# PalmSecure Revolutionizing Transport with Biometric Precision

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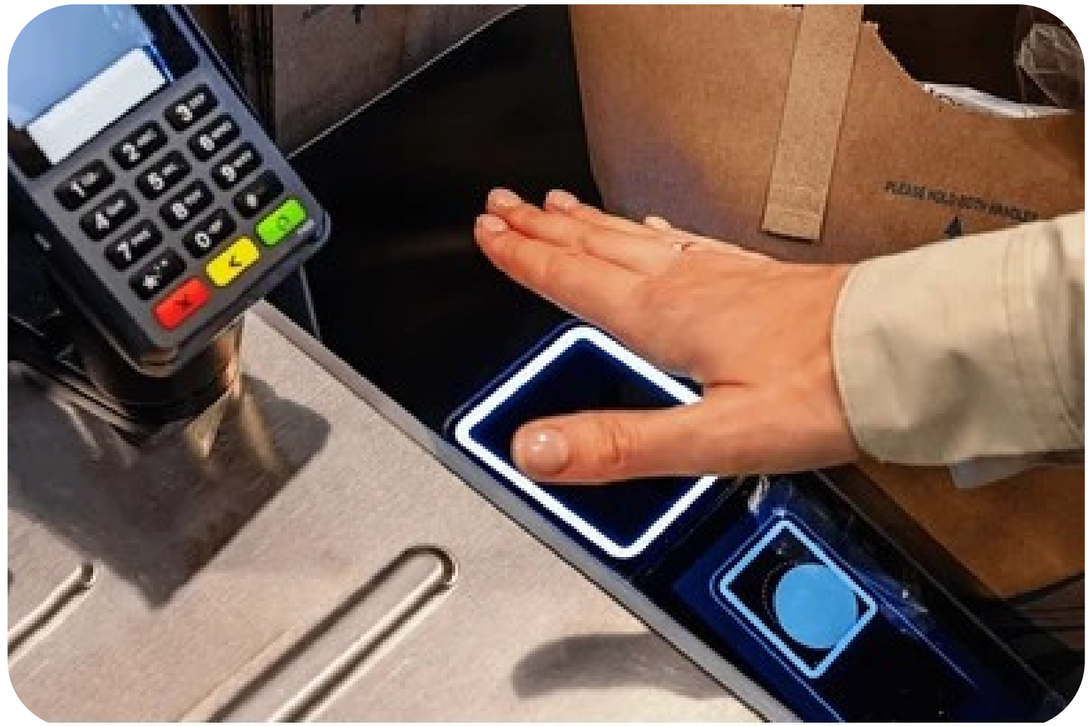
Existing transportation biometric systems are vulnerable to environmental factors, health risks, and accuracy limitations, requiring complex hardware compromising security, efficiency, and revenue. A robust, accurate, and hygienic solution is urgently needed



- Security breaches and unauthorized access in transport.
- Passenger safety concerns.
- Inefficient identity verification systems

## Objective

To develop a palmprint verification system tailored for the transport industry using biometric and deep learning technologies

## Challenges in the Transport Industry

- Security vulnerabilities in current biometric systems
- Environmental sensitivity of facial and fingerprint recognition
- Health concerns due to contact-based methods
- Accuracy limitations under diverse conditions

## Why Comprehensive Coordination Mechanism?

- Extracts multi-order texture and spatial features
- Overcomes limitations of other biometric methods

