Online Fingerprint Verification

INTERNATIONAL INSTITUTE OF INFORMATION TECHNOLOGY

HYDERABAD

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By

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Fingerprint verification

Two phases

- Minutiae Extraction
  - Image Acquisition
  - Image Enhancement
  - Image Morphology
- Minutiae Matching

Minutiae extraction

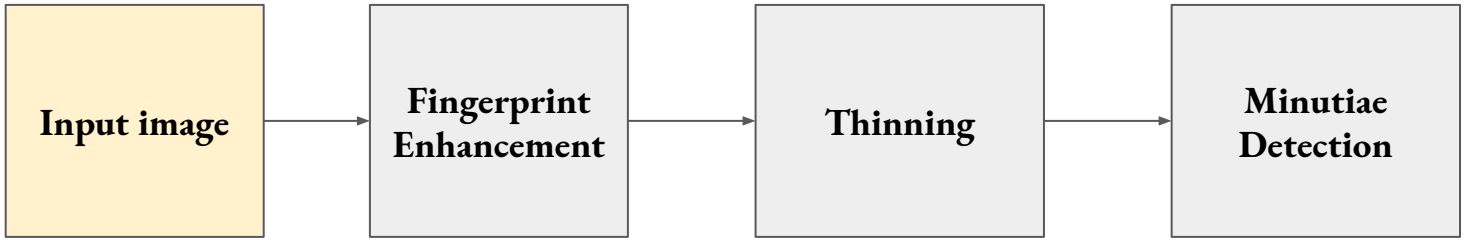
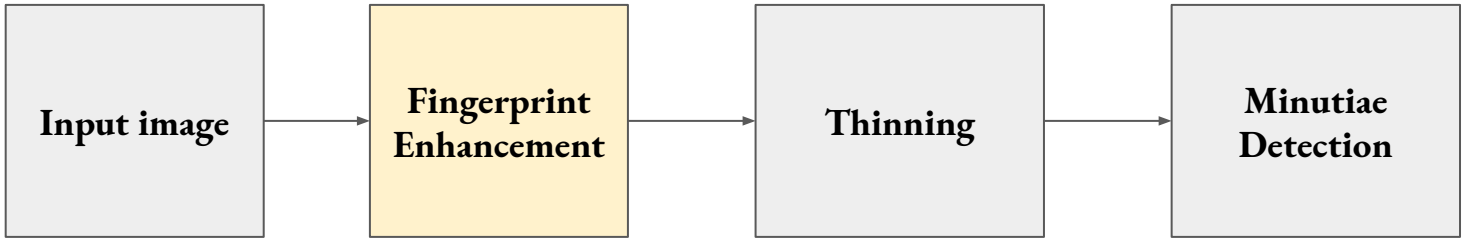


