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SMART CAMPUS CASHLESS PAYMENT SYSTEM USING RFID AND IOT

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Abstract **- In many educational institutions, payment systems in canteens and campus stores are still cash-based, leading to delays during peak hours, difficulty in transaction tracking, and risks associated with cash handling. These issues reduce operational efficiency and create inconvenience for students and staff.**

To address these challenges, this paper proposes a Smart Campus Cashless Payment System using RFID and IoT technologies. The system enables users to perform quick and secure transactions using RFID cards linked to a digital wallet. The RFID reader reads the card UID, and the ESP32 microcontroller processes the data and communicates with a backend server via Wi-Fi.

The backend system verifies user details, checks account balance, processes transactions, and stores records in a centralized database. A web-based admin dashboard allows monitoring of users, transactions, and balances in real time. The system improves transaction speed, enhances security, and provides centralized control over campus payments.

Index Terms - RFID, IoT, ESP32, Cashless Payment System, Smart Campus, Web Application, Digital Wallet

I. INTRODUCTION

In modern educational institutions, efficient management of daily transactions is essential to ensure smooth operations. However, many campuses still rely on traditional cash-based payment systems in canteens and stores. These systems often result in long queues, slow transaction processing, and lack of proper record keeping.

Cash handling also introduces risks such as errors in calculation, theft, and difficulty in tracking financial transactions. During peak hours, manual payments cause delays and inconvenience for both students and vendors.

With the advancement of IoT and embedded systems, there is an opportunity to develop smart and automated payment solutions. RFID technology provides a fast and contactless way to identify users, while IoT enables real-time communication between hardware and servers.

The major challenges in current systems include:

- Slow transaction processing during peak hours
- Lack of centralized transaction tracking
- Risk of cash handling errors or loss
- No real-time monitoring system
- Difficulty in managing user balances

To overcome these issues, this paper proposes a Smart Campus Cashless Payment System that uses RFID cards and IoT technology to enable secure, fast, and trackable transactions.

II. LITERATURE REVIEW

Several cashless payment systems have been developed using RFID and smart card technologies. RFID-based systems are widely used in transportation, access control, and payment applications due to their speed and reliability.

Research studies show that RFID technology can significantly reduce transaction time compared to traditional payment methods. RFID-based payment systems allow users to perform transactions by simply tapping their card on a reader, eliminating the need for manual input.

IoT-based systems further enhance functionality by enabling real-time data communication between devices and servers. Many modern systems use microcontrollers such as Arduino or ESP32 to connect hardware devices with cloud or local servers.

Existing systems, however, have some limitations:

- Limited integration with centralized monitoring systems
- Lack of real-time transaction analytics
- Dependence on standalone systems without web dashboards
- Security concerns in card-based systems

Therefore, there is a need for a system that integrates RFID, IoT, and web technologies to provide a centralized, secure, and scalable cashless payment solution.

III. METHODOLOGY

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The proposed system is designed as an RFID and IoT-based cashless payment platform. The system follows a structured workflow involving hardware components, server communication, and database processing.

A. RFID Card Scanning

Each user is assigned an RFID card with a unique UID. The user scans the card at the terminal.

B. Data Processing using ESP32

The RC522 RFID reader reads the UID and sends it to the ESP32 microcontroller. The ESP32 processes the data and sends it to the server via Wi-Fi.

C. Server Communication

The ESP32 sends an HTTP request to the backend server. The server verifies the UID, checks the user balance, and processes the transaction.

D. Database Update

The transaction details are stored in the MySQL database. User balance is updated accordingly.

E. Output Display

The transaction result is displayed on the TFT screen, and the admin dashboard is updated in real time.

IV. SYSTEM ARCHITECTURE

The system architecture consists of hardware, network, and software layers.

- Hardware Layer: RFID card, RC522 reader, ESP32, TFT display
- Network Layer: Wi-Fi communication between ESP32 and server
- Application Layer: PHP backend processing
- Database Layer: MySQL database for storing users and transactions
- Interface Layer: Web dashboard for admin monitoring