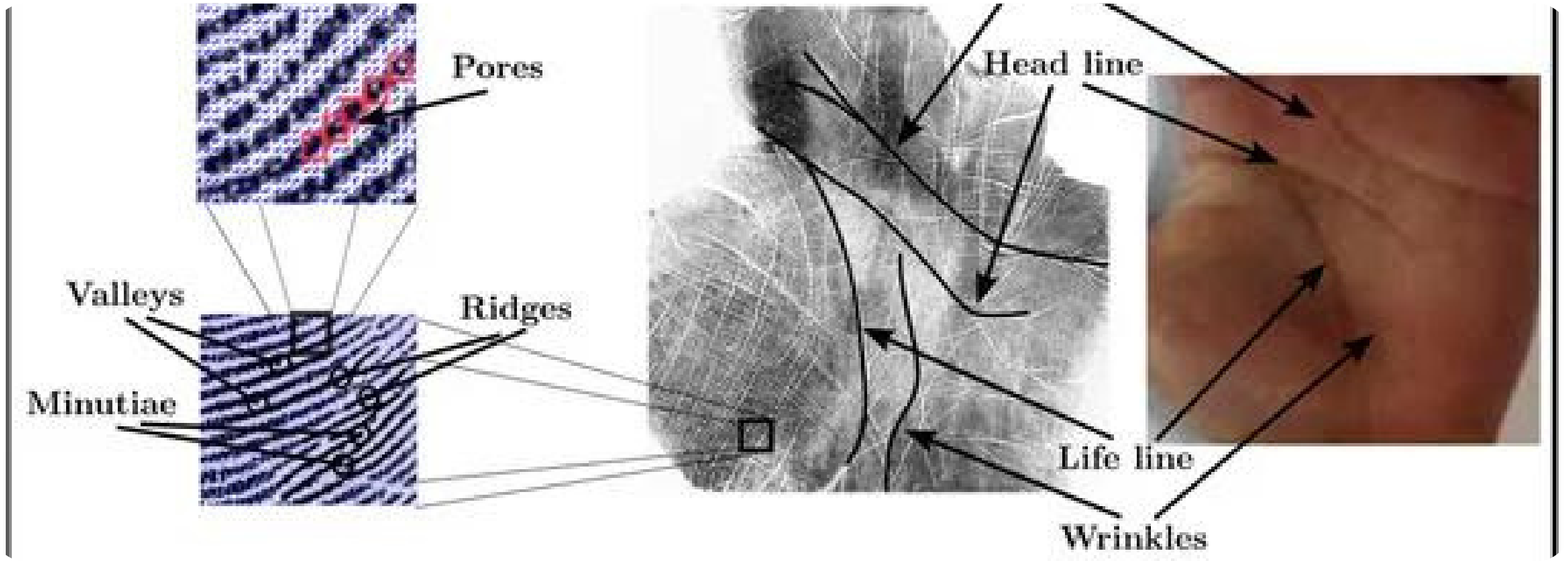


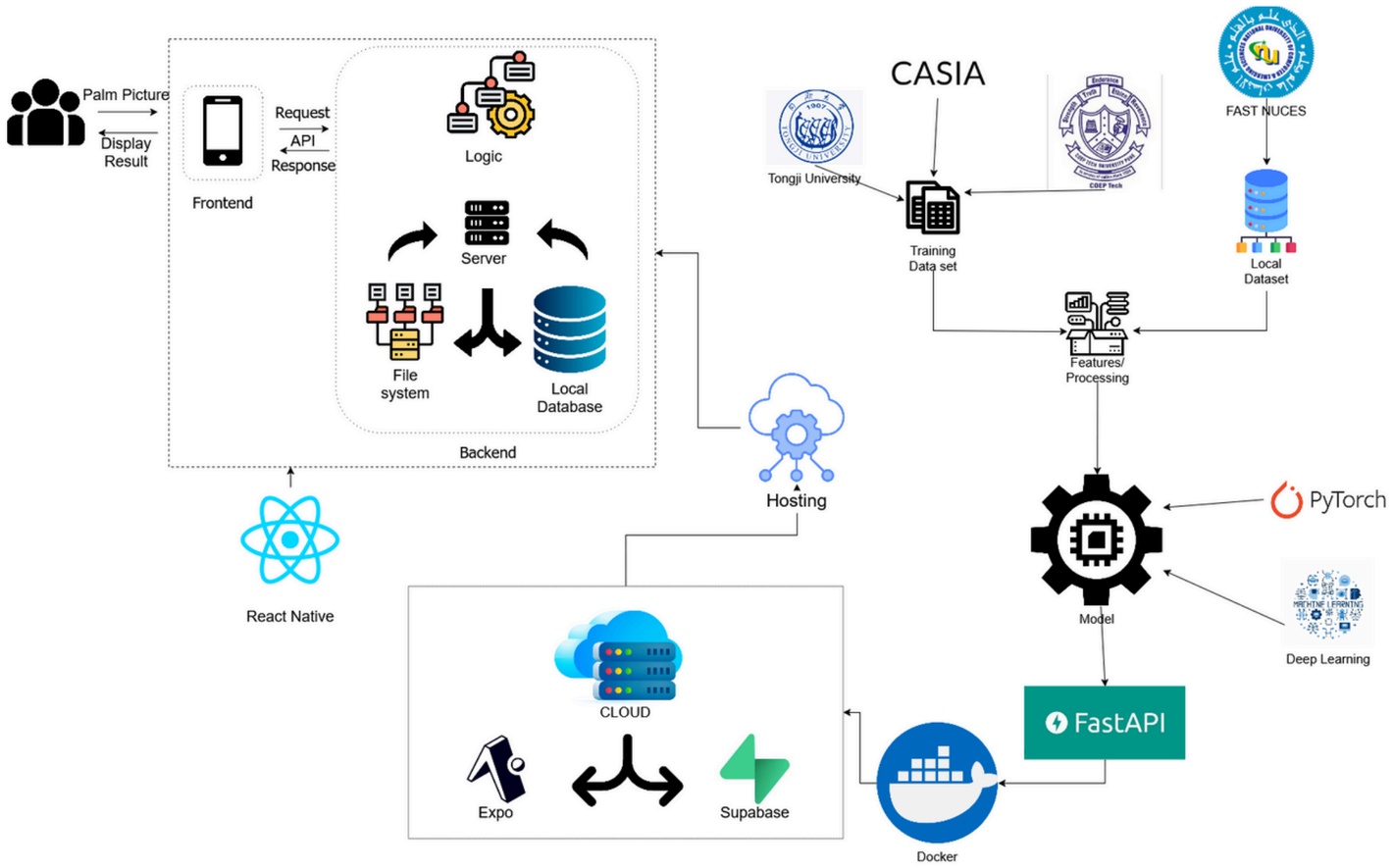

Fig 2: https://www.sciencedirect.com/science/article/pii/S0031320304001001

## Why Comprehensive Coordination Mechanism?

- Robust Feature Extraction: extracts multi-order texture and spatial features
- Improved Generalizability: eliminates the need for class labels or pre-trained filters
- Improved Robustness: provides robust feature extraction mechanisms
- Non-Contact and Hygienic: supports touchless palmprint recognition
- Scalability: CCM's efficient architecture allows for scalable deployment

## Implementation Methodology

- Data Collection: Local dataset and publicly available databases (Tongji Palmprint Database, CASIA Palmprit Dataset, COEP Palmprint Dataset)
- Data Augmentation: Techniques like rotation, , and illumination variations to improve robustness
- Model Training
- Spatial, Channel, and Multi-Order Competition Modules for feature extraction
- Mobile App  Developed using React Native for real-time palmprint verification



## Dataset Details

### Tongji Contactless Palmprint Dataset:

- 12,000 images from 300 individuals
- Contactless nature, suitable for hygienic applications

### CASIA Palmprint Image Database

- 5,502 gray-scale images from 312 individuals
- Images captured from both left and right palms

Fig 1: A sample Image from Tongji Contactless Palmprint Database

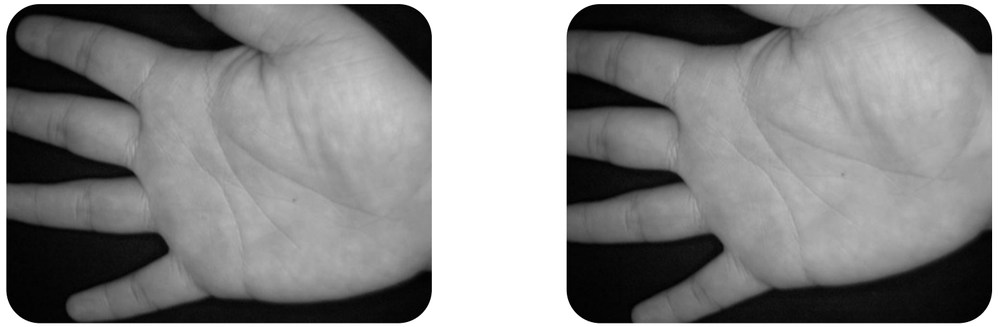


Fig 2: A sample Image from CASIA Palmprint Dataset

## Dataset Details

**COEP Palmprint Dataset:**

- 1,344 palmprint images from 168 individuals
- Variations in hand orientation and positioning