Image Acquisition

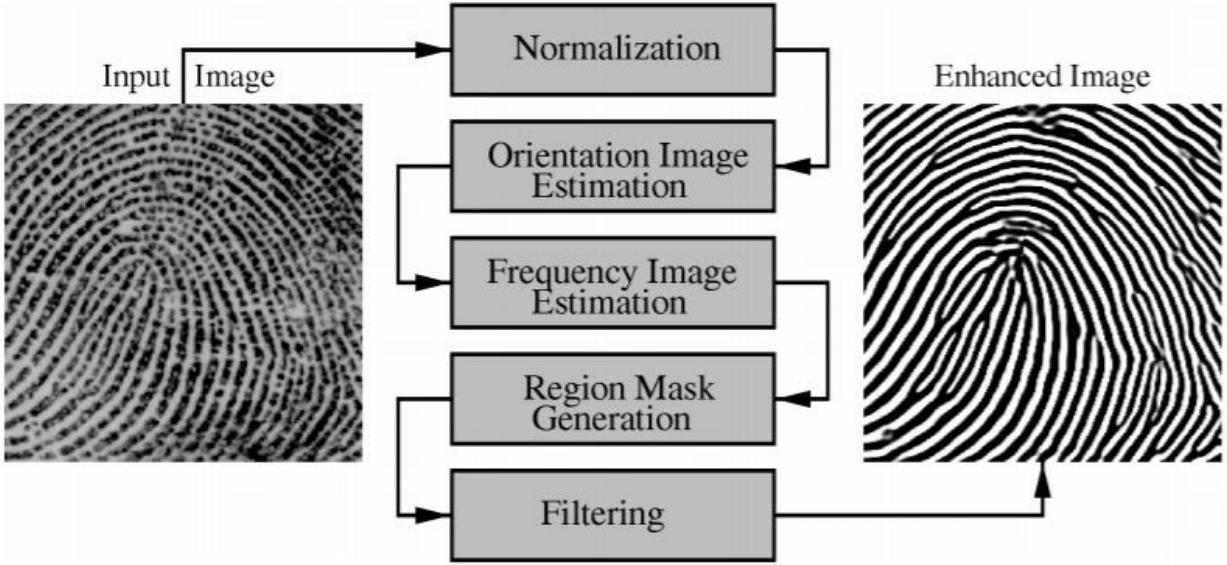
Assumptions

- All fingerprint images are taken from unique fingerprint scanner.
- Images are captured at 500 DPI
- All fingerprints are 8-bit images

Minutiae extraction



Fingerprint Enhancement[1]



Flow chart of fingerprint enhancement algorithm

[1] Lin Hong, Student Member, IEEE, Yifei Wan, and Anil Jain, Fellow, IEEE *Fingerprint Image Enhancement: Algorithm and Performance Evaluation.*

Fingerprint Enhancement

Four step process

- Ridge Segmentation
  - Image is normalized so that it has a prespecified mean and variance
  - Returns the segmented ridge region image
- Ridge Orientation
  - Find orientation of each window(16x16) by using the formula on the right side

$$V_x(i,j) = \sum_{u=i-\frac{w}{2}}^{i+\frac{w}{2}} \sum_{v=j-\frac{w}{2}}^{j+\frac{w}{2}} 2\partial_x(u,v)\partial_y(u,v),$$

$$V_y(i,j) = \sum_{u=i-\frac{w}{2}}^{i+\frac{w}{2}} \sum_{v=j-\frac{w}{2}}^{j+\frac{w}{2}} \left(\partial_x^2(u,v)\partial_y^2(u,v)\right),$$

$$\theta(i,j) = \frac{1}{2}\tan^{-1}\left(\frac{V_y(i,j)}{V_x(i,j)}\right),$$

Ridge orientation at each pixel (i,j)

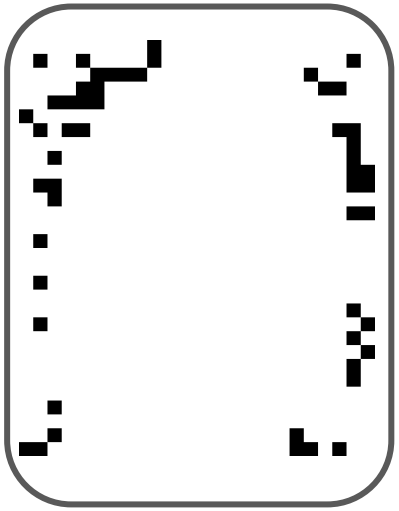
Fingerprint Enhancement (Continued)

Four step process (continued)

- Ridge frequency estimation
  - Compute the rate at which number of ridges/valleys appear in the block (16x16)
  - Typically lies between (1/3 to 1/25)
  - If not in this range, we can safely assume, no ridge is present
  - This information is used to fix the breaks in ridges
- Gabor filtering to remove noise between fingerprint ridges
  - Bandpass filter to remove pixel lying outside the frequency obtained in last step

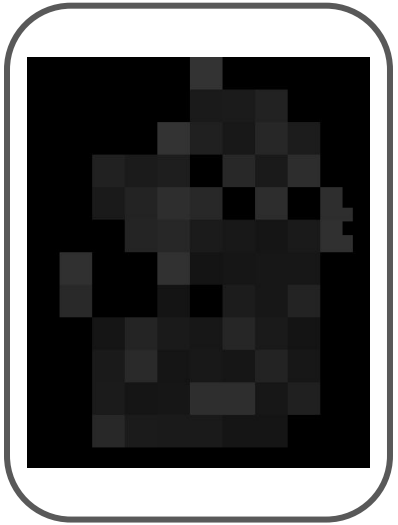
Fingerprint Enhancement (Continued)

