summaries program used has proposed a hybrid algorithm which combines phase-based image matching and feature-based matching technique for improvement of matching performance of both fingerprint images with poor image quality and with non linear shape distortions.

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