**Locally Collected Dataset:**

- 120 images from 30 users
- Variability in image quality, resolution, and environmental conditions

Fig 3: A sample Image from COEP Palmprint Dataset

Fig 4: A sample Image from Locally Collected Palmprint Dataset

## CCNet Architecture

The CCNet model integrates multiple competition mechanisms to enhance feature extraction and recognition accuracy

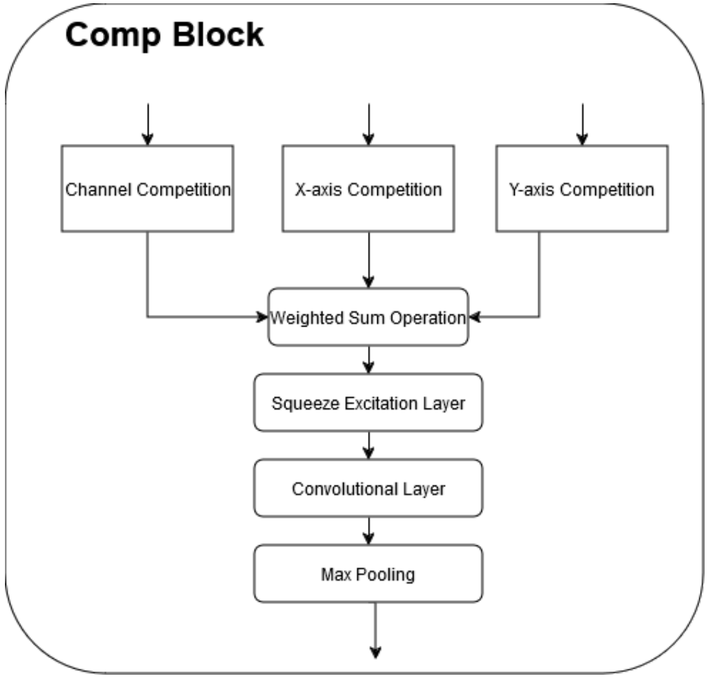
Key Components:

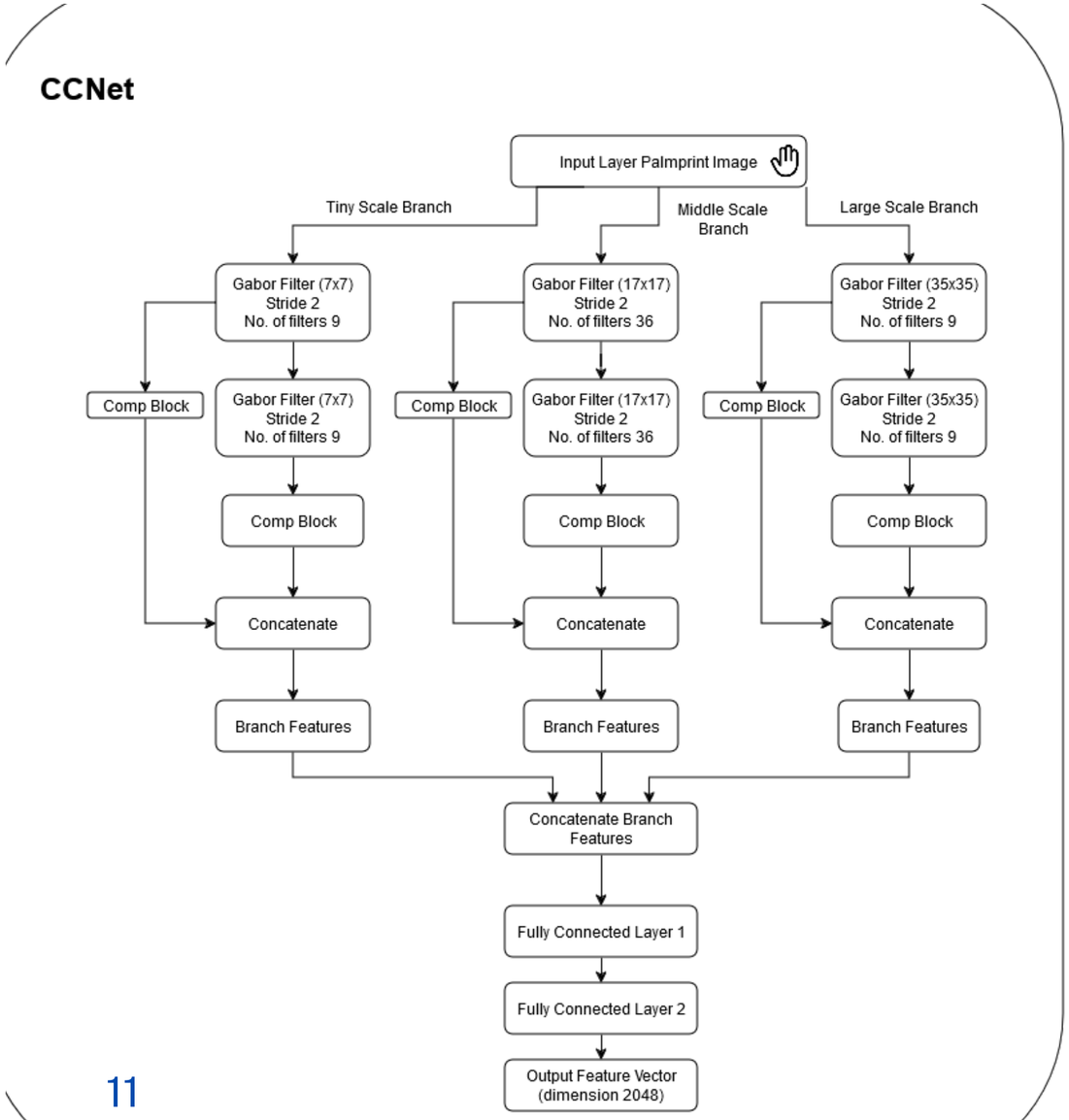
- **Learnable Gabor Filters:** Automatic adaptation to varying input features.
- **Spatial Competition Module:** Analyzes relationships between different palmprint regions
- **Channel Competition Module:** Determines dominant texture responses along specific feature channels
- **Multi-Order Competition Module:** Captures multiscale and higher-order texture features
- **Comprehensive Competition Mechanism:** Unifies spatial, channel, and multi-order competition mechanisms for efficient feature extraction

