SVM for Hand Based Identification

Biometric Systems Project 2024-25

SAPIENZA
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Goal & Used Technologies

Goal

Train and test a classifier for individual identification based on the hand's anatomical features, exploiting things such as size, shape, texture and hand proportions

How

After having separated the images and having executed the preprocessing phase, handcrafted features are extracted and uses to train a SVM
For each side and each feature extractor used, a separate SVM is trained
The results are then combined to achieve multi biometric identification

Dataset

Using “11k Hands dataset” an open access dataset

Characteristics

- 11,076 hand images of size 1600x1200 pixels
- 190 subjects of varying ages between 18 - 75 years old
- Photos of both hand sides (palm and dorsal)
- Multiple varying pictures for each subject
- Metadata record associated to every image

Metadata

Available metadatas for each image:

1. subject ID
2. subject gender
3. subject age
4. hand skin color
5. hand side
6. right or left hand
7. presence of accessories or nail polish

Dataset management

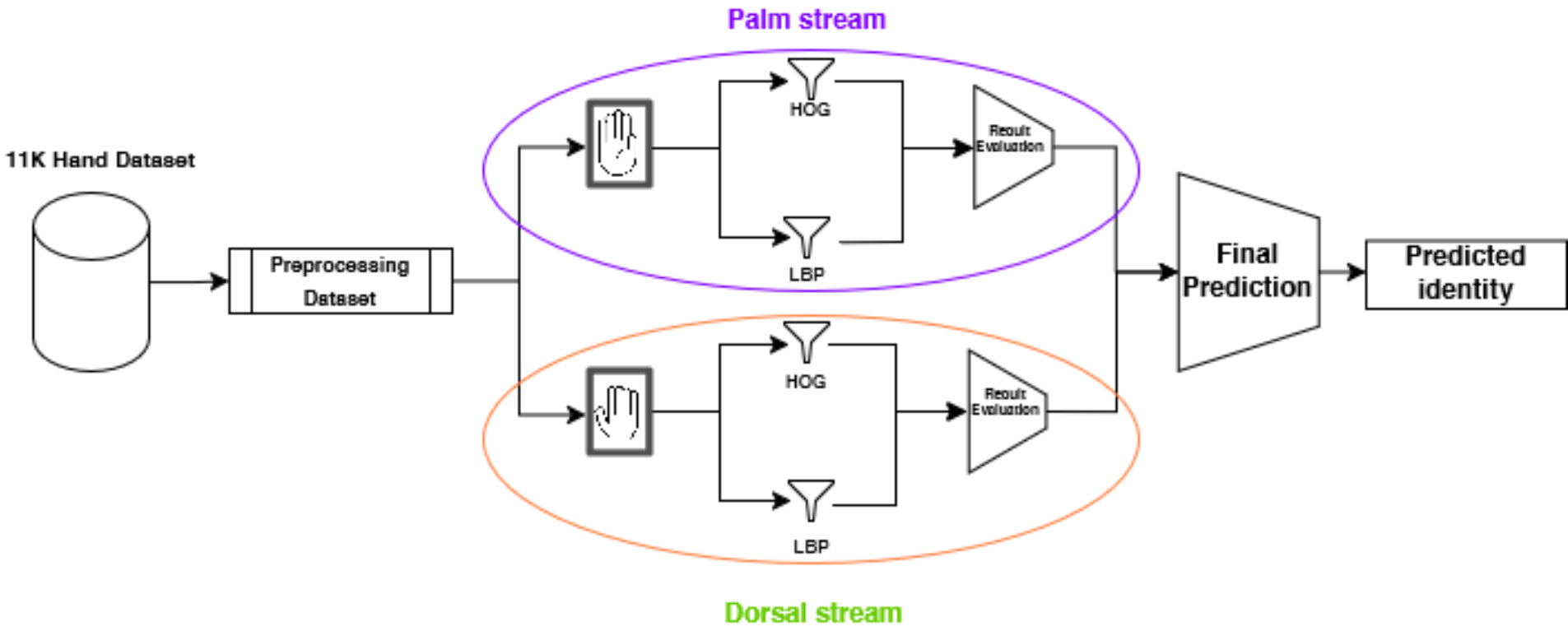
Problem

- Images for each person are not balanced by side (palm / dorsal)
- Images are not balanced for person

