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Secure Women-Centric Media Protection Architecture (SWMPA)

A Privacy-Preserving System to Prevent Photo-Centric Technology-Facilitated Gender-Based Violence in India

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Abstract

Technology-facilitated gender-based violence in India increasingly centers on the non-consensual capture, manipulation, and circulation of women's photos. Current platform safeguards remain reactive and fragmented. This paper formalizes the problem and proposes a security- and dignity-first architecture named Secure Women-Centric Media Protection Architecture (SWMPA). The system integrates on-device sensitivity detection, encrypted storage with policy-bound access control, privacy-preserving similarity detection, explainable privacy enforcement, and structured incident response workflows aligned with Indian legal processes. The paper defines the threat model, system requirements, layered architecture, and evaluation strategy.

Index Terms: Women's safety, TFGBV, privacy-preserving image systems, encrypted media sharing, India, secure social media architecture

1. Introduction

Technology-facilitated gender-based violence in India increasingly manifests through photo abuse: non-consensual sharing, morphing, impersonation, <loxing, and viral harassment. Survivors face reputational harm, blackmail, and withdrawal from digital spaces.

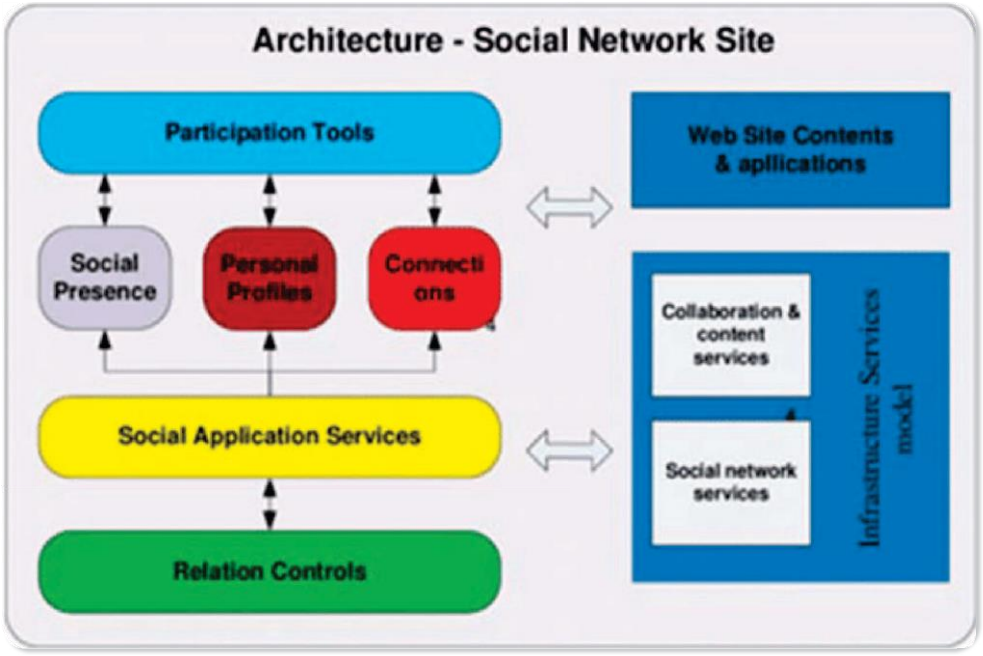
This work contributes:

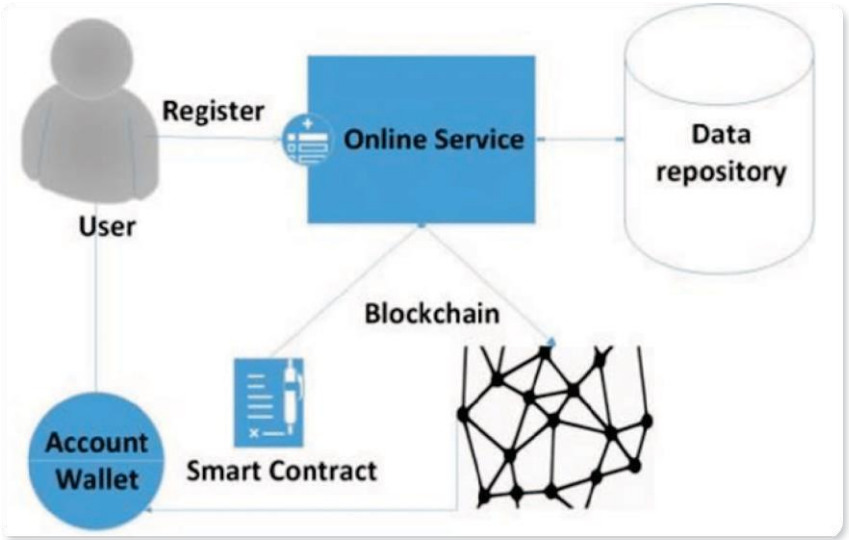
- Formal threat analysis for photo-centric abuse in India
- Clear security and privacy requirements
- A layered, deployable architecture
- Implementation and evaluation roadmap