## CCNet Architecture

Benefits:

- Improved recognition accuracy
- Efficient feature extraction
- Robustness to varying input features



## Evaluation Metrics for Palmprint Recognition

### Key Metrics:

- **Equal Error Rate (EER):** Measures the balance between False Acceptance Rate (FAR) and False Rejection Rate (FRR)
- **False Acceptance Rate (FAR):** Percentage of unauthorized users incorrectly accepted
- **False Rejection Rate (FRR):** Percentage of legitimate users incorrectly rejected
- **Accuracy:** Ratio of correctly classified samples to total samples

### Why EER is Preferred Over Accuracy:

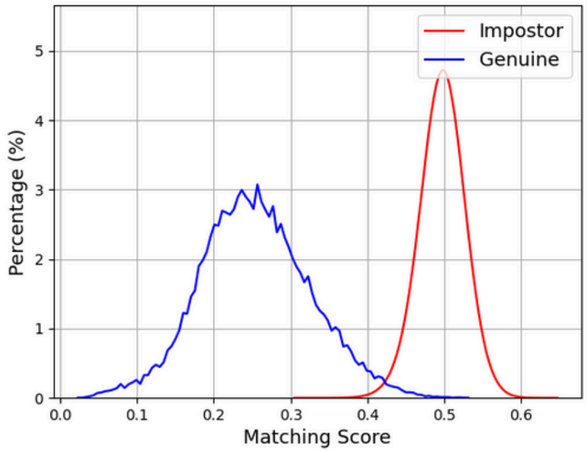
- EER provides a balanced measure of performance, addressing the trade-off between FAR and FRR
- Accuracy may obscure the trade-offs between FAR and FRR, making EER a more reliable metric for biometric systems

## Tongji Contactless Palmprint Dataset

**Key Performance Indicators:**

- Equal Error Rate (EER): 0.4%, Testing Accuracy: 94%

Our implementation achieved an EER of 0.4%, closely matching the state-of-the-art performance of CCM. Both methods demonstrated excellent separation in inner-class and outer-class score distributions, indicating effective feature learning and matching. This suggests that both methods are highly accurate in distinguishing between genuine and impostor pairs



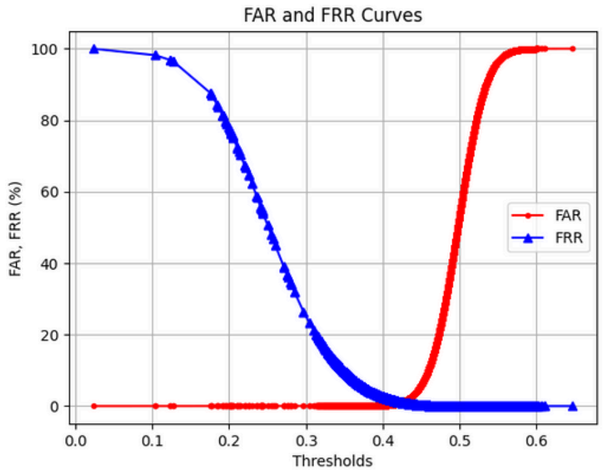



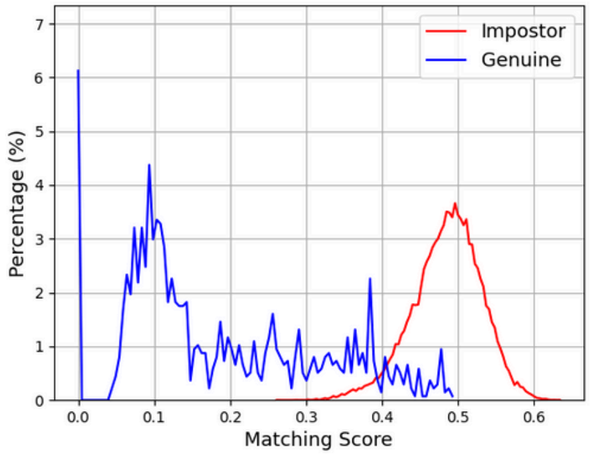

Figure 1: Tongji Dataset Results

## COEP Palmprint Dataset:

**Key Performance Indicators:**

- Equal Error Rate (EER): 5.77%, Testing Accuracy: 96%

The CCNet model demonstrated exceptional performance, characterized by a clear separation between inner-class and outer-class scores. This indicates the model's ability to effectively extract discriminative features in contactless palmprint recognition.



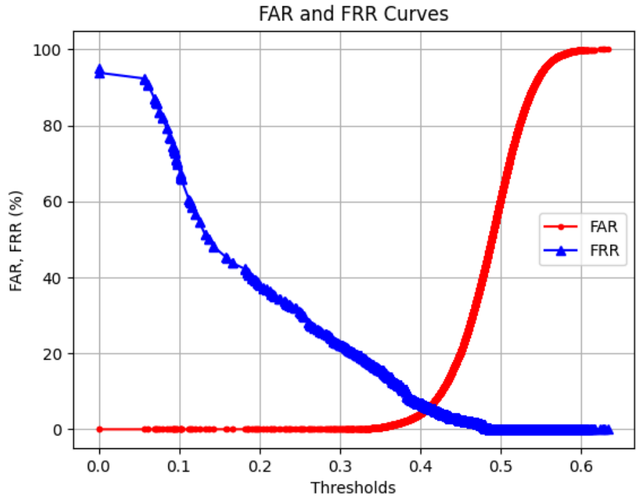




Figure 1: COEP Dataset Results

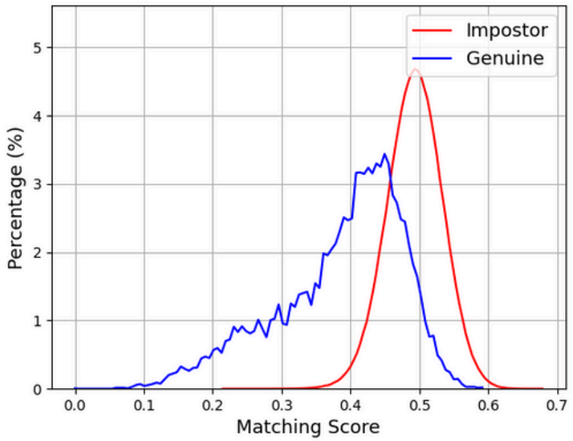
# CASIA Palmprint Image Database

**Key Performance Indicators:**

- Equal Error Rate (EER): 20%, Testing Accuracy: 84%

**Challenges and Future Improvements:**

- Higher EER indicates challenges in generalization due to intra-class variability and noise
- Potential improvements through dataset-specific tuning of the CCNet architecture



