



# Fingerprint Recognition

CPE409 Image Processing

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# Introduction

**Biometric:** A human generated signal or attribute for authenticating a person's identity Operate on Behavioral/Physical features.

Physical biometric features are:

- Face
- Fingerprint
- Iris
- Signature
- Voice

# Introduction

- Fingerprints are most useful biometric feature in our body.
- Due to their durability, stability and uniqueness fingerprints are considered the best passwords.
- In places of access security, high degree authentication, and restricted entry, fingerprints suggests easy and cheap solutions.

# What Is Fingerprint ?

- A fingerprint is the feature pattern of one finger.
- A fingerprint is collection of many ridges and furrows (Valleys).
- The continuous dark pattern flow in fingerprint is called ridges and the light area between ridges is called furrows.
- Fingerprint has some unique points on the ridge which is known as minutiae point.
- A ridge ending is defined as the point where a ridge ends abruptly.
- A ridge bifurcation is defined as the point where a ridge forks or diverges into branch ridge.



Fig: Fingerprint[1]

# Why Fingerprints?

## **The advantages of using fingerprint**

- fingerprint identification is one of the most reliable identification technique.
- Fingerprint identification is acceptable in a court of law.
- A fingerprint is an individual characteristic.
- Fingerprints will remain unchanged during an individual's lifetime.



# What is Fingerprint Recognition?

- Fingerprint recognition is the process of comparing questioned and known fingerprint against another fingerprint to determine if the impressions are from the same finger or palm.
- The fingerprint recognition problem can be grouped into two sub-domains:
  - fingerprint verification
  - fingerprint identification.
- Fingerprints are highly reliable for of identification because of their uniqueness and consistency over time.

➤ Fingerprint verification :

- Fingerprint verification is to verify the authenticity of one person by his fingerprint.

➤ Fingerprint identification:

- Fingerprint identification is to specify one person's identity by his fingerprint(s).

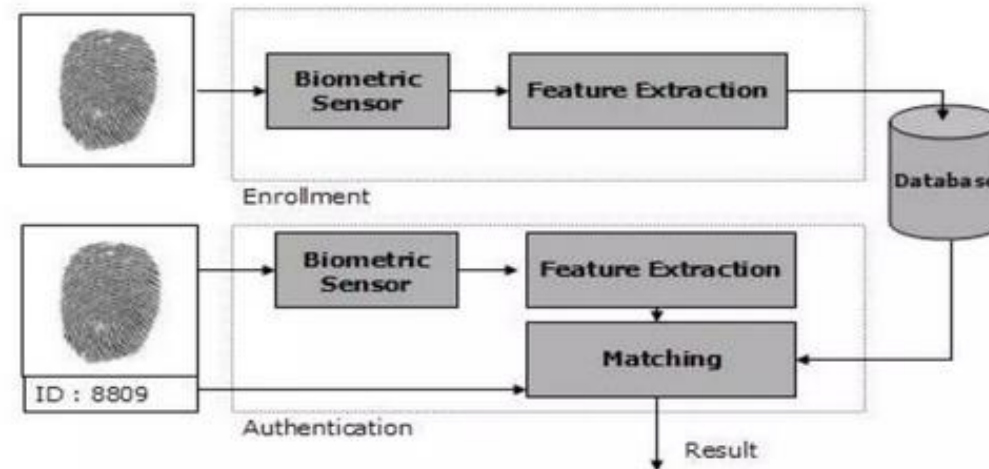


Fig.Verification vs. Identification



# Fingerprint Patterns & Features

Minutia Features : - Minutiae are major features of a fingerprint, using which comparisons of one print with another can be made.

- Ridge ending - the abrupt end of a ridge.
- Ridge bifurcation - a single ridge that divides into two ridges.
- Short ridge, or independent ridge - a ridge that commences, travels a short distance and then ends.
- Island - a single small ridge inside a short ridge or ridge ending that is not connected to all other ridges.
- Ridge enclosure - a single ridge that bifurcates and reunites shortly afterward to continue as a single ridge.
- Spur - a bifurcation with a short ridge branching off a longer ridge.
- Crossover or bridge - a short ridge that runs between two parallel ridges.
- Delta - a Y-shaped ridge meeting.
- Core - a U-turn in the ridge pattern.