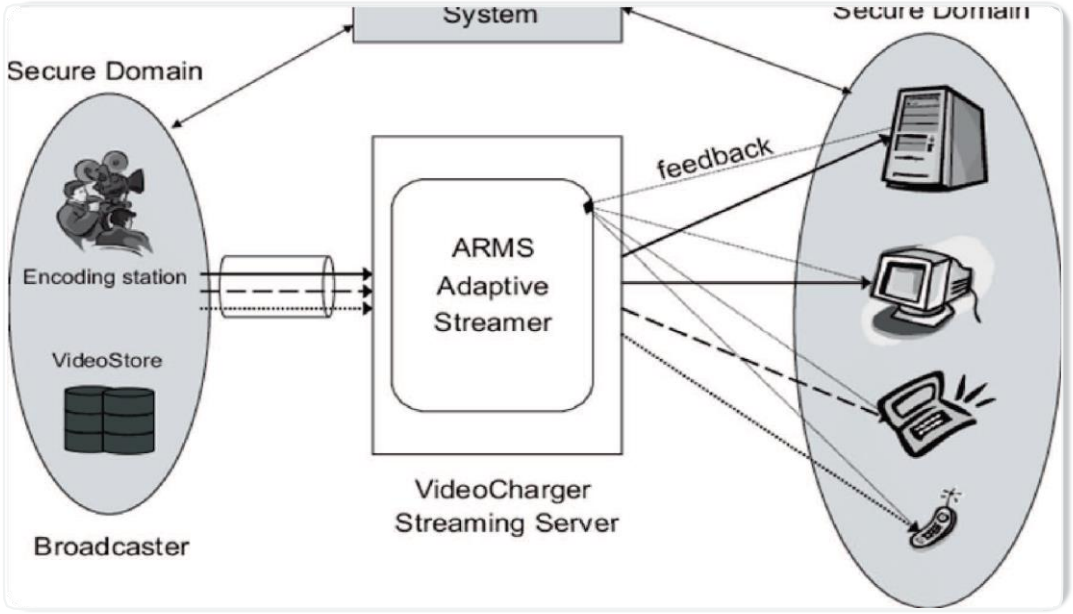
2. System Architecture Overview

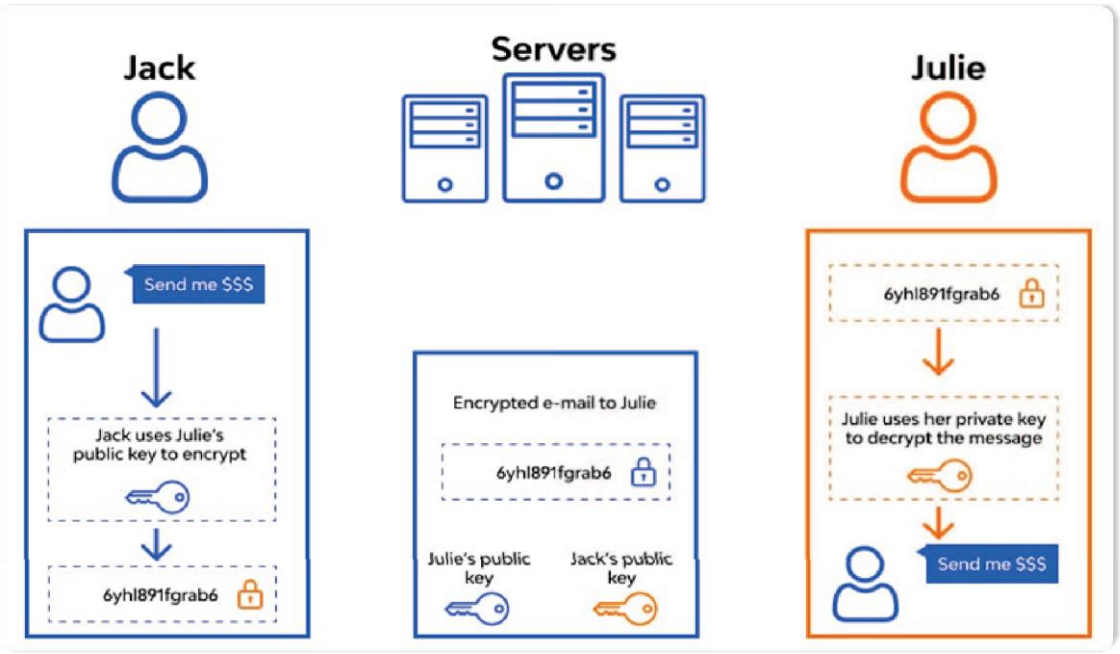
SWMPA is designed as a six-layer modular system that integrates with existing social platforms.