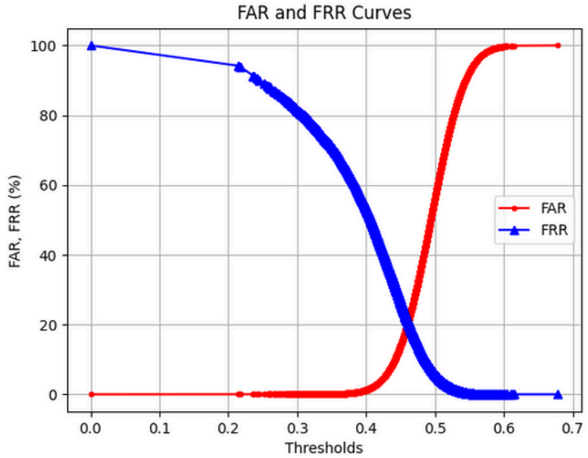



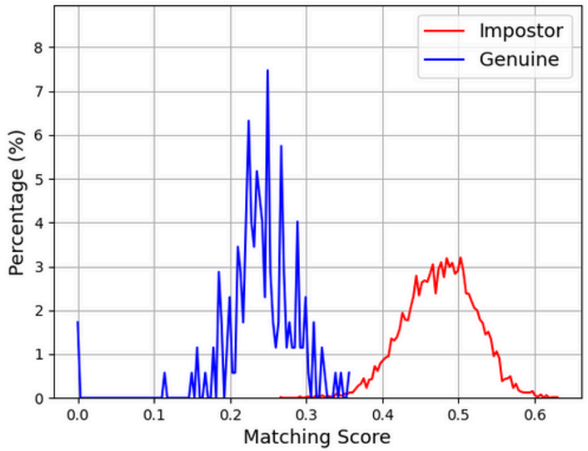

Figure 1: Casia Dataset Results

## Locally Collected Dataset

**Key Performance Indicators:**

- Testing Accuracy: 99%, Equal Error Rate (EER): 0.1%

The CCNet model demonstrated robustness and high reliability in real-world scenarios, achieving impressive results despite variations in image quality. Its adaptability and potential applicability in diverse conditions make it suitable for practical deployment.



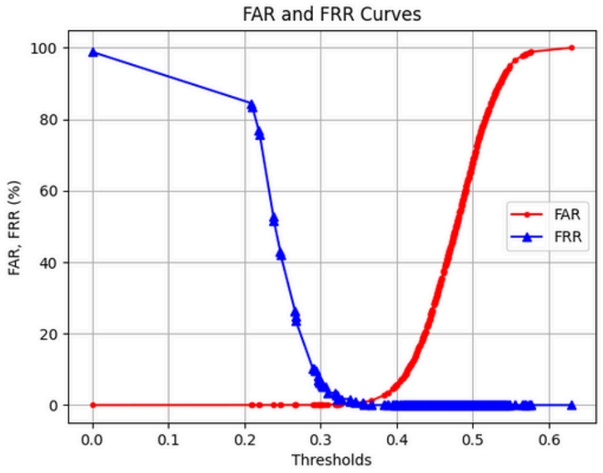




Figure 1: Local Dataset Results

## Completed Deliverables - Phase I

- **Data Preparation for Public Datasets:** Preparation of public datasets for model training and evaluation of the Tongji Contactless Palmprint Dataset, CASIA Palmprint Image Database, and COEP Palmprint Dataset
- **Collection and Preparation of Locally Collected Dataset:** Gathering and preparation of a diverse and representative dataset of palmprints for model training and evaluation
- **Development of the CCNet Model:** Design and implementation of the CCNet model for palmprint recognition, incorporating spatial, channel, and multi-order competition mechanisms for robust feature extraction

## Completed Deliverables - Phase I

- **Integration and Training of Datasets:** Integration of public and locally collected datasets for training and evaluation of the CCNet model
- **Evaluation of Model Performance:** Accuracy, loss curves, Matching Score Distribution curves, Equal Error Rates (EER), and FAR-FRR curves
- **Preliminary Testing on Locally Collected Dataset:** Initial testing of the CCNet model on the locally collected dataset to assess its generalizability to real-world conditions

