

Identification of time-invariant
unique features of Objects

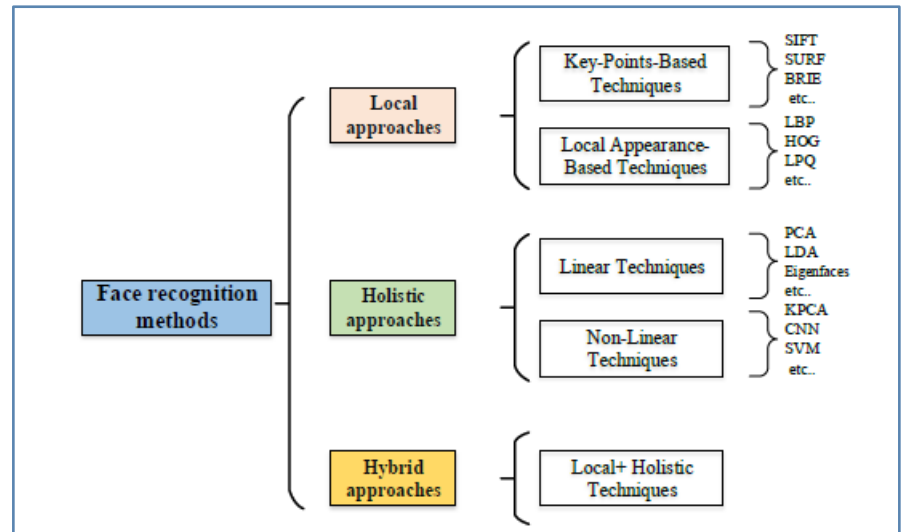
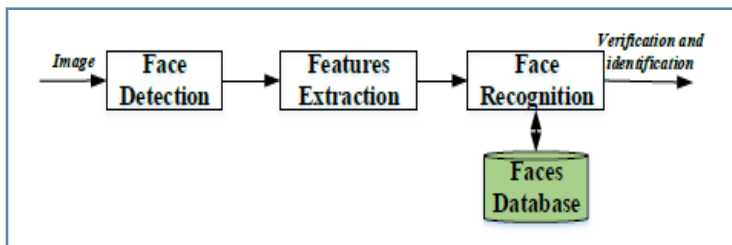
- Task 1:
 - Analysis on the algorithms and techniques used in Biometric recognition use case, for recognising unique features.
- Task 2:
 - Understanding ‘Phylogenetics’ to model evolutionary behaviour of a complex system, eg: biological systems, financial systems, linguistics structure.

Task 1

- Biometric recognition
 - Finger print recognition
 - Facial recognition
 - Iris recognition
 - voice recognition

1.1 face recognition

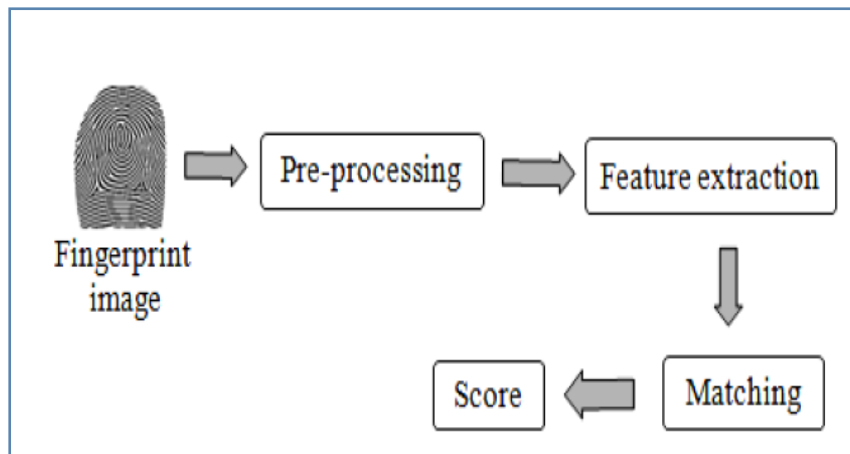
- This is computer vision problem, for which there exists a lot of heuristic techniques for feature recognition and classification.
- The general pipeline of facial recognition works as below:
- The various approaches are used to identify 'Unique features'.