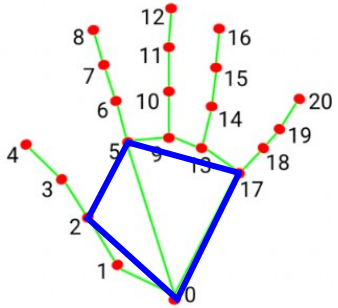
Sampling

- Random choice of dataset images using sometimes already used images for class balancing
- Use the same subset of people in both train and test (eventually adding some impostors for open set)
- Balancing extracted images by person, such that having the same weight for all classes

Data analysis pipeline



Data analysis pipeline



Create a new dataset with cutted palmar images

Images extraction

PALMAR

LBP Transform	HOG Transform
RESIZE GRAYSCALE CANNY	RGB GAUSSIAN RESIZE
LBP	**HOG**

Fusion palmar score

DORSAL

LBP Transform	HOG Transform
RESIZE GRAYSCALE	RGB GAUSSIAN RESIZE
LBP	**HOG**

Fusion dorsal score

Multibiometric final evaluation

Data analysis pipeline

The images are first and foremost cut using CV2 to remove unnecessary parts, then they are altered to ensure they all follow the same criteria (size, orientation…)

Hand-crafted features are then extracted from each image:

- Used to capture informations on texture and palm lines
- For each pixel the neighbouring pixels are evaluated and based on their intensity a bitmap is generated
- The bitmap is then turned into an histogram

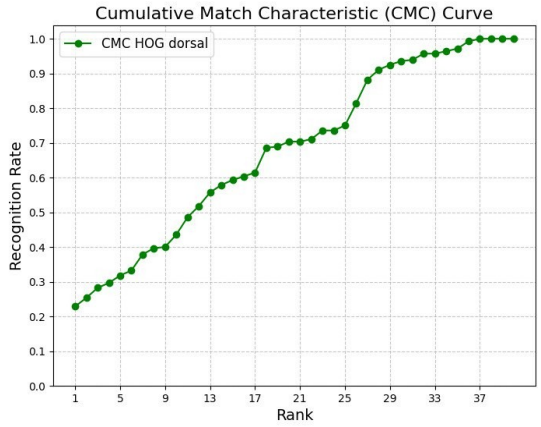
LBP

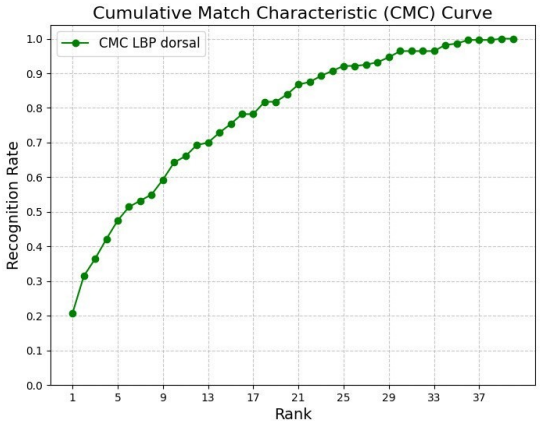
- Used mainly to capture informations on the hand's shape
- Each image is divided in cells and for each the direction of the intensity gradient is calculated
- The predominant directions are grouped in histograms

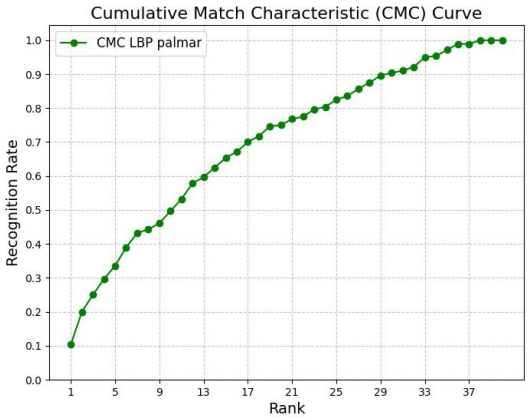
HOG

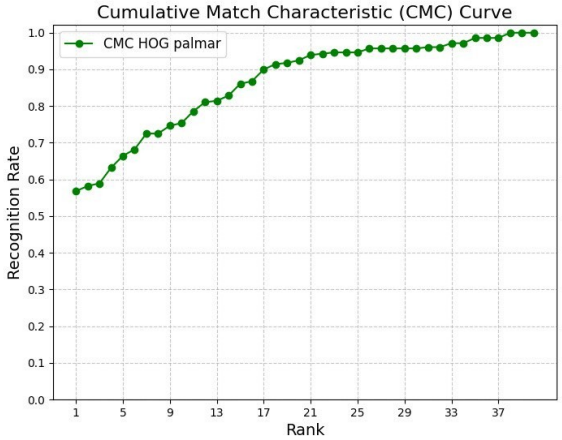
In the end the results from the two streams are unified into a final prediction that is then used to identify the subject