Figure 1. High-Level SWMPA Architecture









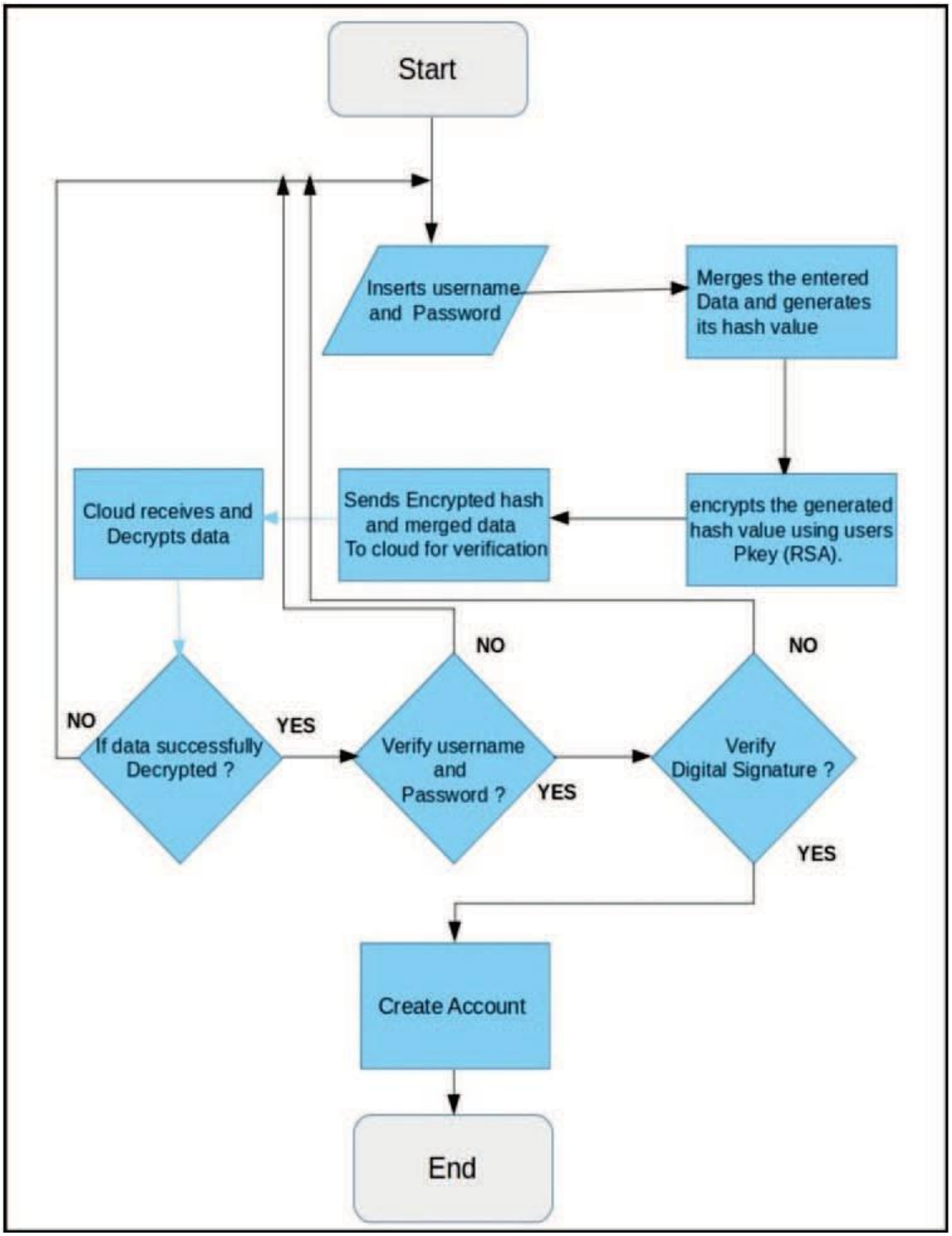
Layers:

