Multimodal Biometric Systems

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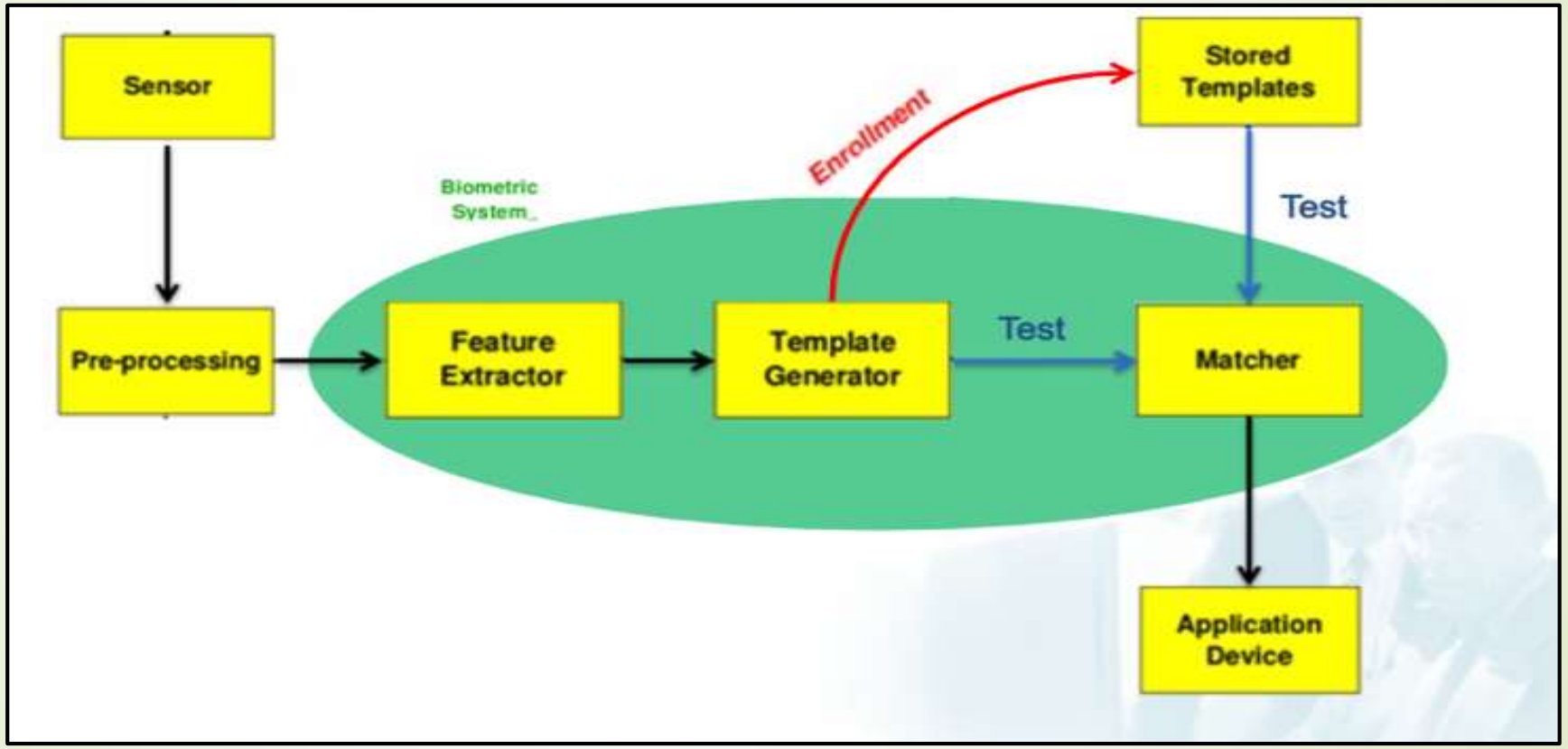
What are Biometric Systems ?

- Biometric Systems use personal characteristics of a person to authenticate or identify a person.