Evaluation: Closed Set

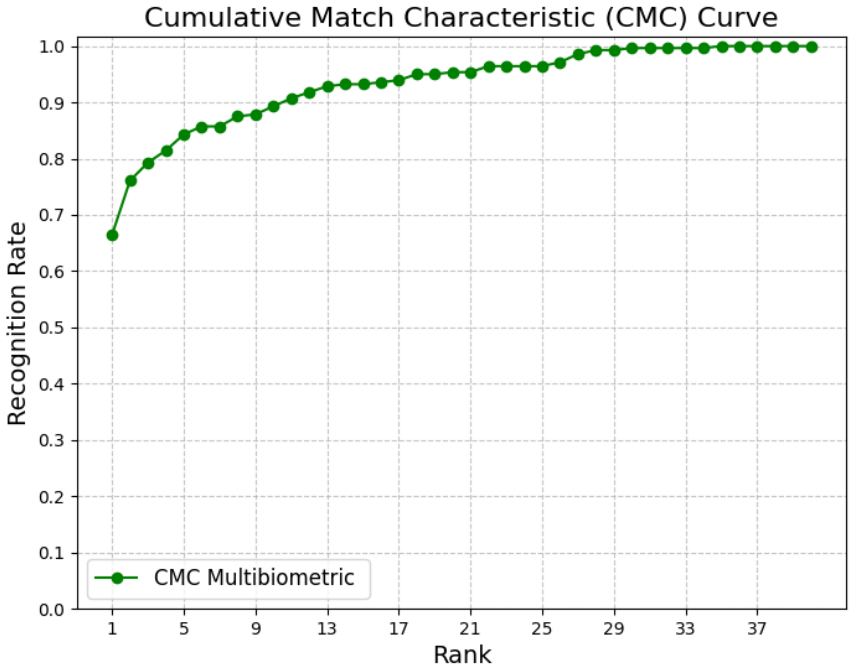


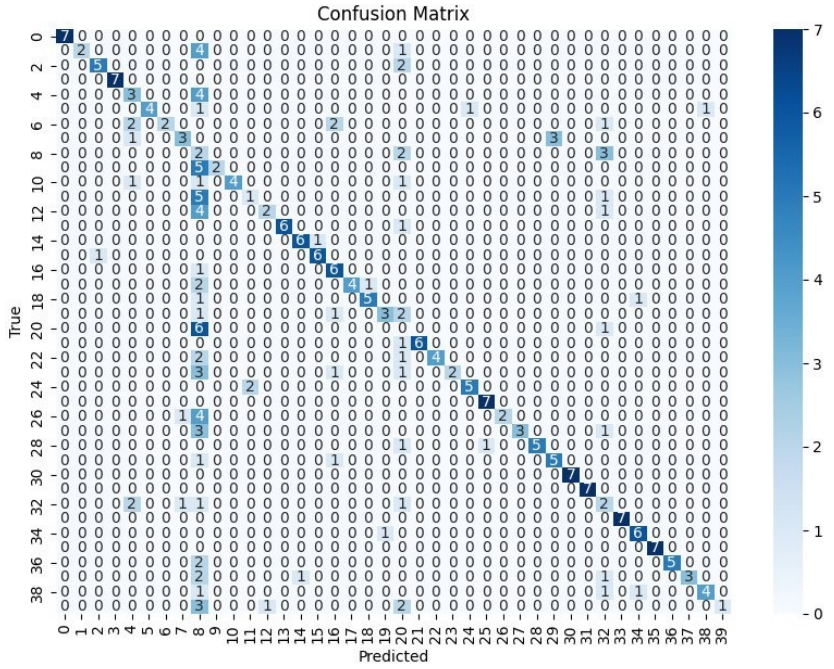






Evaluation: Closed Set

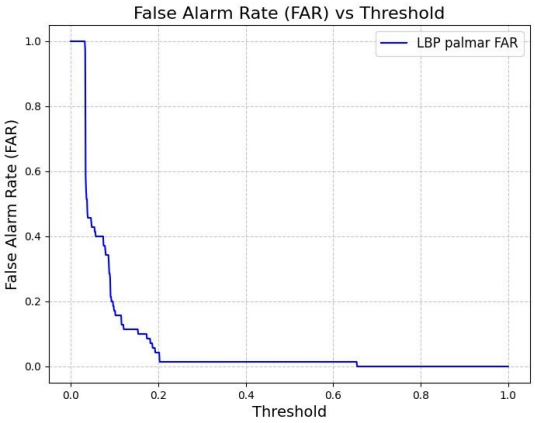


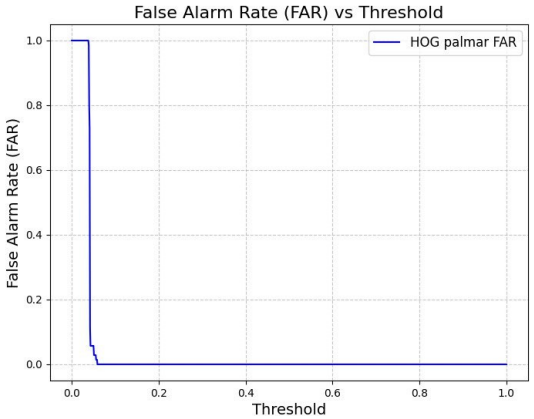


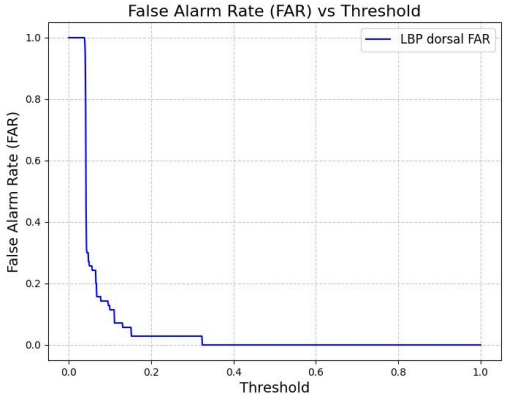
Evaluation: Closed Set

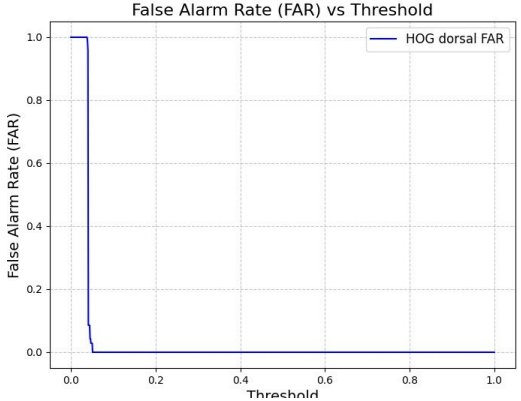
Test Case	Accuracy
LBP Palmar	10.3%
LBP Dorsal	20.7%
HOG Palmar	56.7%
HOG Dorsal	22.8%
Multibiometric System	60.0%