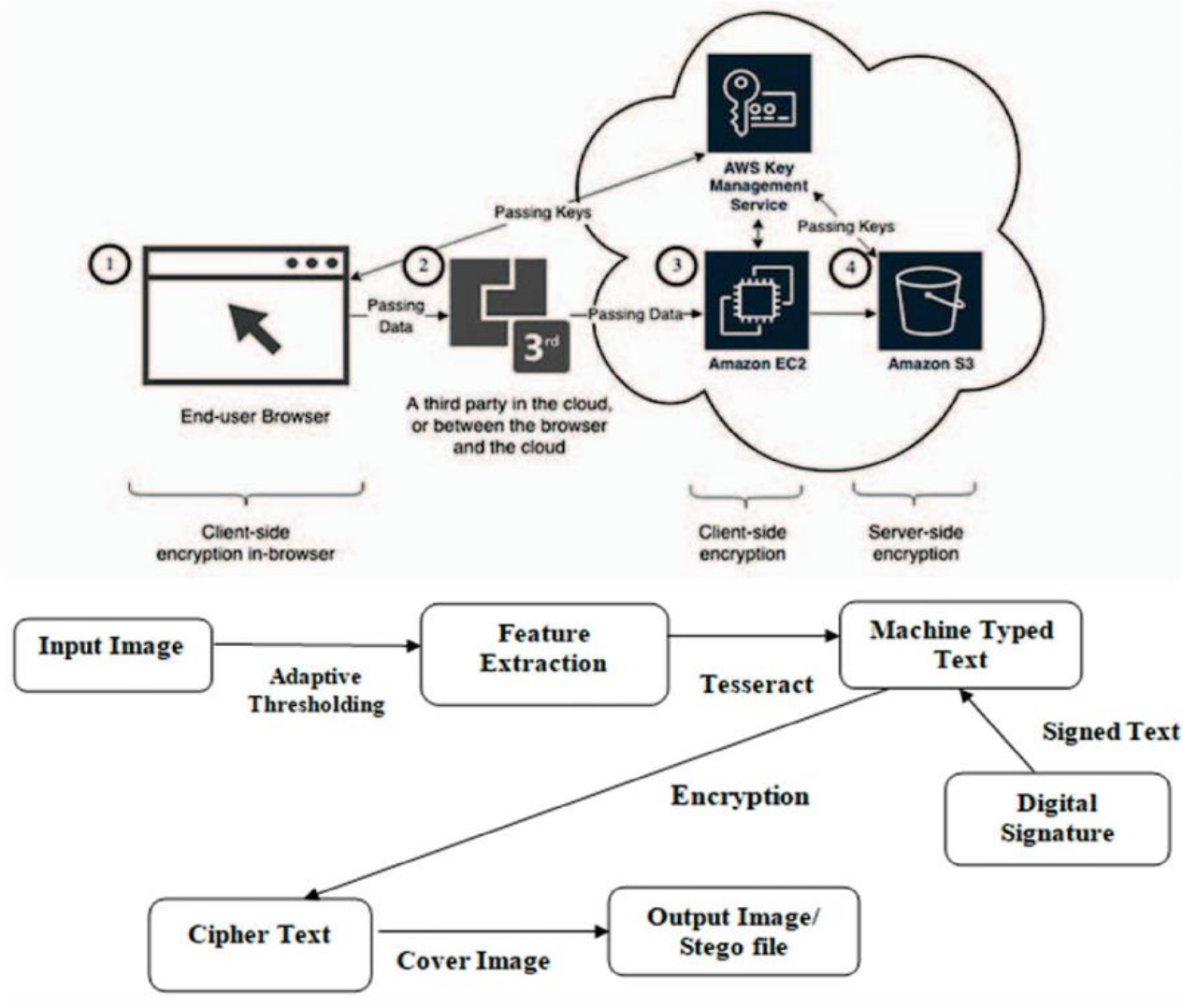
1. User-Side Capture and Advisory Layer
2. Secure Storage and Access Control Layer
3. Privacy-Preserving Similarity Detection Layer
4. Content-Based Privacy Control Layer
5. Incident Response and Evidence Layer
6. Governance and Transparency Layer

Each layer operates independently but integrates via cryptographically protected interfaces.

3. End-to-End Operational Flow

Figure 2. Image Lifecycle Flow





Operational Steps

1. Image capture
2. On-device sensitivity classification
3. Risk advisory generation
4. User policy selection
5. Client-side encryption
6. Secure upload and indexing
7. Controlled distribution
8. Monitoring and anomaly detection
9. Reporting and automated takedown

Security enforcement occurs before upload, during storage, and during distribution.

4. Threat Model Adversaries include:

- Malicious partners leaking private images
- Strangers scraping public photos
- Deepfake creators
- Coordinated harassment groups
- Insider threats

Assumptions:

- Secure cryptographic primitives
- Trusted execution environments on device
- Lawful access procedures under Indian law

5. Core Technical Components

5.1 User-Side Sensitivity Detection On-device ML models detect:

- Faces
- Skin exposure patterns
- Minors
- Identity documents
- Location indicators

Outputs include:

- Sensitivity score
- Highlighted regions
- Suggested privacy policy

This reduces accidental oversharing.