1.1 extension of facial recognition in our use case

- Image == signal + noise == our feature vector
- pre processing:
 - Facial images have a preprocessing step which removes background noise from the main signal as much as possible.
 - In our use case, the precision of the sensors will define the proportion of background noise.
- Feature extraction:
 - based on the chosen approach. (local approach, holistic, hybrid etc.,)
 - Depends highly on the nature of feature
- Matching:
 - Similarity measure, Distance measures etc for finding best matches for the representation of sample instance.
 - The input is represented in different/simpler format to compare with the database. Technique depends on the nature of the representation and use case.

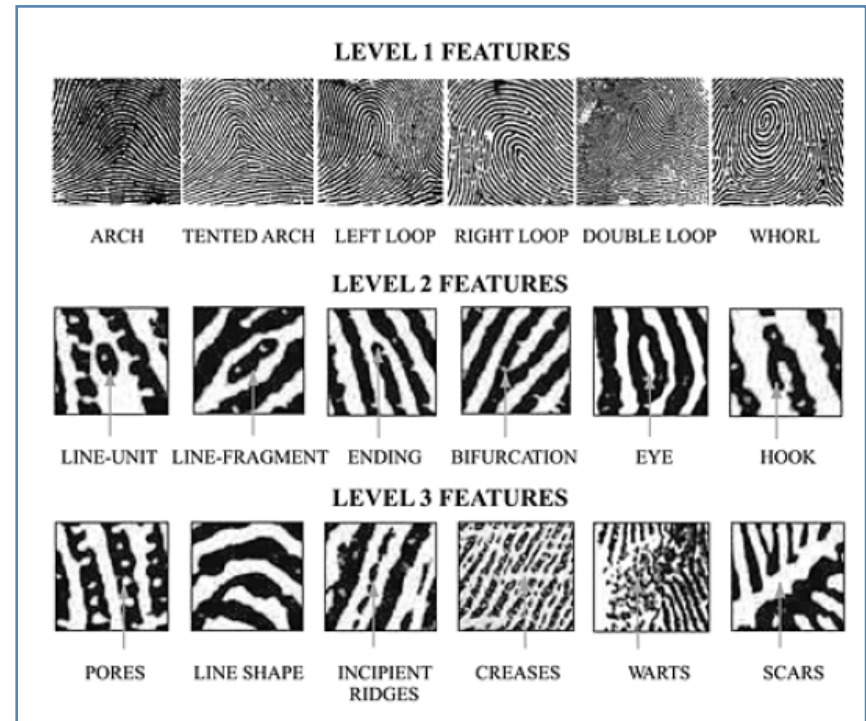
1.2 Finger print recognition



Methods	
Method	Features
Image-based method	Pixel intensities [30]; Texture features such as Gabor response [30] [32], LBP [33], [41], HoG [34]
Ridge feature-based method	Ridge orientation [35], Ridge frequency [36], Ridge count [42]
Level 3 feature-based method	Pores [28], Dots and incipient ridges [37], Ridge contour
Feature-point-based method	Key-points such as SIFT [38], A-KAZE [39], [40]

1.2 features/Minutiae extraction

- Descriptors:
 - descriptors like SIFT, HOG, ORB etc are scale and rotation invariant in nature.
 - Such descriptors at mineutea points define them uniquely.

