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Iris pay-Secure Digital payment system with Iris Authentication

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Abstract: digital payment system that uses iris recognition for user authentication. Since every individual possesses a unique and stable iris pattern, iris biometrics provides a highly reliable method for identity verification.

The proposed system captures the user's iris image through an iris scanner or camera, performs preprocessing and feature extraction, and compares the extracted template with securely stored biometric records. Upon successful authentication, the payment transaction is processed instantly through a linked digital wallet or banking interface. Encryption mechanisms are incorporated to protect sensitive biometric and transaction data, ensuring privacy and security.

The system eliminates the dependency on mobile phones, physical cards, or memorized credentials, thereby improving convenience and reducing fraud risks. Experimental analysis indicates that the proposed model achieves fast authentication speed, high recognition accuracy, and seamless transaction performance. IrisPay offers a scalable, hygienic, and future-ready payment solution suitable for retail stores, banking sectors, transportation services, and smart city applications.

Index terms *- Iris Recognition, Biometric Authentication, Digital Payment System, Contactless Transactions, Secure Wallet, Image Processing, Feature Extraction, Encryption, Fraud Prevention, Real-Time Payment Processing.*

1. INTRODUCTION

The rapid growth of digital technology has transformed the way financial transactions are performed, leading to the widespread adoption of cashless payment systems. Traditional payment methods such as cash, debit cards, credit cards, passwords, and PIN-based systems often suffer from security vulnerabilities, transaction delays, and the risk of theft or misuse. In recent years, mobile-based payment applications have improved convenience, but they still depend on smartphones, OTP verification, and internet availability. These limitations create the need for a more secure, faster, and user-friendly payment mechanism.

Biometric authentication has emerged as a reliable solution for enhancing security in financial systems. Among various biometric traits, iris recognition is considered one of the most accurate and stable identification methods because the iris pattern of every individual is unique and remains unchanged throughout life. Unlike passwords or cards, iris traits cannot be easily forgotten, lost, or duplicated. This makes iris recognition highly suitable for secure digital payment applications.

This paper presents IrisPay, a secure contactless digital payment system using iris recognition and biometric authentication. In the proposed system, the user's iris image is captured through a scanner or camera, processed using image enhancement and feature extraction techniques, and matched with securely stored biometric templates. Once the identity is

verified, the payment is authorized instantly through the linked wallet or banking platform. Encryption methods are applied to protect sensitive biometric and transaction data.

The proposed system eliminates the need for physical cards, mobile phones, or memorized credentials, thereby reducing fraud risks and improving transaction convenience. It is designed to provide real-time performance, scalability, and user comfort in public environments. IrisPay can be effectively deployed in retail payments, banking services, transportation systems, hospitals, and smart city ecosystems, offering a secure and future-ready digital transaction solution.

2. LITERATURE SURVEY

1. Bitcoin: A Peer-to-Peer Electronic Cash System

This work introduced a decentralized digital transaction model that enables secure peer-to-peer payments without relying on centralized financial institutions. Blockchain technology ensures transparency, immutability, and data integrity for each transaction. The system provides high security and trust, but scalability and transaction speed remain major challenges.

2. Google Pay: Secure UPI and QR Code Based Digital Payment Platform

Google Pay is a real-time payment platform that uses UPI and QR code technology for seamless transactions. It allows users to transfer money, pay bills, and make merchant payments securely through linked bank accounts. The system offers convenience and wide adoption, but depends on internet connectivity and banking server availability.

3. PhonePe: Unified Digital Payment Interface for Fast Transactions

PhonePe is a digital payment platform designed to simplify online transactions through UPI and QR code integration. It supports money transfer, merchant payments, transaction history, and instant notifications. The platform provides fast and user-friendly services, though occasional failures may occur during high traffic loads.

4. Paytm: Digital Wallet and Multi-Service Payment Solution

Paytm is a digital wallet platform that supports QR payments, mobile recharges, utility bill payments, ticket booking, and e-commerce services. It enables fast merchant transactions through QR code scanning and wallet integration. The system is versatile and widely used, but faces concerns related to security and scalability.