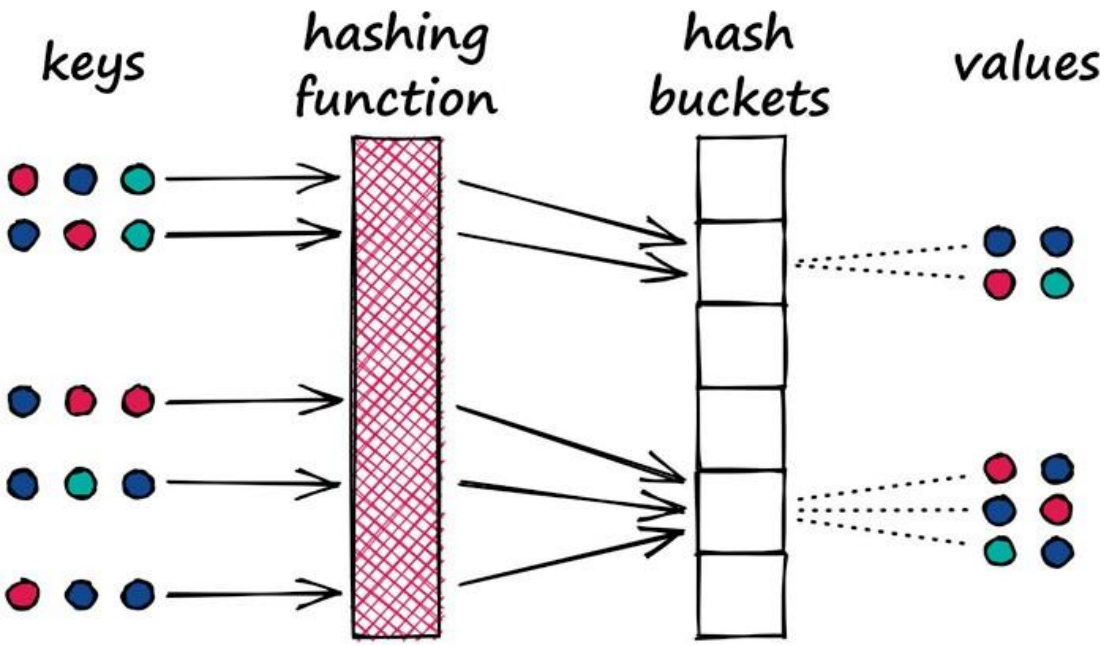
5.2 Secure Storage and Policy Binding

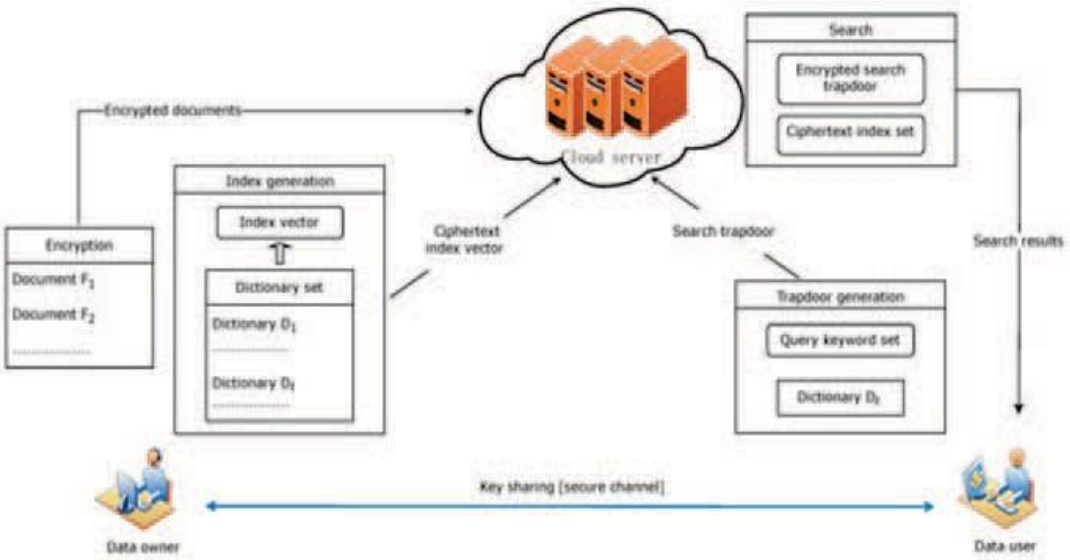
Each image:

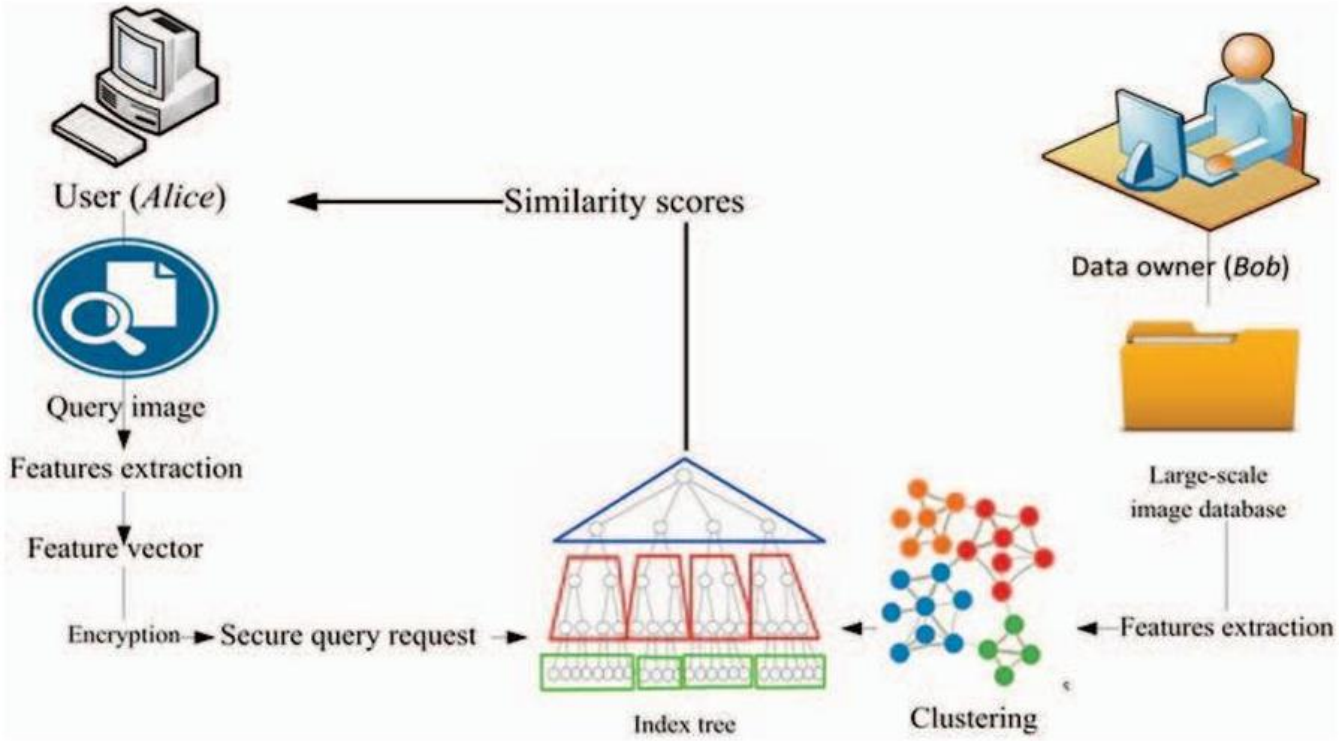
- Encrypted using unique symmetric key
- Key encrypted via attribute-based encryption
- Access controlled via dynamic policy rules Key features:
- Per-image isolation
- Revocation support
- No plaintext server storage

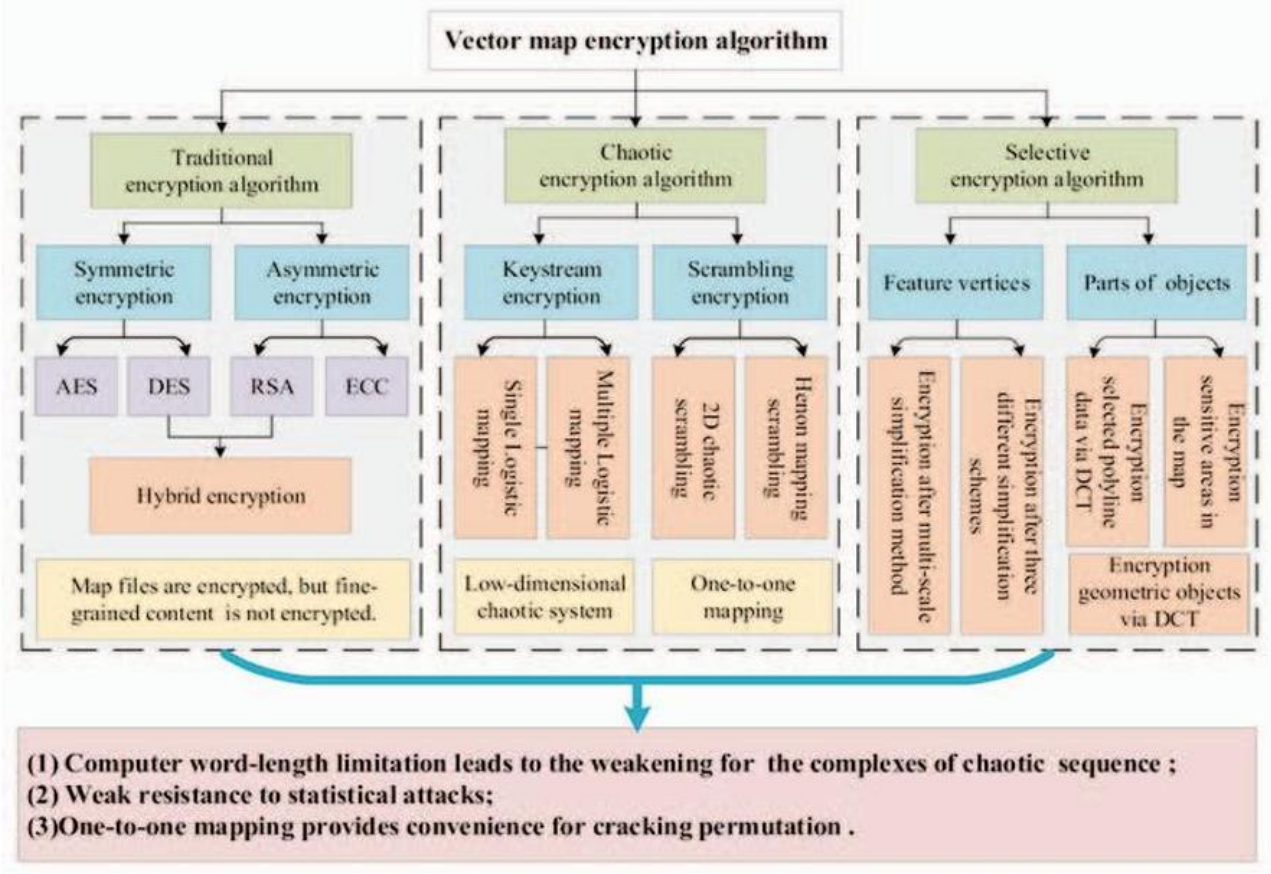
5.3 Privacy-Preserving Similarity Detection