Evaluation: Open Set

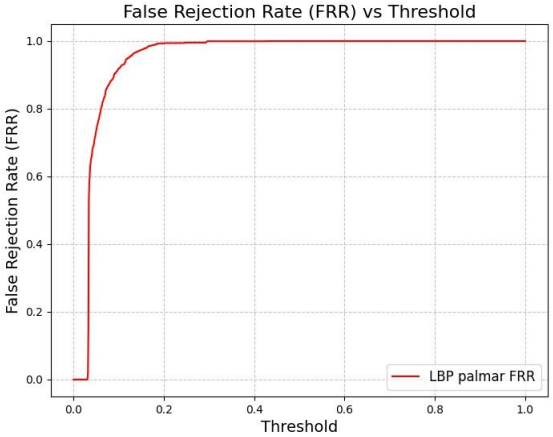


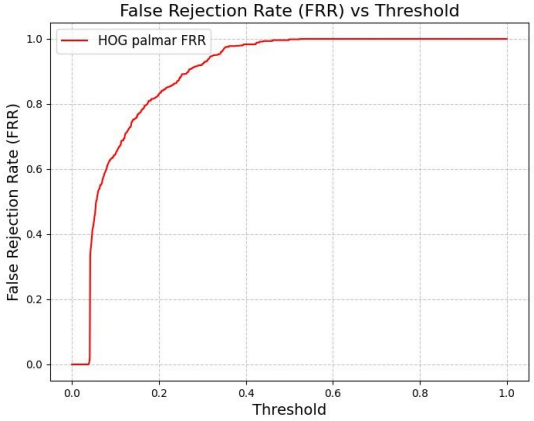


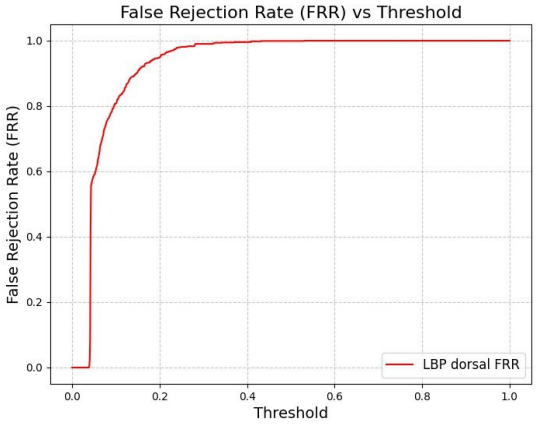


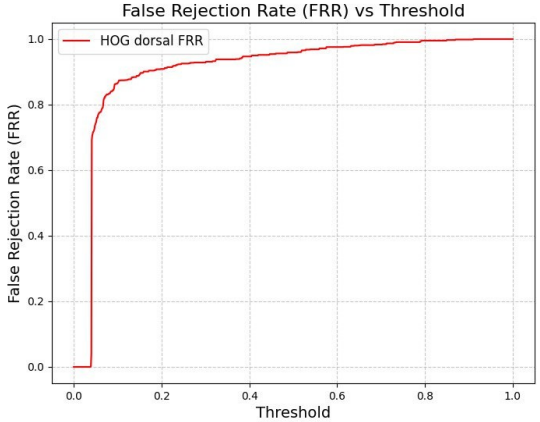


Evaluation: Open Set