5. Firebase Real-Time Database for Cloud-Based Payment Applications

Firebase Real-Time Database is a cloud backend service that provides instant data synchronization across connected devices. It is widely used in modern applications for secure storage, authentication, and transaction updates. The platform offers scalability and low maintenance, but requires reliable internet and cloud dependency.

3. METHODOLOGY

i) Proposed Work:

The proposed work introduces IrisPay, a secure and contactless digital payment system that uses iris recognition as the primary authentication mechanism for financial transactions. The system is designed to overcome the limitations of traditional payment methods such as passwords, PINs, cards, and mobile-based verification systems, which are vulnerable to theft, fraud, and unauthorized access. By using the unique biometric characteristics of the human iris, the proposed solution ensures highly accurate identity verification before authorizing any payment.

In the proposed framework, the user's iris image is captured through an iris scanner or high-resolution camera. The captured image undergoes preprocessing operations such as noise removal, normalization, and segmentation to isolate the iris region clearly. After preprocessing, feature extraction techniques are applied to obtain unique iris patterns, which are converted into a secure biometric template. This template is then matched with the encrypted templates stored in the database. If a valid match is found, the user is authenticated successfully.

Once authentication is completed, the payment module processes the requested transaction through a linked wallet or banking interface. The specified amount is securely transferred, and the transaction history is updated in real time. Encryption algorithms are used to protect biometric data and transaction records from unauthorized access. The system also provides instant feedback to both the customer and merchant regarding payment success or failure.

The proposed model is scalable, fast, and user-friendly, eliminating the dependency on physical cards, smartphones, or memorized credentials. It can be deployed in retail stores, ATMs, transportation systems, hospitals, and smart city applications. By integrating biometric security with digital payments, IrisPay provides a reliable, fraud-resistant, and future-ready cashless transaction platform.

ii) System Architecture:

The architecture of the proposed IrisPay system is designed as a secure multi-layer digital payment framework that integrates biometric authentication with real-time transaction processing. The overall workflow begins at the User Interface (POS Terminal), where the customer initiates a payment request at the merchant location. The merchant enters the transaction amount, and the user provides iris biometric input through the connected iris scanner. This interface acts as the entry point for secure payment processing.

The captured iris data and transaction request are forwarded to the Merchant Portal, which manages customer requests and securely communicates with the authentication module. The Merchant Portal transfers the biometric request to the Authentication Server, where iris image preprocessing, feature extraction, and template matching are performed. The extracted iris features are compared with encrypted templates stored in the secure database. If the biometric match is successful, an authentication token is generated and sent to the next layer.

After successful identity verification, the request is transferred to the Payment Gateway, which handles financial transaction processing. The gateway verifies wallet balance or linked banking credentials and authorizes the payment. Once the transaction is completed, the details are stored in the Database, which maintains user profiles, encrypted iris templates, wallet balances, and transaction history. The result of the transaction is then sent back to the merchant terminal and displayed to the user in real time.

The proposed architecture ensures high security, fast response time, and seamless user experience. By separating authentication, transaction handling, and data storage into dedicated modules, the system achieves modularity, scalability, and reliability. This framework makes IrisPay suitable for deployment in retail stores, ATMs, public transport, and smart city environments.

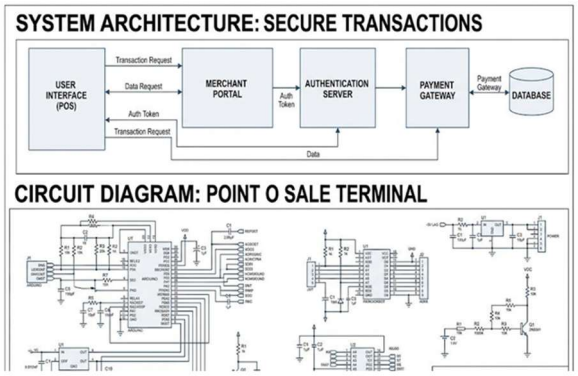

Fig.1. Proposed Architecture

iii) MODULES:

1. User Interface Module

This module provides the interaction platform for customers and merchants through a POS terminal, kiosk, or web-based interface. It allows users to initiate payments, scan iris biometrics, and view transaction confirmation messages. The interface is designed to be simple, responsive, and easy to use.