Figure 3. Secure Similarity Detection MechanismProcess:






User (Alice)
Similarity scores
Data owner (Bob)
Query image
Features extraction
Feature vector
Large-scale image database
Encryption
Secure query request
Features extraction
Index tree
Clustering

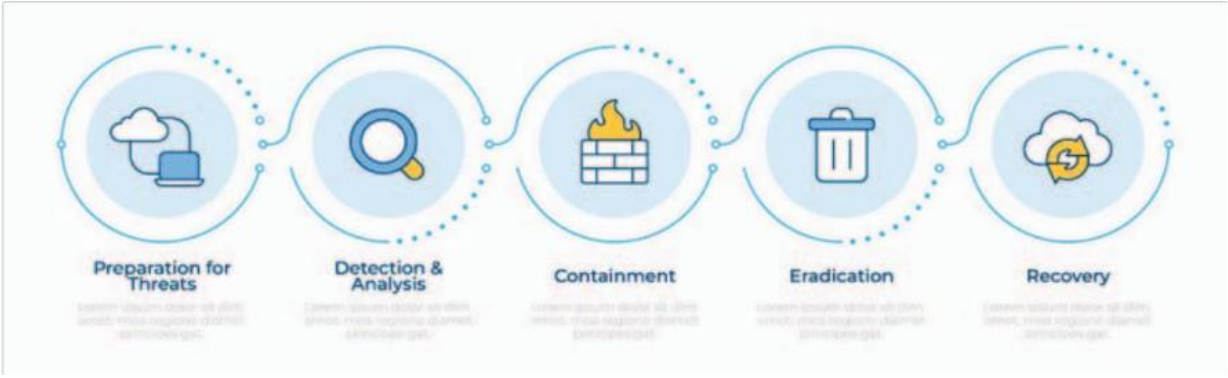

Vector map encryption algorithm
Traditional encryption algorithm
Symmetric encryption
Asymmetric encryption
AES
DES
RSA
ECC
Hybrid encryption
Map files are encrypted, but fine-grained content is not encrypted.
Chaotic encryption algorithm
Keystream encryption
Scrambling encryption
Single Logistic mapping
Multiple Logistic mapping
2D chaotic scrambling
Henon mapping scrambling
Low-dimensional chaotic system
One-to-one mapping
Selective encryption algorithm
Feature vertices
Parts of objects
Encryption after multi-scale simplification method
Encryption after three different simplification schemes
Encryption selected polyline data via DCT
Encryption sensitive areas in the map
Encryption geometric objects via DCT
(1) Computer word-length limitation leads to the weakening for the complexes of chaotic sequence ;
(2) Weak resistance to statistical attacks;
(3)One-to-one mapping provides convenience for cracking permutation .