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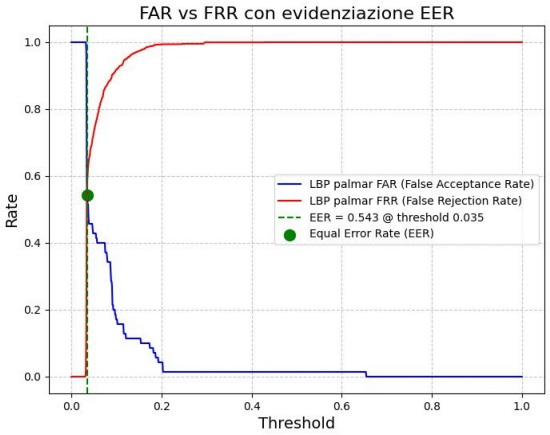
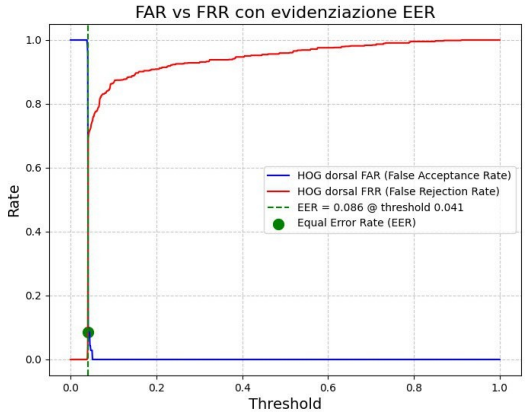
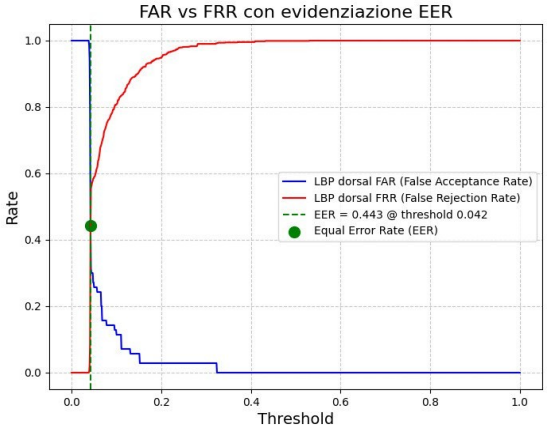
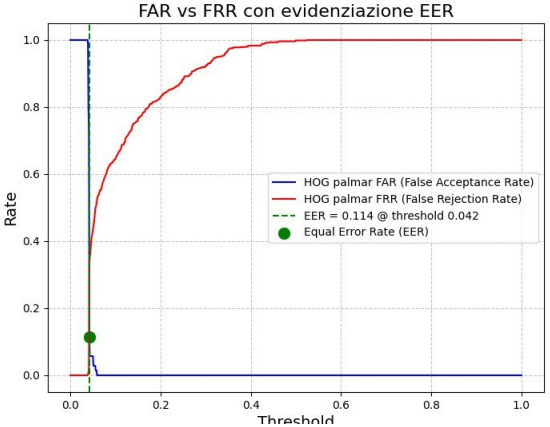
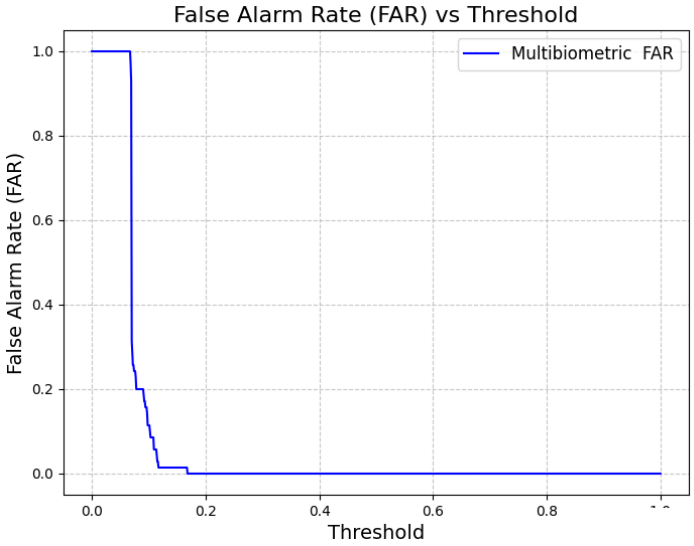