Normalized Image



Mask Image

Orientation Image

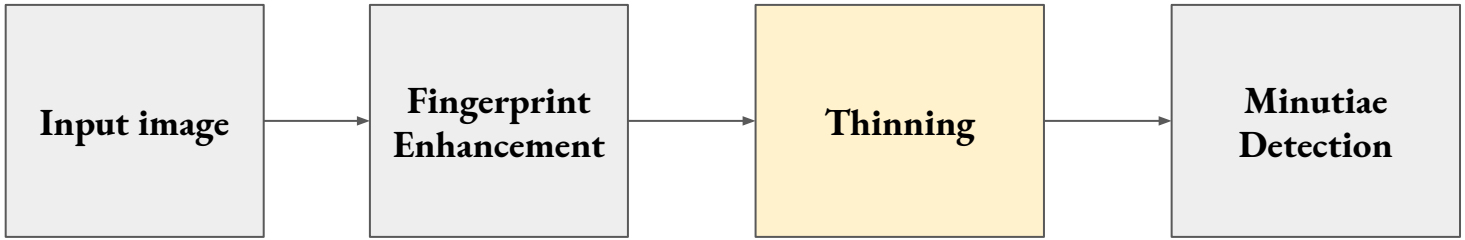


Frequency Image

Fingerprint Enhancement (Continued)