- Some of the Biometric characteristics that can be used are as follows :

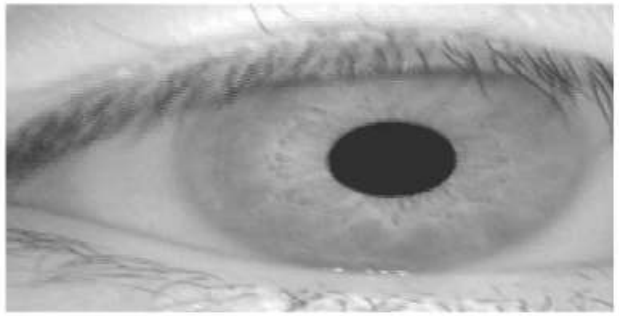
  - Face
  - Fingerprint
  - Hand Geometry
  - Palm Print
  - Iris
  - Voice
  - Signature
  - Keystroke dynamics

Working of a Unimodal Biometric System



Why Multimodal Biometrics ?

- Unimodal Biometric systems perform person recognition based on a single source of biometric information.
- Unimodal Biometric systems are affected by the following problems :
- **Noisy Sensor Data** – Noise can be present in the biometric data which is acquired due to defective or improperly maintained sensors.



Why Multimodal Biometrics contd….

- **Non-Universality** – A Biometric trait is said to be universal if every individual in the target population is able to present biometric trait for recognition. NIST reported 2% people cannot enroll using finger print.

- **Lack of Individuality** – Features extracted from biometric characteristics of different individuals can be quite similar. A small proportion of population can have nearly identical facial appearance due to genetic factors.

Why Multimodal Biometrics contd….

- **Lack of invariant representation** – The biometric data acquired from user during verification may not be identical to data used for generating user's template during enrollment.

- **Spoofing** – Unimodal Biometrics is vulnerable to spoofing where the biometric data can be imitated or forged.

Literature Survey

- **"Multimodal Biometric System Based on Fingerprint, Iris and Face Recognition" By Smith et al.**
  - Proposes a multimodal biometric system that combines fingerprint, iris and face recognition modalities.
  - The paper focused on developing efficient feature extraction techniques for each modality and explore fusion strategies to integrate information efficiently.
  - The authors conducted experiments using a large dataset and achieved superior recognition accuracy compared to unimodal biometric systems.
  - The multimodal biometric system designed has enhanced security and robustness against spoofing attacks.