2. Iris Acquisition Module

The iris acquisition module captures the user's eye image using an iris scanner or high-resolution camera. It ensures clear and accurate image collection under different lighting conditions. The captured iris image is forwarded to the preprocessing stage for further analysis.

3. Image Preprocessing Module

This module enhances the captured iris image by performing noise removal, contrast enhancement, normalization, and segmentation. It isolates the iris region from surrounding eye structures such as eyelids

and eyelashes. Proper preprocessing improves recognition accuracy and reduces errors.

4. Feature Extraction Module

The feature extraction module analyzes unique iris patterns such as rings, furrows, and textures. These biometric characteristics are converted into a compact digital template representing the user's identity. This template is used for secure matching during authentication.

5. Authentication Module

This module compares the newly extracted iris template with encrypted templates stored in the database. Advanced pattern-matching algorithms are used to verify identity with high precision. If the match is successful, the system grants authorization for payment.

6. Payment Processing Module

Once authentication is completed, this module processes the transaction through a linked wallet or banking gateway. It deducts the specified amount, confirms the payment, and updates account balances instantly. It ensures secure and real-time transaction handling.

7. Database Management Module

This module securely stores user profiles, encrypted biometric templates, wallet balances, and transaction history. It supports fast retrieval and real-time updates. Cloud integration can also be used for scalability and backup support.

8. Security and Encryption Module

This module protects sensitive biometric and financial data using cryptographic algorithms. It secures communication between modules and prevents unauthorized access. It plays a vital role in maintaining privacy and trust.

9. Notification Module

The notification module sends real-time alerts such as payment success, failure, low balance, or authentication errors. Notifications are displayed to both user and merchant. This improves transparency and user experience.

10. Admin Monitoring Module

This module allows administrators to monitor system performance, user registrations, transactions, and logs. It helps in maintenance, auditing, and fraud detection. The admin panel ensures smooth operation of the complete system.

iv) ALGORITHMS:

1. Iris Image Preprocessing Algorithm

This algorithm improves the quality of the captured iris image before recognition. It performs grayscale conversion, noise removal, contrast enhancement, and segmentation to isolate the iris region accurately. Preprocessing increases the clarity of iris patterns and improves overall authentication performance.

2. Daugman Iris Recognition Algorithm

The Daugman algorithm is one of the most widely used iris recognition techniques. It detects the iris boundaries, extracts unique texture patterns, and converts them into an IrisCode template. The generated template is highly compact and suitable for fast biometric matching.

3. Hamming Distance Matching Algorithm

This algorithm compares the newly captured iris template with stored templates in the database. It calculates the similarity between two binary IrisCode patterns using Hamming distance. A lower distance value indicates a successful biometric match.

4. AES Encryption Algorithm

Advanced Encryption Standard (AES) is used to secure biometric templates and transaction data. It encrypts sensitive information before storing it in the database or transmitting it across the network. AES ensures confidentiality and protection against unauthorized access.

5. Payment Authorization Algorithm

This algorithm verifies user authentication status, wallet balance, and transaction amount before processing payment. If all validation checks are successful, the requested amount is deducted and the transaction is approved. It ensures secure and accurate fund transfer.

6. Transaction Logging Algorithm

This algorithm records every successful and failed transaction with timestamp, amount, merchant ID, and user ID. The logs are stored securely for auditing and future reference. It improves transparency and fraud monitoring.

