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Contactless Fingerprint Authentication

UIDAI SITAA Challenge Submission - Complete 4-Track Solution

YellowSense Technologies Pvt. Ltd.

Building AI-First Identity Solutions for Bharat

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The Challenge

UIDAI requires robust contactless fingerprint authentication for Aadhaar at national scale. With 1.4 billion Aadhaar users but only 20 million hardware scanners deployed, the need for mobile-based solutions is critical.

Key Requirements

- Real-time quality assessment for reliable capture
- Image enhancement for improved processing
- Cross-modal matching (contactless to contact)
- Multi-modal liveness detection against spoofing

Accuracy is NOT the criterion - pipeline clarity and biometric thinking ARE

Market Need

1.4B Aadhaar users nationwide

20M hardware scanners currently deployed

Massive gap in accessibility

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Complete 4-Track Implementation

We're the **only team** with all four tracks fully implemented, demonstrating comprehensive biometric thinking and pipeline clarity.

Track A: Quality Assessment

Real-time on-device analysis at 10-15 FPS

Track B: Image Enhancement

OpenCV pipeline on mobile device

Track C: Fingerprint Matching

Siamese Neural Network at 78% accuracy

Track D: Liveness Detection

5-component analysis at 90% detection

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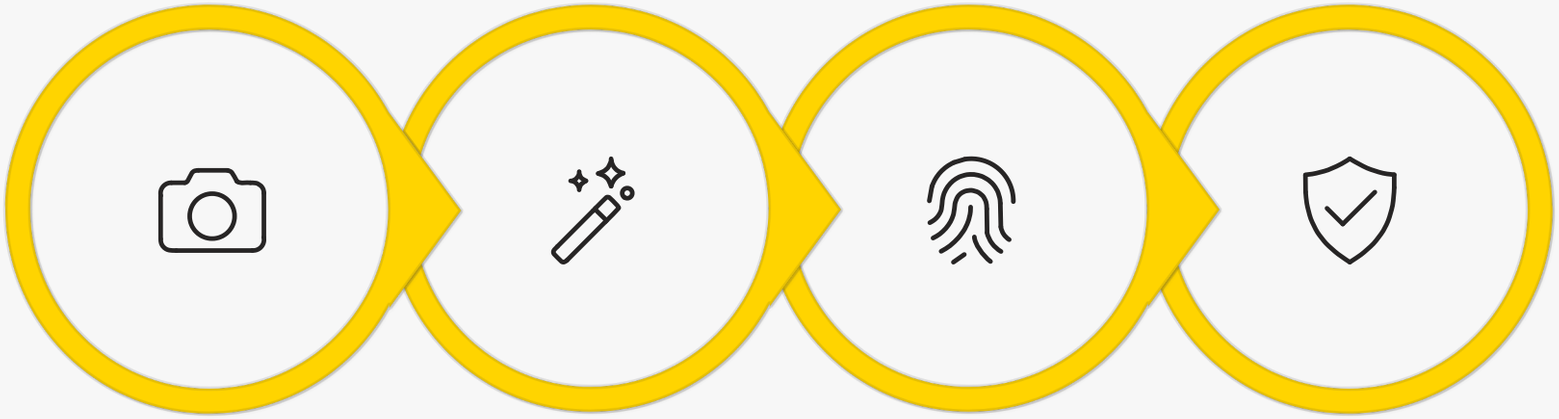
System Design - End-to-End Pipeline



Capture **Enhance** **Match** **Verify Liveness**

Processing Architecture

- **On-Device**: Tracks A, B, D (privacy-preserving)
- **Cloud API**: Track C (matching service)
- **Mobile App**: React Native unified APK
- **Backend**: FastAPI + TensorFlow

Deployment Platform

Google Cloud Platform with RESTful APIs for seamless communication between mobile client and cloud services.

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Track A: Quality Assessment

On-Device Real-Time Analysis

MediaPipe and OpenCV pipeline delivers instant feedback with zero network latency.

Three Critical Metrics

1. **Blur/Focus** - Laplacian variance analysis
2. **Illumination** - Brightness and contrast measurement
3. **Coverage** - Position and size validation

Status-driven capture: READY_TO_CAPTURE at 70%+ score ensures optimal image quality.

Key Benefits

- 100% privacy-first processing
- 10-15 FPS throughput
- <100ms processing time
- Zero cloud dependency

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Track B: Image Enhancement

On-Device Classical Computer Vision Pipeline

OpenCV for Android delivers efficient processing without deep learning overhead.