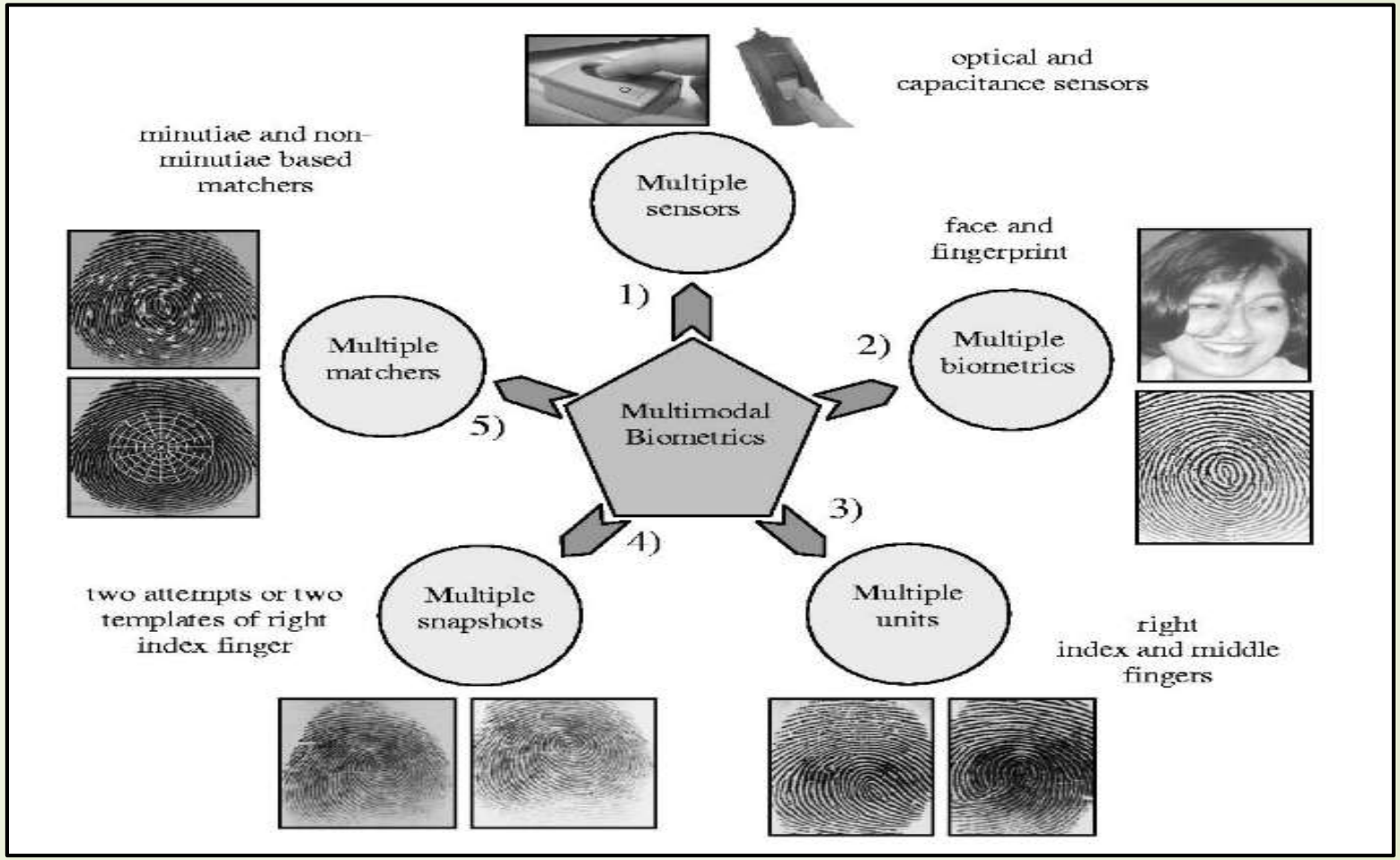
Literature Survey contd....

- "**A Novel Approach for Multimodal Biometric Fusion using Deep Learning" By Lee et al.**
  - This paper presents a novel approach for multimodal biometric fusion using deep learning techniques.
  - It presents a deep neural network architecture which combines features extracted from fingerprint, iris and face modalities.
  - Deep Learning improved the accuracy and reliability of multimodal biometric systems.
  - These systems can be used where accurate identification is crucial.

Literature Survey contd....

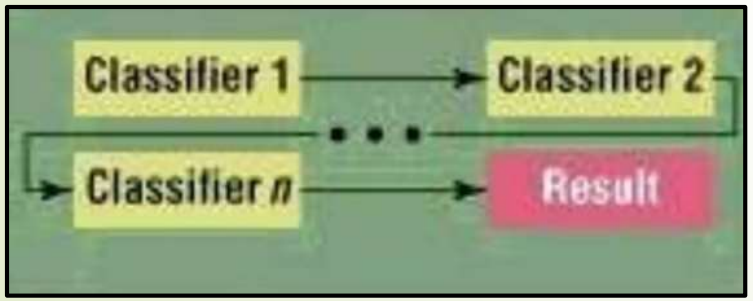
- **"Secure Multimodal Biometric System based on Fingerprint and Palmprint Fusion" By Chen et al.**
  - This research paper focused on development of secure multimodal biometric system using fingerprint and palmprint fusion.
  - The proposed system combines features extracted from fingerprint and palmprint modalities using a fusion algorithm based on score-level and feature-level fusion techniques.
  - The proposed system demonstrates enhanced accuracy and resilience against spoofing attacks compared to unimodal systems.
  - These systems can be used in access control and identity verification.