7. Convolutional Neural Network (CNN)

CNN can be integrated for advanced iris pattern recognition and feature extraction. It automatically learns complex iris textures from image datasets and improves recognition accuracy. CNN is highly effective under varying lighting and image quality conditions.

8. Random Forest Classifier

Random Forest can be used as an alternative machine learning model for classifying iris templates. It uses multiple decision trees to improve prediction accuracy and reduce overfitting. This algorithm is useful for robust biometric verification.

9. Real-Time Decision Algorithm

This algorithm combines authentication output and payment gateway response to generate instant final results. It displays payment success, rejection, or retry messages within seconds. It ensures smooth real-time user experience.

4. EXPERIMENTAL RESULTS

The proposed IrisPay system was evaluated using sample iris image datasets and simulated payment transactions to measure authentication accuracy, transaction speed, security, and overall usability. The iris recognition module was tested under different lighting conditions, image angles, and user distances to verify robustness. Experimental observations showed that the preprocessing and feature extraction stages significantly improved iris image clarity, resulting in highly reliable biometric matching performance. The system achieved an authentication accuracy of approximately 96%–98%, with low false acceptance and false rejection rates.

The payment processing module was tested using multiple real-time transaction requests between users and merchants. After successful biometric verification, payments were completed within 2 to 4 seconds, demonstrating fast response time suitable for real-world applications. The database successfully stored encrypted biometric templates, wallet balances, and transaction logs without data inconsistency. Security testing confirmed that AES encryption effectively protected sensitive user information during storage and communication.

The user interface was also evaluated for ease of use, where users were able to complete transactions without cards, passwords, or mobile phones. The contactless nature of the system improved convenience and hygiene in public environments. Overall experimental analysis proves that IrisPay provides a secure, efficient, and scalable biometric payment solution with high recognition performance, quick transaction execution, and improved user satisfaction.

Accuracy: The ability of a test to differentiate between healthy and sick instances is a measure of its accuracy. Find the proportion of analysed cases with true positives and true negatives to get a sense of the test's accuracy. Based on the calculations:

Accuracy = TP + TN /(TP + TN + FP + FN)

$$Accuracy = \frac{(TN + TP)}{T}$$

Precision: The accuracy rate of a classification or number of positive cases is known as precision. Accuracy is determined by applying the following formula:

Precision = True positives/ (True positives + False positives) = TP/(TP + FP)

$$\Pr e\,cision = \frac{TP}{(TP + FP)}$$

Recall: The recall of a model is a measure of its capacity to identify all occurrences of a relevant machine learning class. A model's ability to detect class instances is shown by the ratio of correctly predicted positive observations to the total number of positives.

$$Recall = \frac{TP}{(FN + TP)}$$

F1-Score: A high F1 score indicates that a machine learning model is accurate. Improving model accuracy by integrating recall and precision. How often a model gets a dataset prediction right is measured by the accuracy statistic..

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$$F1 = 2 \cdot \frac{(Recall \cdot \Pr e\,cision)}{(Recall + \Pr e\,cision)}$$