## Completed Deliverables - Phase II

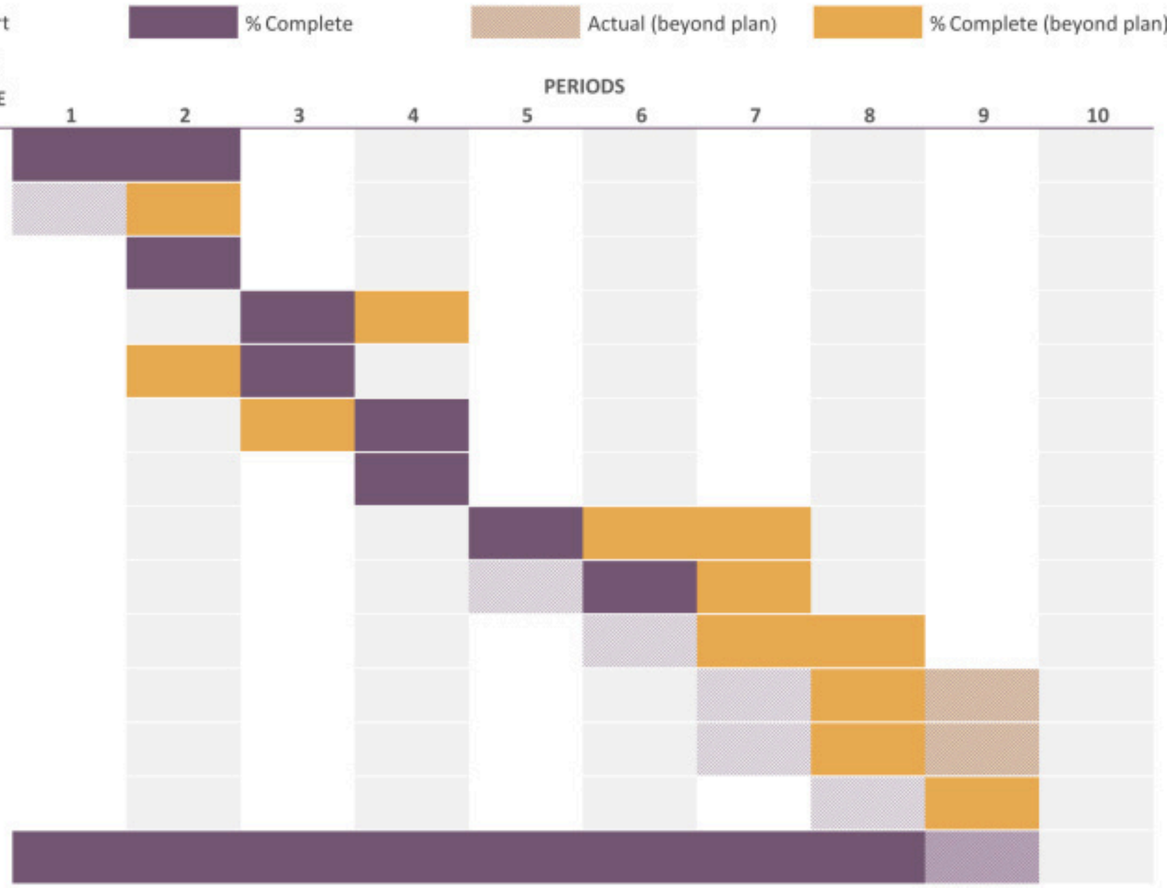
- **Complete Local Dataset Testing:** Finalize dataset collection, conduct extensive evaluations, and identify areas for improvement
- **Performance Enhancement Techniques**: Implement advanced preprocessing techniques, optimize hyperparameters, and improve accuracy
- **Develop Mobile Application (PalmSecure):** Design a user-friendly, secure, and efficient mobile app for real-time palmprint recognition

# Project Timeline and Key Milestones

## Project Planner

Plan Duration | Actual Start | % Complete | Actual (beyond plan) | % Complete (beyond plan)

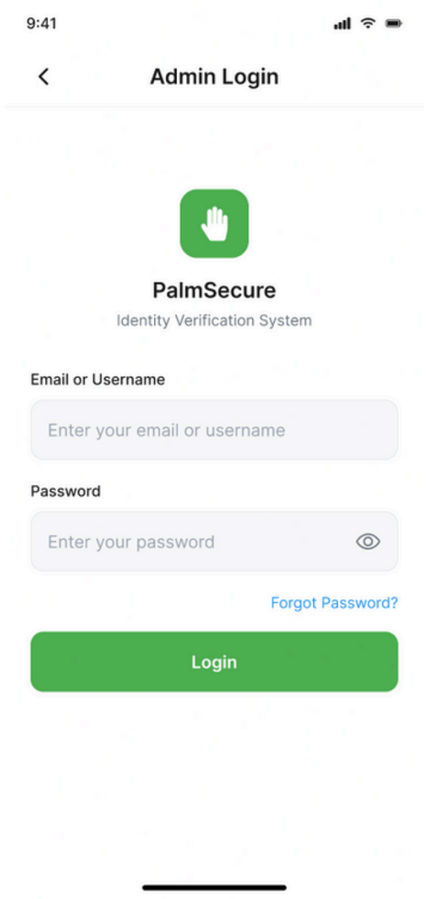
| ACTIVITY | PLAN START | PLAN DURATION | ACTUAL START | ACTUAL DURATION | PERCENT COMPLETE |
|---|---|---|---|---|---|
| Literature Review | 1 | 2 | 1 | 2 | 100% |
| Defense Preparation | 1 | 1 | 2 | 1 | 100% |
| Dataset Gathering | 2 | 1 | 2 | 1 | 100% |
| Model Development | 3 | 1 | 3 | 2 | 100% |
| Dataset Preparation | 3 | 1 | 2 | 2 | 100% |
| Model Training | 4 | 1 | 3 | 2 | 100% |
| Model Testing | 4 | 1 | 4 | 1 | 100% |
| System Optimization | 5 | 1 | 5 | 3 | 100% |
| Mobile App Development | 5 | 2 | 6 | 2 | 100% |
| System Integration | 6 | 1 | 7 | 2 | 100% |
| Testing | 7 | 1 | 8 | 2 | 75% |
| Performance Evaluation | 7 | 1 | 8 | 2 | 75% |
| Final Reporting | 8 | 1 | 9 | 1 | 50% |
| Project Completion | 1 | 9 | 1 | 9 | 90% |

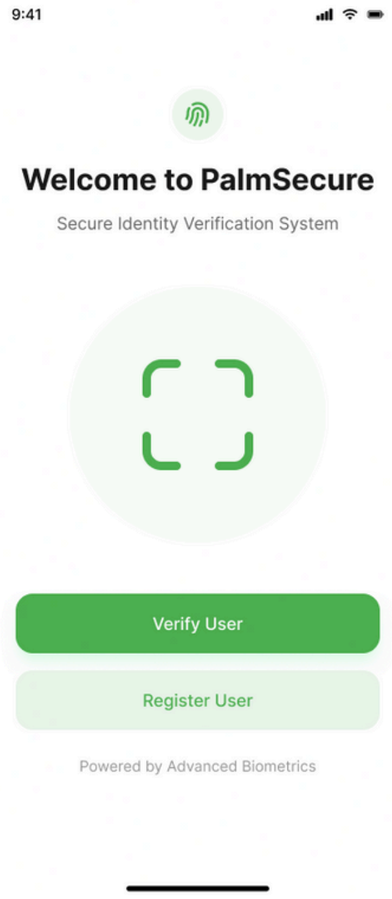


# App workflow and UI

## Home Page & Core Workflow

- Two Primary Options:
  - Verify User: For instant palmprint authentication.
  - Register User: Admin-privileged operation (requires login)
- Flow: Users start here and choose between verification or registration