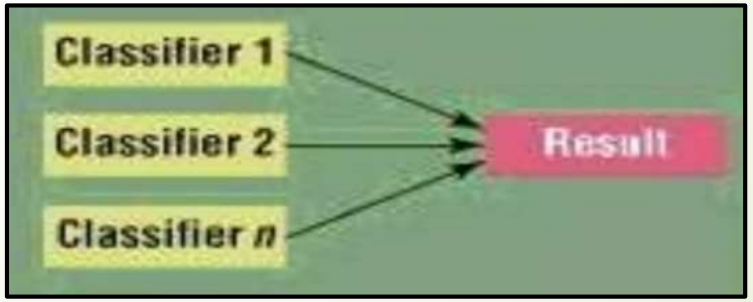
Scenarios in Multimodal Biometric Systems

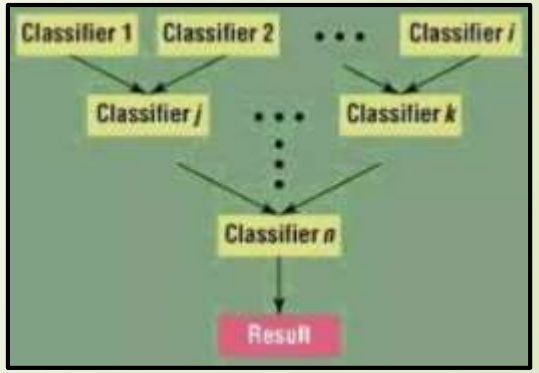


Modes of Multimodal Biometric System

- A Multimodal Biometric System can operate in one of 3 different modes :
  - **Serial –** The Output of one biometric trait is used to narrow down the possible identities before next trait is used.
  - **Parallel** – Information from multiple traits is used simultaneously to perform recognition,
  - **Hierarchical** – Individual classifiers are combined in tree-like structure.







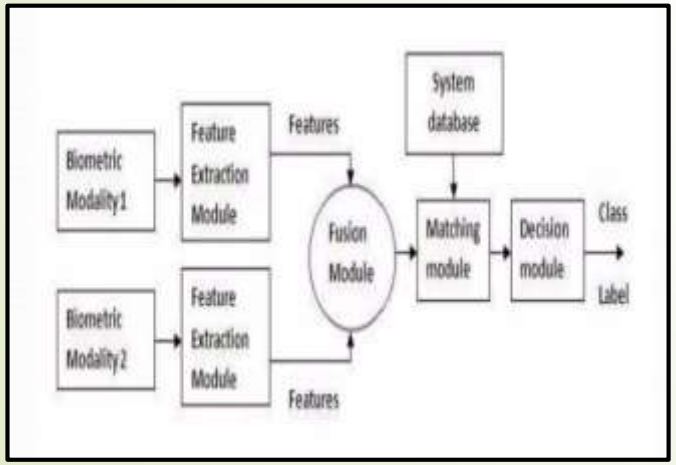
Fusion in Multimodal Biometric Systems

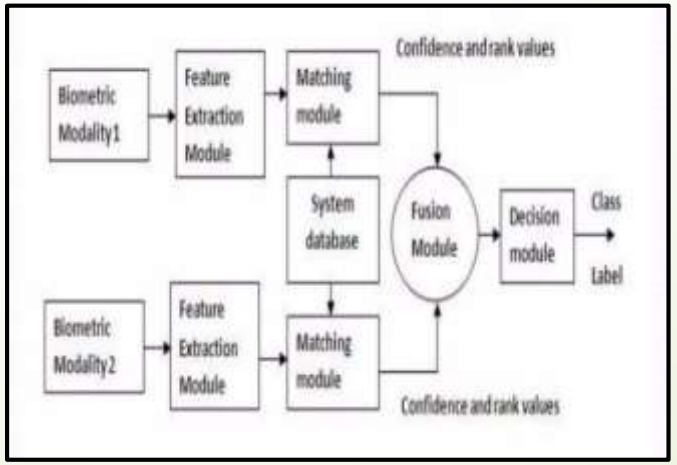
- Multimodal Biometric Systems integrate information from multiple biometric indicators.