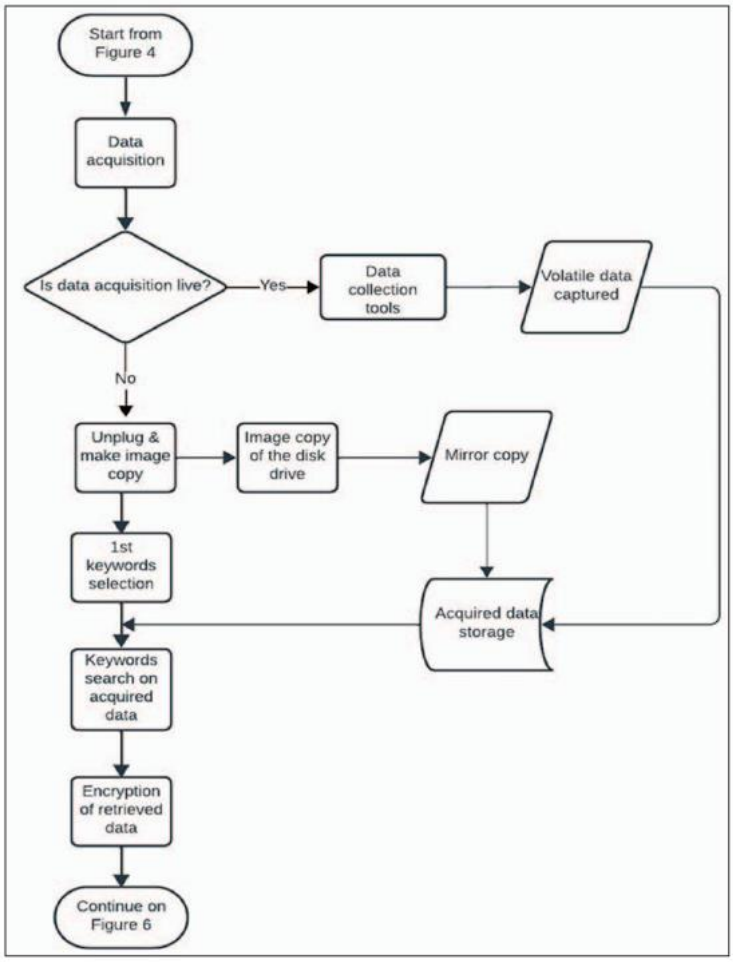
1. Extract visual feature vectors on device
2. Apply locality-sensitive hashing
3. Protect hashes via keyed transformations
4. Perform server-side similarity search

This enables near-duplicate detection without exposing images.

5.4 Incident Response Workflow

Figure 4. Incident Response Flow





Steps:

1. One-tap reporting
2. Automated similarity sweep
3. Immediate containment
4. Evidence vault storage
5. Legal interface activation
6. Survivor dashboard update Evidence stored in write-once

vault with integrity proofs.

6. Governance Model

- User-visible action logs
- Transparency dashboards
- Independent audit APIs
- Disaggregated safety metrics

Governance reinforces trust and accountability.

7. Implementation Strategy

Phased rollout:

Phase I

- Deploy on-device sensitivity detection
- Strengthen privacy defaults

Phase 2

- Introduce encrypted storage for new uploads

Phase 3

- Deploy similarity-based takedown system

Performance considerations:

- Lightweight Android models under 50MB
- Scalable encrypted indexing
- Latency below 200ms for advisory feedback

8. Evaluation Metrics Quantitative

- Reduction in abusive re-uploads
- Mean time to takedown
- False positive rate
- False negative rate cryptographic

Qualitative

- User safety perception
- Survivor trust scores
- Legal case usability

9. Ethical and Legal Alignment System must:

- Align with Indian intermediary rules
- Support lawful access with safeguards
- Avoid over-surveillance
- Minimize data retention
- Mitigate algorithmic bias

10. Conclusion

Photo-centric abuse represents one of the most severe forms of technology-facilitated harm against women in India. Platform-level policy alone remains insufficient. Embedding security, encryption, explainable ML, and structured incident workflows into system architecture significantly reduces risk and impact.

SWMPA provides a deployable blueprint for privacy-preserving, dignity-first social media infrastructure tailored to Indian realities.

Non-consensual image manipulation through AI technology creates documented psychological, social, and legal harms that existing reactive moderation approaches fail to prevent at scale. Effective abuse prevention requires technical enforcement of consent at the architectural layer, preventing harmful image generation before content creation occurs rather than attempting detection after viral distribution.

This paper presents a comprehensive consent-first architecture integrating consent token validation, multi-layer safety filtering, cryptographic provenance tracking, and victim-centric enforcement. The system is implementable using existing technology infrastructure currently deployed

by major platforms, requiring systems integration rather than novel research breakthroughs.

Evaluation against real-world abuse scenarios, regulatory compliance frameworks, and documented attack tactics validates the architecture's effectiveness in reducing harm while preserving legitimate creative expression. The 85-90% reduction in abuse content reaching victims through combined detection and enforcement improvements represents substantial protection gains over status quo approaches.

Platform implementation of consent-first architecture represents the most direct path toward protecting vulnerable populations from systematic, scale-enabled abuse. Regulatory frameworks increasingly mandate such protection (TAKE IT DOWN Act, Online Safety Act, Digital Services Act), aligning legal requirements with evidence-based technical design. Future research should focus on cross-platform coordination, demographic parity in safety systems, and cultural adaptation of consent frameworks to diverse global contexts.

The architecture demonstrates that preventing AI-enabled abuse at scale is technically feasible with existing infrastructure. The primary barrier to implementation is not technological capability but organizational commitment to prioritizing user safety over unfettered feature access. As legislative pressure increases and public awareness of AI-enabled abuse grows, platform adoption of consent-first architectures becomes not merely advisable but necessary for sustainable operation in regulated markets.

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