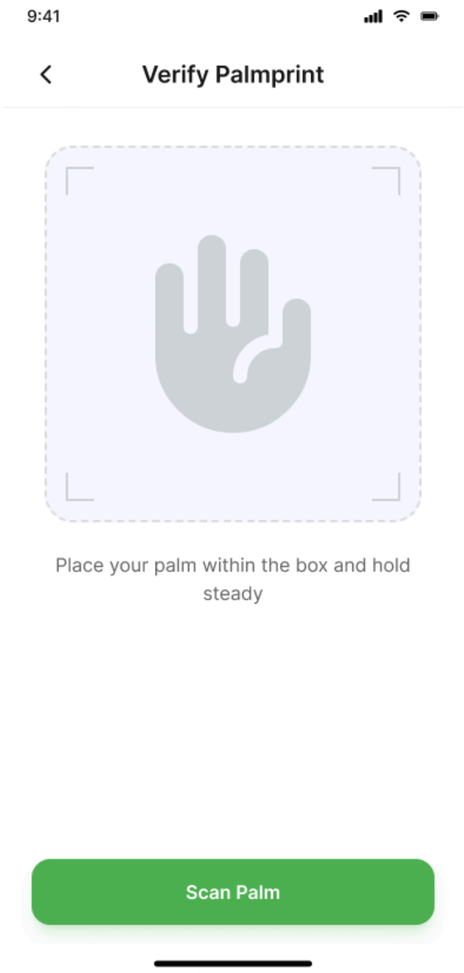


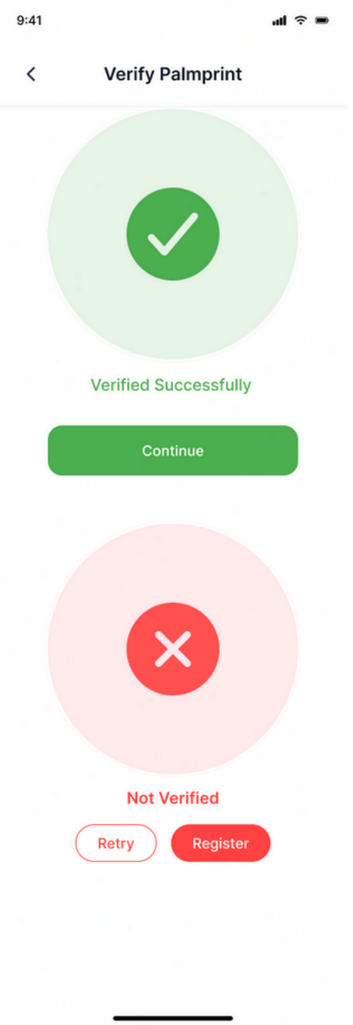



# App workflow and UI

## User Verification Process

- **Instruction:** "Place your palm within the box and hold steady"
- **Action:** Scan Palm button initiates real-time image capture
- **Outcomes:**
  a. Verified Successfully: Redirect to home.
  b. Not Verified: Options to Retry or Register as New User