Finger Detection

Contour analysis

Noise Reduction

Bilateral filtering

Contrast Enhancement

CLAHE algorithm

Sharpness + Upscaling

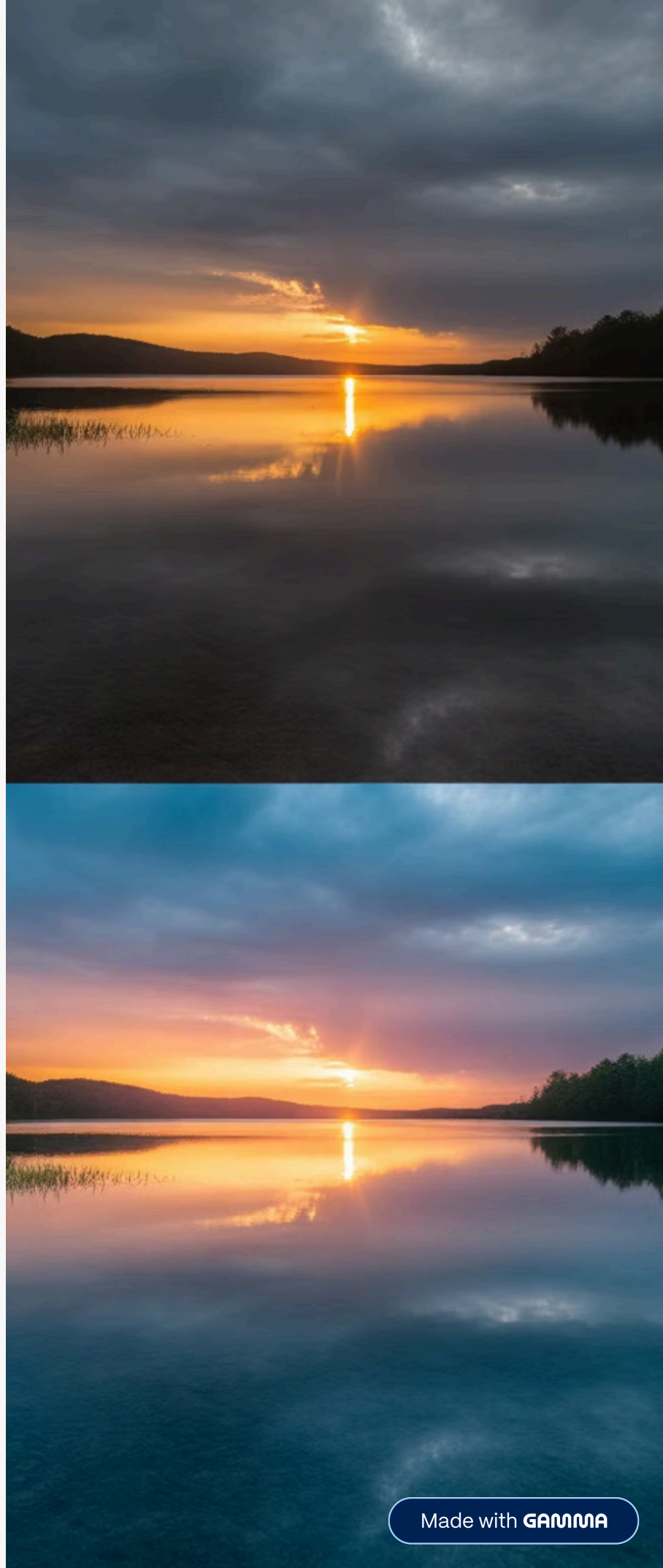
Unsharp mask + bicubic

Performance Results

- 40-60% ridge clarity improvement
- 2-3x contrast enhancement
- <500ms total processing
- Privacy-first approach

Strategic Choice

Classical CV over deep learning for optimal mobile efficiency and minimal battery consumption.



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Track C: Fingerprint Matching

Siamese Neural Network

Deep metric learning architecture using MobileNetV2 feature extractor with L1 distance measurement.

Current Performance

- **78%** validation accuracy
- **36%** FAR (development mode)
- **400ms** processing time
- **1,280-dim** embeddings

Production Targets

99%+ accuracy

<1% FAR

<2% FRR

Deployment

FastAPI on Google Cloud Platform with RESTful endpoints for matching service.

UIDAI priority: Pipeline clarity and biometric thinking take precedence over raw accuracy metrics in evaluation criteria.

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Track D: Liveness Detection

On-Device Multi-Modal Analysis

Five-component scoring using OpenCV for real-time spoof detection with offline capability.

1

Motion Analysis

Optical flow patterns detect natural finger movement

2

Texture Analysis

Local Binary Pattern histograms identify skin texture

3

Edge Density

Canny edge detection verifies ridge structure

4

Color Variance

HSV temporal analysis detects screen artifacts

5

Consistency Score

Cross-validation across frames confirms authenticity

Print Attack

95%+ detection rate

Replay Attack

90%+ detection rate

Silicone Attack

85%+ detection rate

Frame requirement: 3-5 frames at 10 FPS delivers real-time protection at <100ms per frame.

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Why YellowSense?

Government Recognition

- Startup India: DIPP-138388
- MSME: UDYAM-KR-03-0293956
- MEITY TIDE 2.0: ₹7 lakhs grant (Oct 2025)
- Incubated: IIIT Bangalore Innovation Centre

Proven Deployments

- Kerala Government: Welfare fraud detection systems
- New Mangaluru Port: Maritime intelligence platforms
- Experience in biometric AI and liveness detection
- Government compliance expertise

Technical Excellence

- Deep learning optimization specialists
- Production-grade SDK development
- Cloud-native architecture
- Privacy-first design philosophy

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6-Month Development Roadmap

₹2.5 crore total investment across four critical stages

Stage 1: Month 1

₹50 lakh

Project Design Document and dataset protocol establishment

1

Stage 2: Month 2

₹50 lakh

Proof-of-Concept (TRL-3) with 90%+ accuracy targets

2

Stage 3: Month 4

₹75 lakh

MVP (TRL-6) with iOS compatibility and Track B deep learning enhancement

3

Stage 4: Month 6

₹75 lakh

Pre-Commercial (TRL-8) with ISO-19794-4 certification and UIDAI AFIS integration

4

Delivery Team

Technical Leadership

- **Prakhar Goyal** (CTO) - prakhar@yellowsense.in, +91 9869 397 868
- **Abhimanyu Malik** (AI/ML Lead) - abhimanyu@ai.yellowsense.in
- **Talha Nagina** (Backend AI/ML) - talha@ai.yellowsense.in, +91 9104169390
- **Ishita Singh** (Frontend) - ishita@yellowsense.in

Deliverables

- Android APK (V2 - All 4 tracks)
- GitHub repository with complete documentation
- Demo video walkthrough
- Complete technical proposal

> **Ready for Stage 1** - Let's build India's contactless authentication future together
>
> yellowsense.in