Filterbank-Based Fingerprint Matching

Multimedia Systems Project

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Presentation overview

- Introduction
- Background
- Algorithm
- Limitations and Improvements
- Conclusions and future work
Introduction

Filterbank-Based Fingerprint Matching

• Biometrics
• Operating modes – Verification mode, Identification mode
• Fingerprints: One of the most mature and proven technique
• Unique and Permanent
Introduction

- Determine the region of interest with respect to a reference point
- Use of Gabor Filterbank to capture both local and global details in a fingerprint
- Matching based on the Euclidean distance between the FingerCodes
Background

- **Types of Fingerprints:**
  - Arch, Tented Arch, Whorl, Loop

- **Fingerprint Features**
  - Core - Top of the innermost recurving ridge
  - Delta - Point where the ridges diverge
  - Minutiae - local ridge anomalies; bifurcation or ridge ending
Fingerprint Matching

• Minutiae-based
  - Detecting minutiae points
  - Matching relative placement of minutiae in a given finger and the stored template
  - Sensitive to image quality (spurious minutiae, missing genuine minutiae)
  - Does not capture global information
• **Graph based and point pattern-based**
  - Matches minutiae from two fingerprints after aligning the unregistered minutiae points of different sizes
  - Computationally expensive

• **Correlation-based technique**
  - Match the global patterns of ridges and valleys to determine if the ridges align
  - Does not offer good individual discrimination
Authors and their publications

• **Local Correlation-based Fingerprint Matching**
  Anil K. Jain, Karthik Nandakumar

• **Fingerprint Matching Using Minutiae And Texture Features**
  Anil K. Jain, Arun Ross, Salil Prabhakar

• **Online Fingerprint Verification**
  Anil K. Jain, Lin Hong, Ruud Bolle
• **Gabor Filter**
  - Used to extract features such as fingerprint core, the parallel ridges and valley
  - For small scale fingerprint recognition system
  - Computationally economical
• **Filterbank-Based Fingerprint Matching**
  - Fingerprints are represented as fixed length codes called FingerCodes
  - Matching done using Euclidean distance between FingerCodes
  - Application-easy to store on smartcard and credit card
Algorithm

- Ridge Map Orientation
- Reference Point Detection
- Sector Based Normalization
- Gabor Transform
- Generating FingerCode (collection of all features)
- Matching Based on Euclidean Distance between the FingerCodes.
Ridge Map Orientation

- Dividing image into nonoverlapping blocks.
- Calculating gradients at each pixel.
- Estimating Local Orientations of each block.
- Smoothening Orientation field using local averaging filter.
Smoothened Orientation field
Reference Point Detection

- The sine component of the smoothened Orientation field is computed.

\[ A(i, j) = \sum_{R_I} \mathcal{E}(i, j) - \sum_{R_{II}} \mathcal{E}(i, j). \]
Reference Point Detection

Smooth orientations on Normalized Image
Sector Based Normalization

- **Why normalization?**
  - To remove effects of sensor noise and gray level deformation due to finger pressure.

- **Sector based normalization?**
  - Normalization in entire Image cannot compensate for intensity variations
  - Local normalization more effective
Sector Based Normalization
Gabor Transform

- Why Gabor Transform?
  - Extracts both local and global features.
- Tuned for 0, 22.5, 45, 67.5, 90, 112.5, 135, 157.5 degrees
- Why Gabor Filterbank?
  - Fingerprint –oriented texture
Gabor Transform
Gabor Transform
Feature Vector (FingerCode)

- Extracting local features from each sector
- Feature is the average absolute deviation from the mean for each sector
- The combination of all features form a FingerCode
Matching

- Cyclically rotating features in the FingerCode
- Rotation of FingerCode corresponds to rotation of actual Fingerprint
- Storing templates corresponding to five rotations of the FingerCode for each fingerprint
- Input test FingerCode matched with five templates stored in the database
- If matching score (Euclidean Distance) is less than threshold, then the test fingerprint is said to be matched
Advantages and Disadvantages

- Translation Invariant
- Rotation Invariant
- Not sensitive to image quality
- FingerCode formed requires very less memory
- No extensive preprocessing techniques
- Gabor Transform is time consuming
- Not efficient for large database
Limitations

- Background Image orientations considered for finding reference point lead to incorrect position of reference point.
- The feature vectors thus formed are also incorrect.
- Reference point detection not consistent for arch type fingerprints.
Suggestions

• Segment the actual fingerprint from the background and then find the reference point. The unnecessary interference of the orientations of the background is removed by this technique.

• The feature vectors so formed are robust as they don’t depend on the background.
Background Separation

Original Image

Actual Fingerprint Area
Conclusions

• The algorithm works fairly well for Core point detection for whorls, left loops and right loops as there is a lot of activity around the core point of these fingerprints.

• The matching accuracy of the fingerprints is Good.
Future work

• Batch Testing of the algorithm to find out the False Acceptance rate and the false detection rate.

• Efficient reference point detection for arch type fingerprints.
Thank you !!!