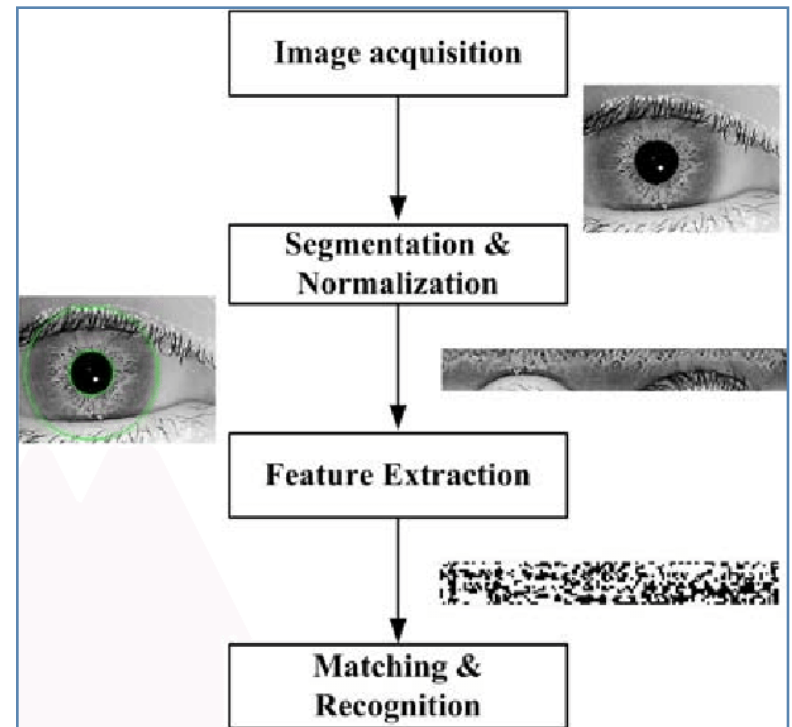


1.2 extension of fingerprint recognition in our use case

- Simplified representation:
 - Finger prints are in a way simplified 2d representations of the ridge data on fingers
 - Such conversion of data into 2d format will be useful because now we can use already available knowledge of computer vision techniques.

1.3 Iris recognition

- Impact of external background noise sources can be reduced by using NIR images.
- Feature extraction:
 - Wavelet transforms
 - Gabor filters
 - Laplacian of Gaussian filters etc.,

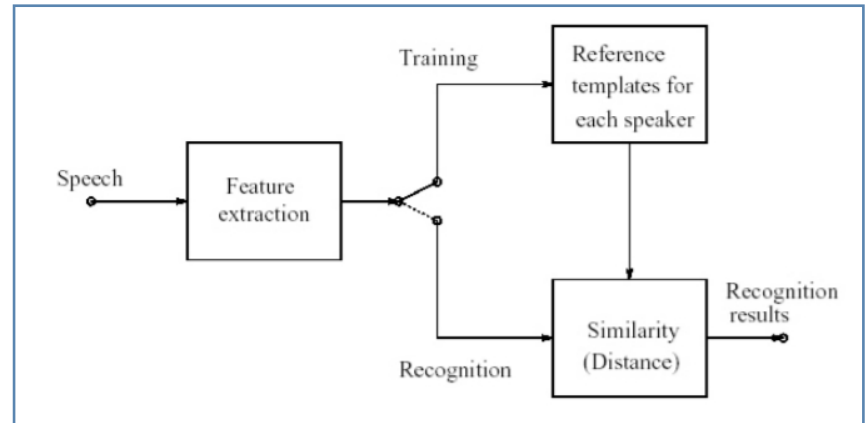


1.3 extension of iris recognition in our use case

- Similar approach of conversion of Complex iris data into simplified 2d image data, followed by usage of computer vision techniques to identify unique features.

1.4 Voice recognition

- Features for Speaker Recognition
 - Frequency Band Analysis
 - Formant Frequencies
 - Pitch Contours
 - Coarticulation etc



References:

- finger print recognition:
 - https://www.youtube.com/watch?v=xD88Qs_DZp4&ab_channel=Computerphile
 - https://www.researchgate.net/publication/338208317_A_Survey_on_State_of_the_Art_Methods_of_Fingerprint_Recognition
- facial recognition:
 - https://www.researchgate.net/publication/338474835_Face_Recognition_Systems_A_Survey
 - chapter 6 of “OpenCV 3 Blueprints” by Quan Hua, Steven Puttemans, Utkarsh Sinha, Joseph Howse
- iris recognition survey:
 - https://www.researchgate.net/publication/282296433_Iris_recognition_techniques_A_Literature_Survey
 - Chapter 25 “How Iris Recognition Works” by Mr. John Daugman from the book “The essential guide to image processing”
- phylogenetics risk assessment:
 - <https://www.actuaries.asn.au/Library/Events/SUM/2013/Sum2013PaperJoshua%20Corrigan%20Neil%20Allan.pdf>
- Phylogenetics:
 - “ <https://link.springer.com/article/10.1007/s12064-018-0264-7> “ Phylogenetics beyond biology
- sound recognition:
 - https://www.youtube.com/watch?v=mJx30g3bzQo&ab_channel=Computerphile
 - https://www.ee.iitb.ac.in/~esgroup/es_mtech03_sem/sem03_paper_03307409.pdf