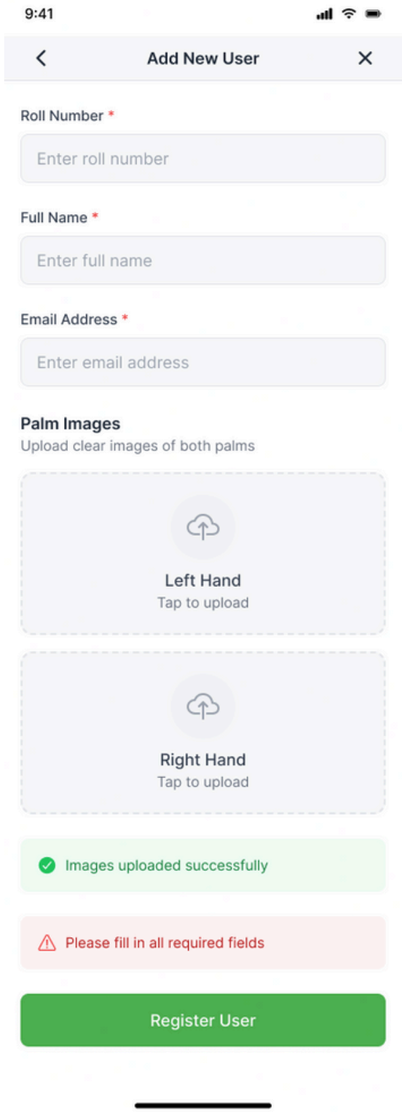



# App workflow and UI

## New User Registration Workflow Steps:

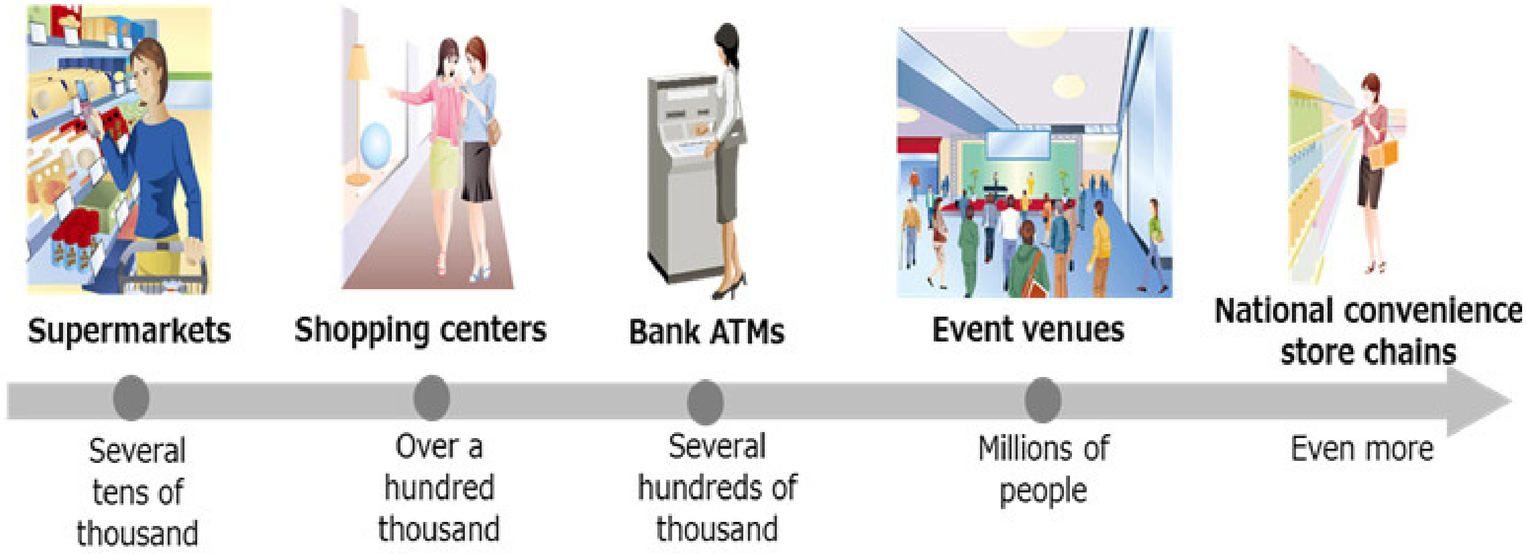
1. Fill user details: Roll number, name, email
2. Upload left and right palm images.
3. Validation: "Fill all fields" prompt for incomplete data
4. Finalize: Register User button.

- **Security:** Palm images stored as biometric templates



# Project Impact

- Transport Industry: Improved passenger safety and operational security
- Expansion: Potential applications in banking, ATMs, healthcare, and law enforcement



# Sustainable Development Goals

- Industry, Innovation, and Infrastructure: Building resilient, secure transport systems
- Sustainable Cities and Communities: Enhancing safety and efficiency
- Peace, Justice, and Strong Institutions: Reducing identity fraud and crime

# Conclusion

- PalmSecure offers a cutting-edge solution to transport security challenges
- Future scalability into various industries, including banking and healthcare
- Comprehensive approach to biometric identity verification using deep learning

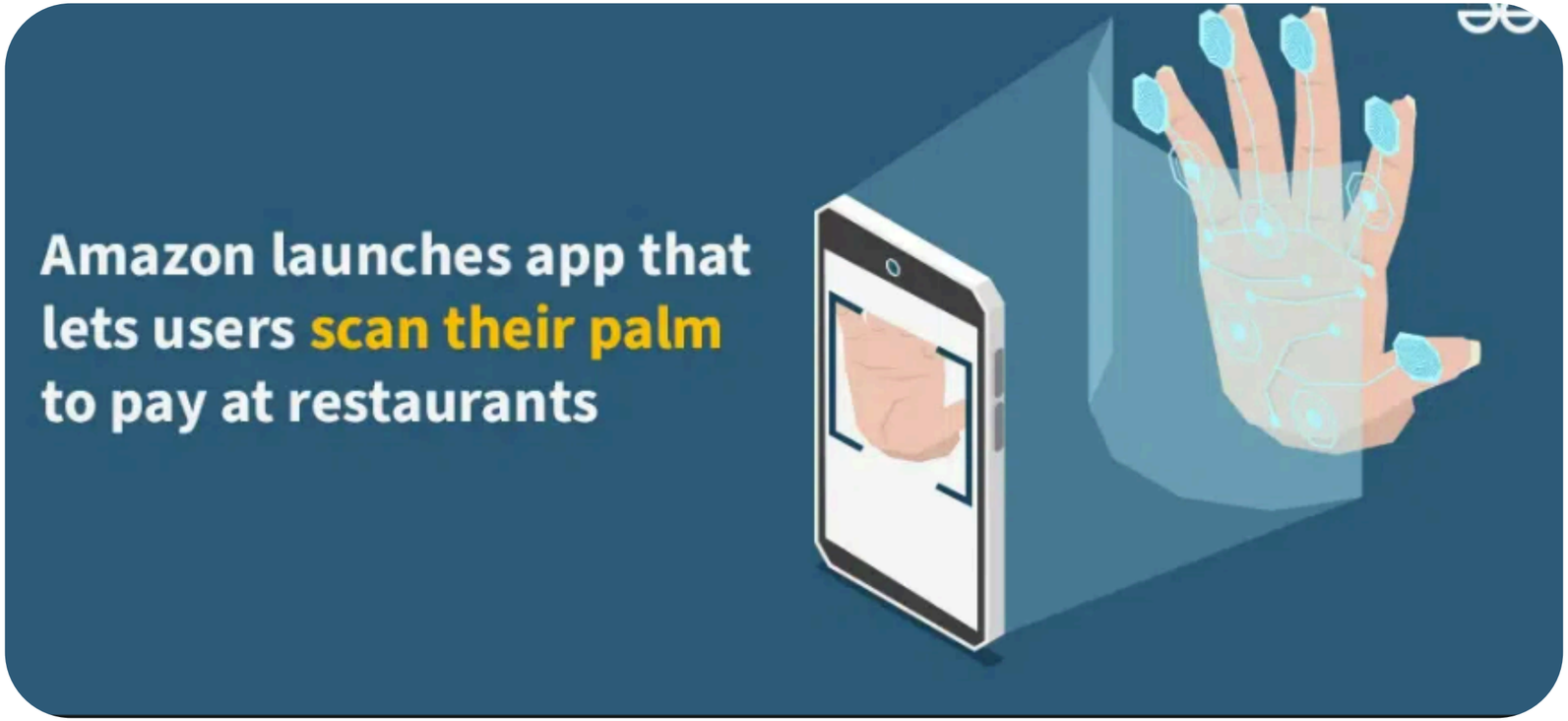



**Figure 3: https://www.geeksforgeeks.org/amazon-app-that-lets-users-scan-their-palm-to-pay-at-restaurants/**

# Thank You For Listening

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