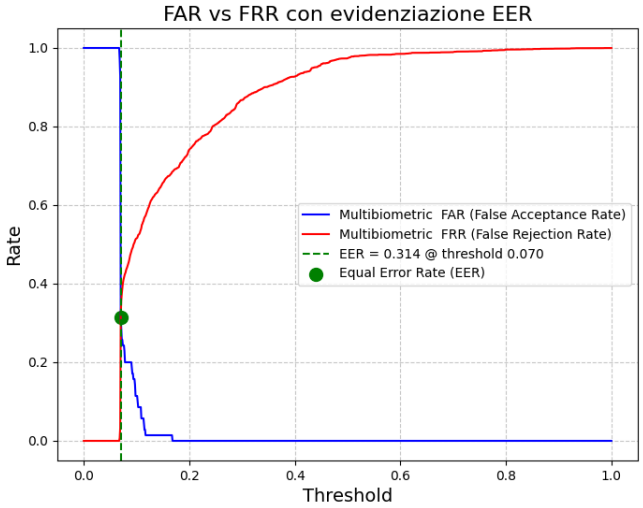


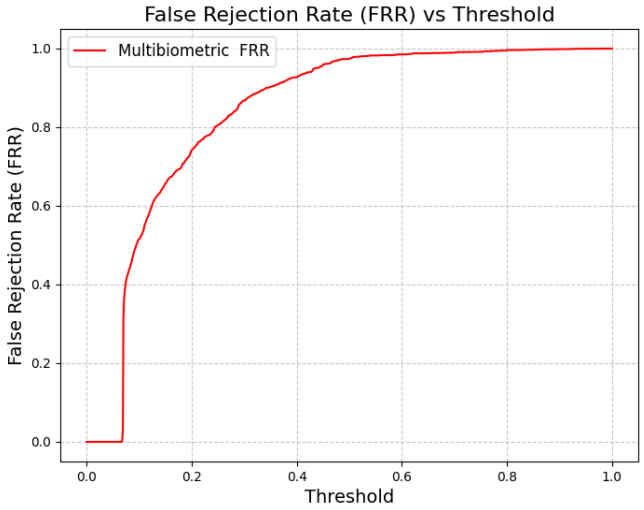




Evaluation: Open Set







Evaluation: Open Set

Test Case	Accuracy
LBP Palmar	13.5%
LBP Dorsal	21.2%
HOG Palmar	66.1%
HOG Dorsal	31.3%
Multibiometric System	68.9%

Resources & Sample literature

- 11k Hands
- Gender recognition and biometric identification paper
- Identity Verification by Using Handprint
- MediaPipe Hand Landmarks

Thanks for your attention!