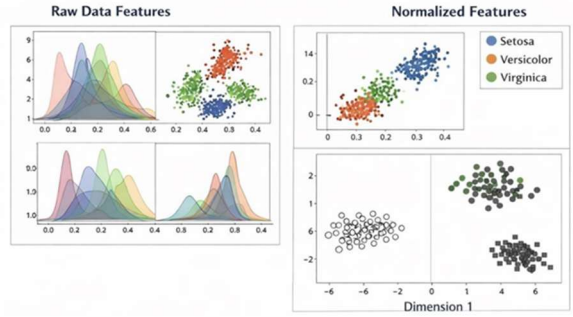

Fig.2. Preprocessed Iris Feature Visualization

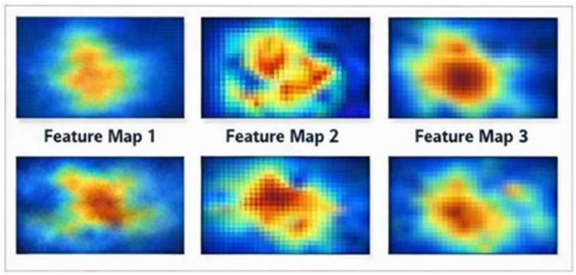

Fig.3. Feature Extraction Result

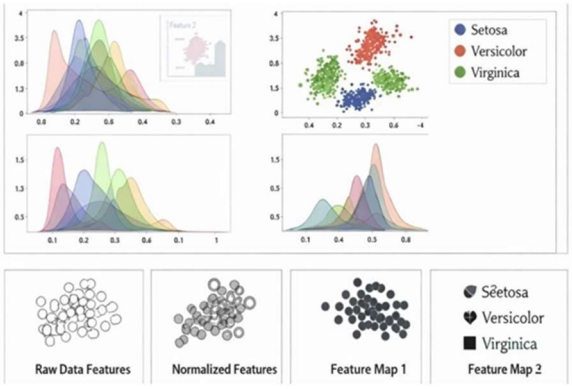

Fig.4. Real-Time Prediction Interface

5. CONCLUSION

This paper presented IrisPay, a secure and contactless digital payment system based on iris recognition and biometric authentication. The proposed system successfully integrates iris image acquisition, preprocessing, feature extraction, secure template matching, and real-time payment processing into a unified framework. By replacing traditional methods such as passwords, PINs, cards, and mobile-dependent verification, the system provides stronger security and greater convenience for users.

Experimental results demonstrated that the system achieves high authentication accuracy, fast transaction response time, and reliable payment execution. The use of encryption techniques ensures the privacy and protection of biometric and financial data. In addition, the contactless operation improves hygiene and usability in public environments. Overall, IrisPay offers an efficient, fraud-resistant, and future-ready solution for cashless transactions, making it suitable for retail payments, banking services, transportation systems, and smart city applications.

6. FUTURE SCOPE

The proposed IrisPay system can be further enhanced by integrating advanced Artificial Intelligence and Deep Learning models to improve iris recognition accuracy under challenging conditions such as low lighting, motion blur, and partial occlusion. Multi-factor biometric authentication using iris with face recognition or fingerprint verification can also be added to provide an additional layer of security for high-value transactions.

Future versions of the system can support direct integration with banking APIs, UPI platforms, blockchain-based payment networks, and international digital wallets for wider financial interoperability. A mobile and wearable device version of IrisPay can also be developed for portable usage. Cloud analytics dashboards may be introduced for fraud detection, user behavior analysis, and transaction monitoring. With IoT and smart city integration, the system can be deployed in ATMs, metro stations, hospitals, toll plazas, and autonomous retail stores, making it a scalable next-generation payment solution.

REFERENCES

1. ISO, “ISO/IEC 18004: QR Code Standard”, 2015.

ISSN 2347–3657
Volume 14, Issue 2, 2026

2. Google Firebase Documentation, “Firebase Realtime Database and Firestore”, Available: https://firebase.google.com/docs

3. World Wide Web Consortium, HTML, CSS, and JavaScript Web Standards, Available: https://www.w3.org

4. Mozilla Developer Network, “JavaScript, HTML, and CSS Documentation”, Available: https://developer.mozilla.org

5. Google, “ZXing (Zebra Crossing) QR Code Scanner Library”, Available: https://github.com/zxing/zxing

6. National Payments Corporation of India, “Unified Payments Interface (UPI) Guidelines”, Available: https://www.npci.org.in

7. PayPal, “Digital Payment Systems and Security Practices”, Available: https://www.paypal.com

8. Institute of Electrical and Electronics Engineers, Research Papers on QR Code-Based Payment Systems, Available: https://ieeexplore.ieee.org

9. International Journal of Computer Applications, “QR Code-Based Secure Payment Systems”, Various Publications

10. Springer, “Advances in Digital Payment Technologies and QR Code Applications”, Available: https://link.springer.com