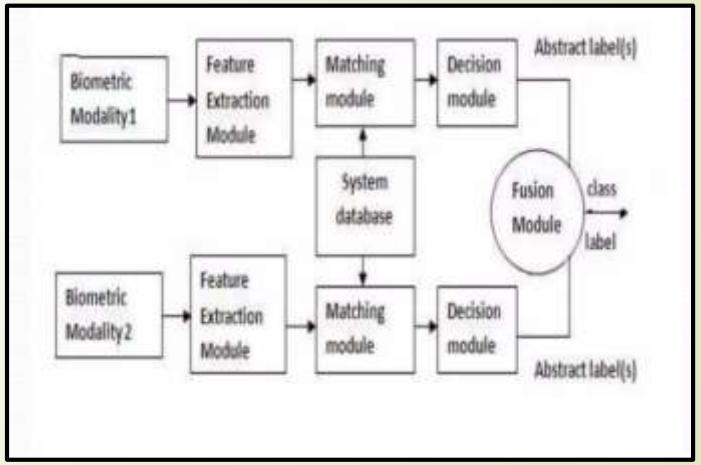
- Fusion is divided into three parts which are as follows :
  - Fusion at the feature extraction level
  - Fusion at the matching score (confidence or rank) level
  - Fusion at the decision (abstract label) level

Types of Fusion

- **Feature Level Fusion** – Combining feature vectors. When features of different modalities are compatible with each other, then more accuracy.
- **Matching Score Level Fusion** – Individual matching score of different feature vectors is found and fused to make classification.
- **Decision Level Fusion** – Each biometric modality makes it own recognition decision based on its feature vector.



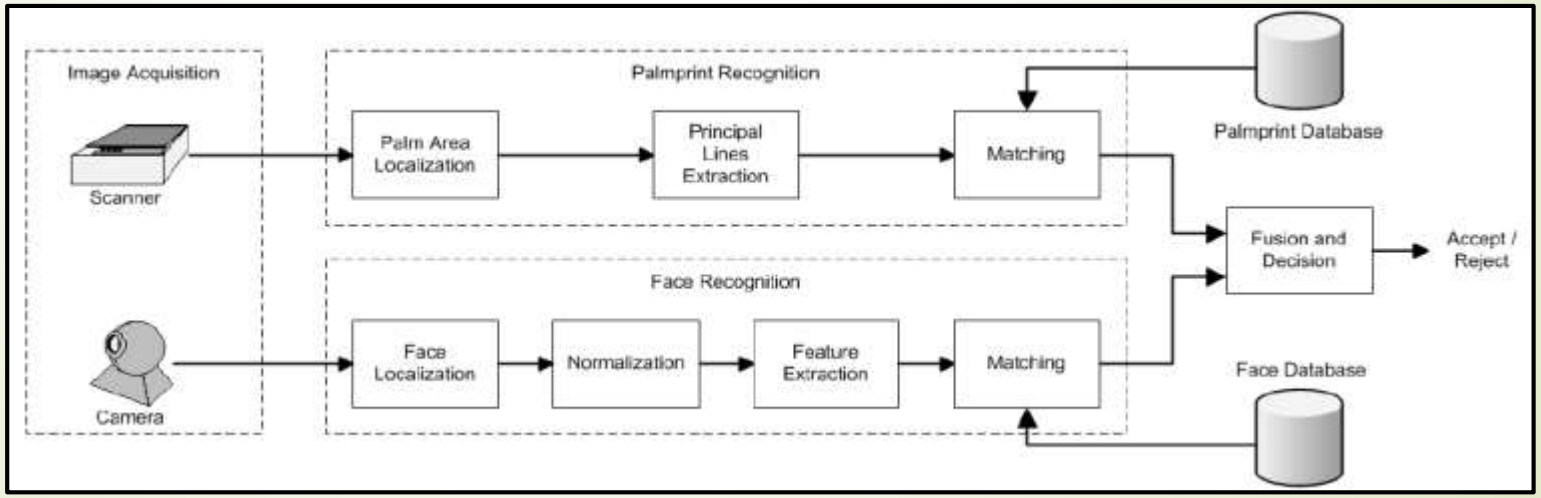




System Designed

- We can make a multimodal biometric system using these two modalities :
  - Palmprint (Haptic/Touch Modality)
  - Facial Features (Visual Modality)