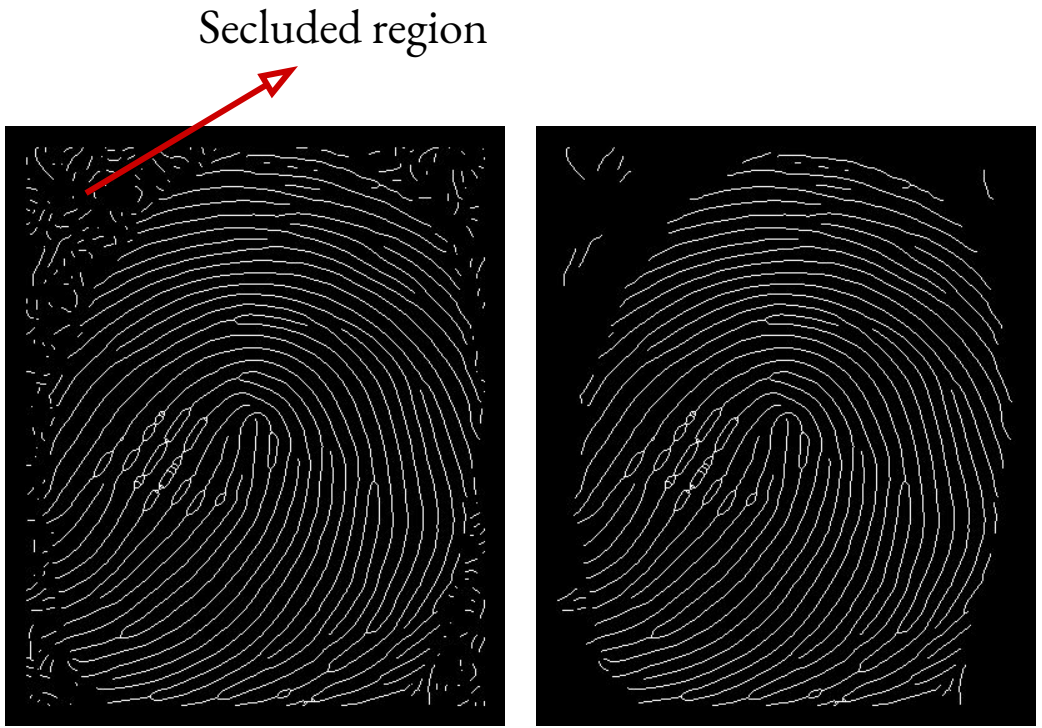
Enhanced Image

Minutiae extraction

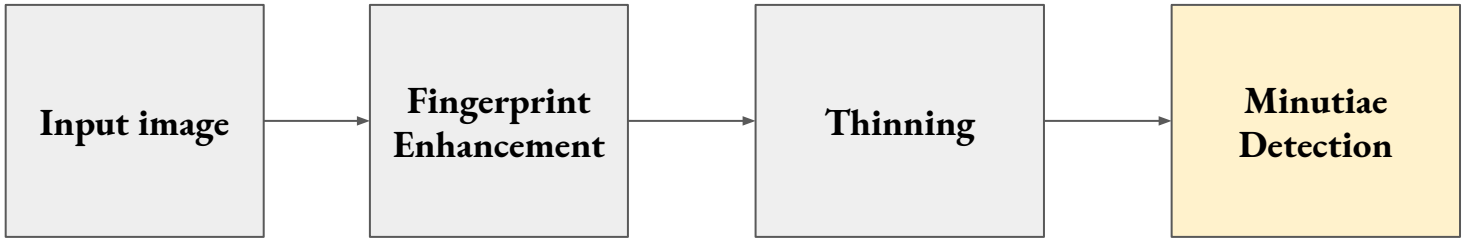


Thinning

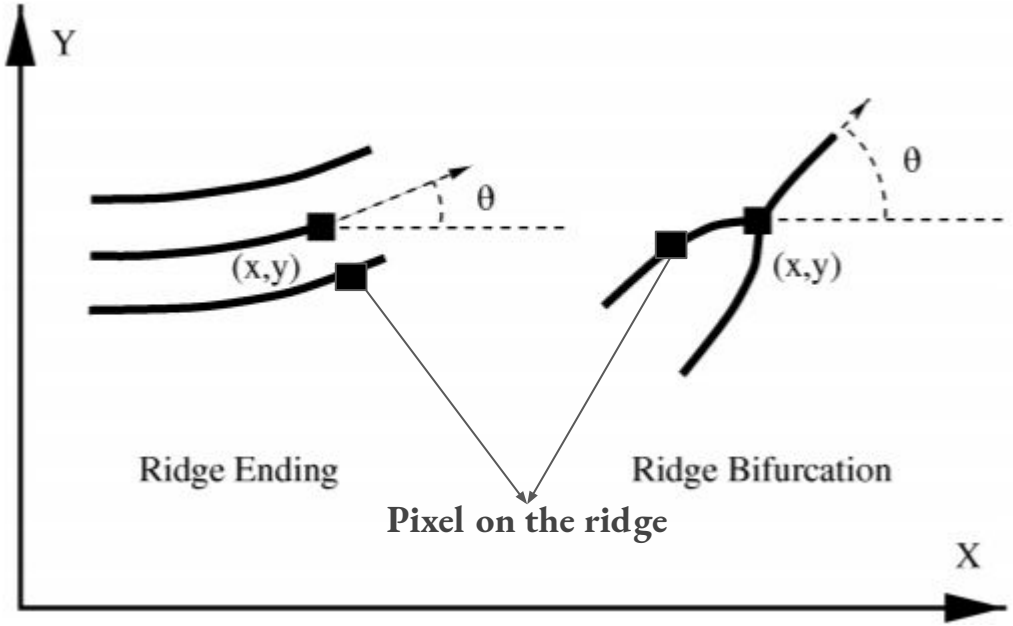
- Use Morphological operation
  - Skeletonization
- Remove noise lying outside of fingerprint mask (Novelty step)
  - Remove secluded points
  - A window with all boundary pixels belonging to background is marked background.



Minutiae extraction



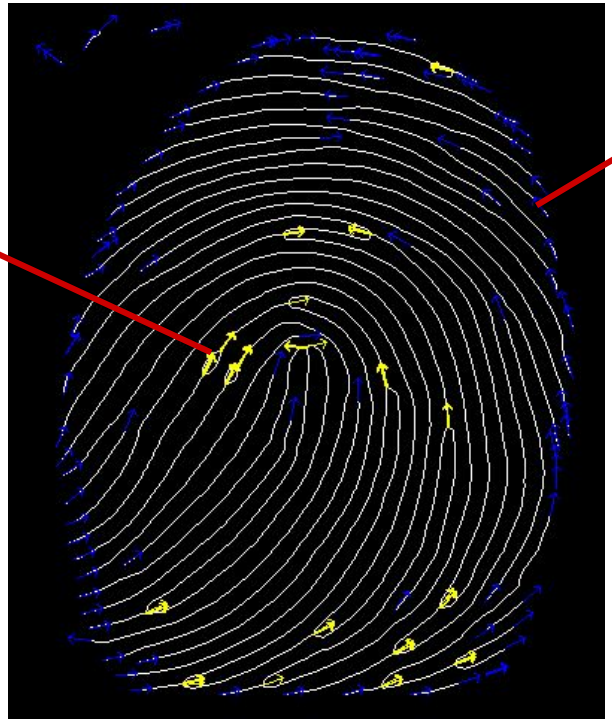
Minutiae Detection



Ridge Ending - One Foreground neighbor
Pixel on the ridge - Two Foreground neighbors
Ridge Bifurcation - More than two foreground neighbors

Minutiae Detection

Ridge Bifurcations



Ridge Endings

Blue arrows - Ridge Endings
Yellow arrows - Ridge Bifurcation

Minutiae Matching

- Minutiae points for template fingerprints are present in database
- For input image,
    - Obtain enhanced skeletonized image
    - Obtain minutiae
    - Obtain Keypoints and Descriptors for minutiae
    - Apply Brute Force Matcher

Work Division

- Umesh
  - Segmentation
  - Orientation estimation
  - Frequency image
  - Finding minutiae
- Priyanka
  - Data collection
  - Filtering
  - Morphology
  - Matching

Thank You