# Fingerprint Patterns & Features



Ridge  
Ending

Ridge  
Bifurcation



crossover

core

bifurcation

ridge ending

island

delta

pore

# Techniques For Fingerprint Matching

- Minutiae-based matching
  - minutiae capture much of individual info.
  - minutiae based representations are storage efficient robust to fingerprint degradation.

## Flow of the presentation:

➤ This particular method of fingerprint matching consists mainly of seven stages.

1. Load Image
2. Enhancement
3. Binarization
4. Region of interest
5. Thinning
6. Minutiae Extraction
7. Matching

# Enhancement

- The performance of minutiae extraction algorithms depends on quality of images
- In general, due to skin conditions (e.g. dry, wet, bruise, etc.), sensor noise, incorrect finger pressure, and inherent low quality fingers, many fingerprints acquired are of low quality.
- Leads to problems in minutiae extraction
- Enhancement improves the clarity of ridge and valley structures in the
  - fingerprint images.
- Histogram equalization method is used for image enhancement

# Binarization

- We have perform binarization on the grayscale image which have image intensity value between (0-255).
- Benefits of grayscale image.
- A Fingerprint-Image-Binarization transforms an 8-bit gray image to a 1-bit binarized image where 0-value holds for ridges and 1-value for furrows.
- An adaptive binarization method is achieved to binarize the fingerprint image.



# Region of interest

- A region of interest are samples within a data set identified for a particular purpose.
- The concept of a ROI is commonly used in many application areas.
- For example, in medical imaging, the boundaries of a tumor may be defined on an image or in a volume, for the purpose of measuring its size.

# Thinning

- Thinning is a operation that is used to remove selected foreground pixels from binary images.
- Reduces the width of the ridges to one pixel.
- Filling holes, removing small breaks, eliminating bridges between ridges etc.



## Example of fingerprint thinning



# Minutiae Extraction

- A ridge bifurcation is defined as the point where a ridge forks or diverges into branch ridges.
- Collectively, these features are called minutiae.
- Most of the fingerprint extraction and matching techniques restrict the set of features to two types of minutiae:
  - I. ridge endings
  - II. ridge bifurcations.
- Most fingerprint recognition systems are based on minutiae matching, but a reliable minutiae matching algorithm requires accurate minutiae extraction.
- Therefore, minutiae extraction is an extremely important step in the whole system, especially in low-quality images where noise may hide the real minutiae.

# Matching

- Minutiae matching is the step which comes after minutiae extraction and it is here that we match the minutiae obtained from two sample fingerprint images and test whether they are from the same fingerprint or not.
- Minutiae matching are performed for verification. Basically, minutiae Matching are a process which completed in two steps:
  - 1)Find Total Minutia Points
  - 2)Find Location of Minutiae Points.



# Advantages

- Physical attributes are much stronger to be faked than ID cards.
- Fingerprints can't be guessed unlike passwords.
- Fingerprints can't be misplaced unlike a card.
- Fingerprints can't be forgotten unlike passwords.
- Sudden enhancement in the current security level.
- Less security concerns lead to increased productivity.



# Disadvantages

- High efficiency needed as the fields of application are related to security.
- It can be trick by a picture or a mold of finger using Gelatin.
- Fingerprints if stolen, can be a great threat to Security and intellectual property.
- Requires a very large data base of fingerprints.
- Some of the employees may find it uncomfortable to have their fingerprint stored with the employer.

# Applications

- Financial services (e.g. ATM )
- Immigration & border control (e.g. points of entry declared for frequent travelers, passport and visa cases )
- Social services (e.g. fraud prevention in entitlement programmers)
- Health care (e.g. security measure for privacy or medical records)
- Physical access control (e.g. at institutional, government & residential establishment)
- Time & attendance (e.g. replacement of time punch card)
- Computer Security (e.g. personal computer access, network access, Internet use, e-commerce, e-mail, encryption)
- Telecommunications (e.g. mobile phones, call center technology, phone cards, televised shopping)
- Law enforcement (e.g. criminal investigation, national ID, driving license, rehabilitation institutions/prison, home confinement, small gun)

# Thanks!

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