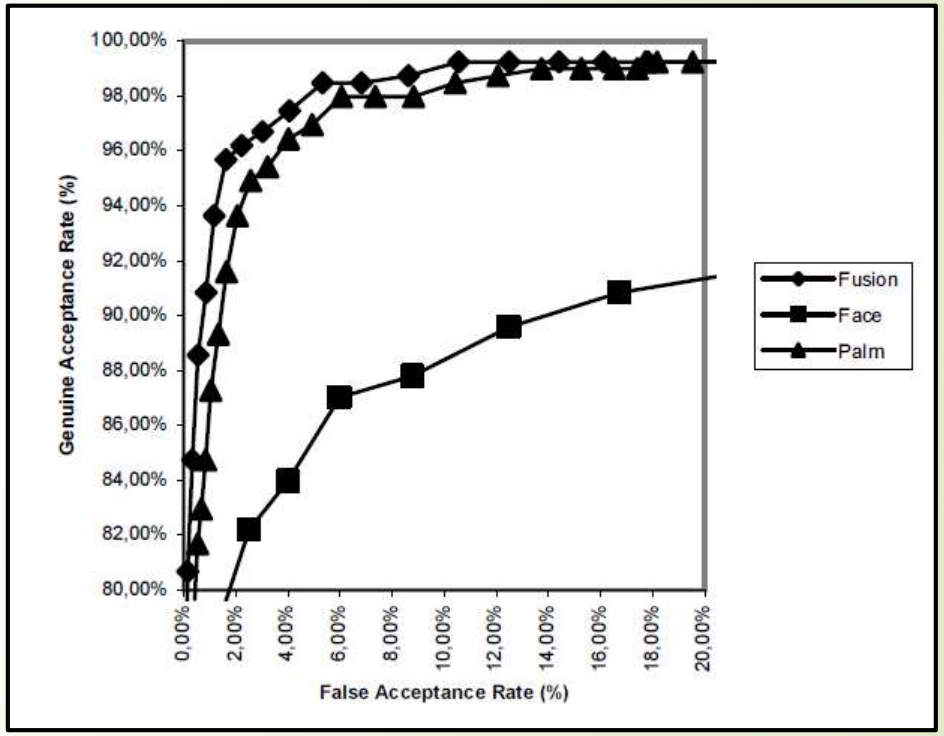
- The Block Diagram for the system designed will be :



Results and Findings

The findings from the graph are as follows :

- Verification based on palmprint easily outperforms the verification based on the face.
- Fusion of palmprint and facial features improves the verification score.



Pros and Cons of Multimodal Biometrics

- Pros :
  - More Secure, spoofing is hard
  - Accuracy is more
  - Reduce Failure to enroll rate (FTE)
  - Reduce False accept rate (FAR)
  - Reduce False reject rate (FRR)
- Cons :
  - High Cost
  - Scalability
  - Increase System Complexity
  - Sensor Limitations are there
  - Ethical Considerations

Conclusion and Future Work

- In conclusion, multimodal biometric systems enhances accuracy and reliability compared to their unimodal counterparts.
- However, there are still some challenges which need to be addressed which are :
  - **Performance Improvement** – We can develop more advanced fusion algorithms that reduce false acceptance and false rejection rates and are more accurate.
  - **Usability and User Experience** – Efforts can be made to address user concerns and improve the usability of multimodal biometric systems.
  - **Scalability and Efficiency** – We can conduct research to develop scalable and efficient multimodal biometric systems to handle large user populations.
  - **Ethical and Privacy Considerations** – Future work in multimodal biometrics should emphasize on ethical considerations and privacy protection.

References

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THANK YOU