A. Data Flow:

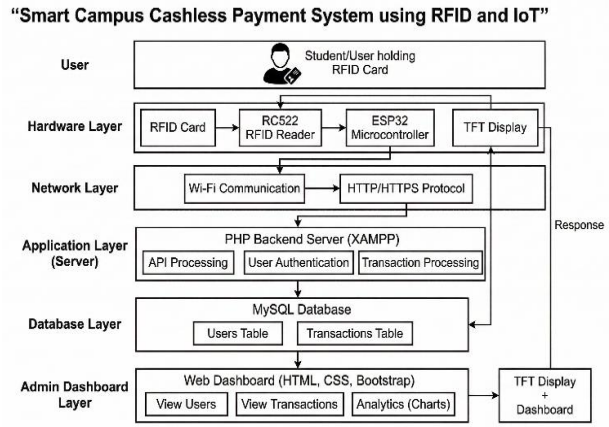

Figure 1: Architecture Diagram

V. SYSTEM MODULES

A. User Module

- RFID card-based identification
- Balance management

B. Transaction Module

- Debit and credit operations
- Real-time processing

C. Admin Module

- View users and balances
- View transaction history
- Block/unblock cards

D. Dashboard Module

- Graphical analytics
- Transaction monitoring

VI. OUTPUT

The system provides real-time transaction output through both hardware and software interfaces. When a user scans an RFID card, the system processes the transaction and displays the result on the TFT screen, including user name, balance, and transaction status.

The web dashboard displays transaction history, user details, and analytics in graphical format. This allows administrators to monitor all activities efficiently.

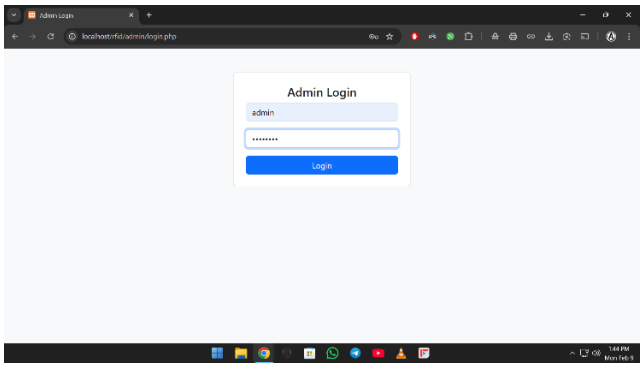

Figure 2: Login Page

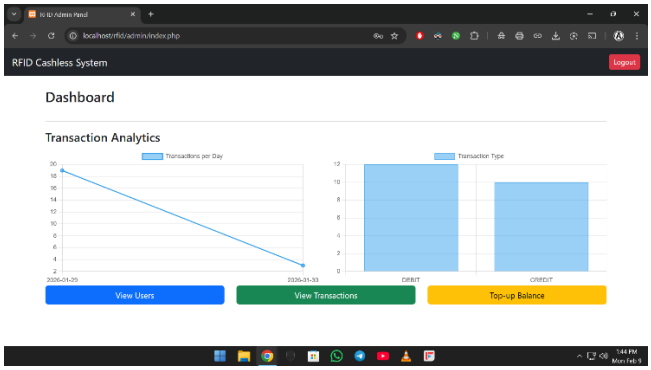

Figure 3: Dashboard Page

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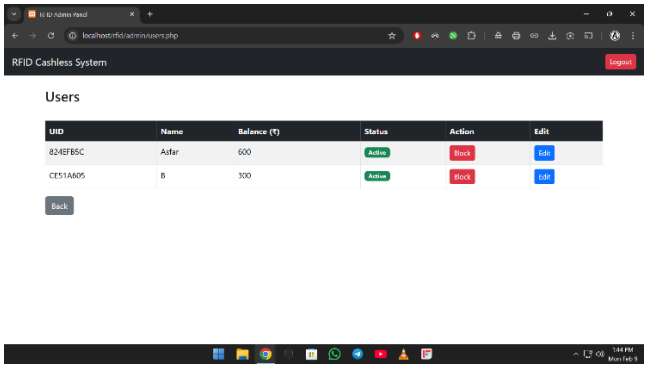

Figure 4: Users Management Page

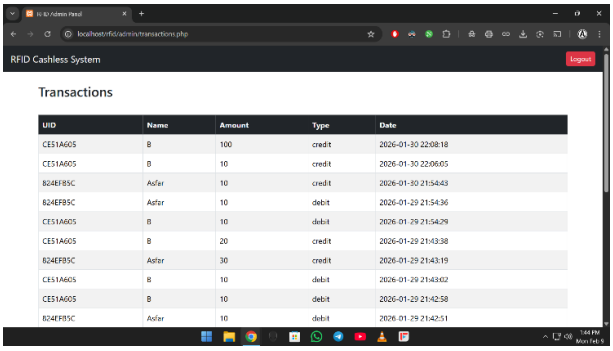

Figure 5: Transactions Page

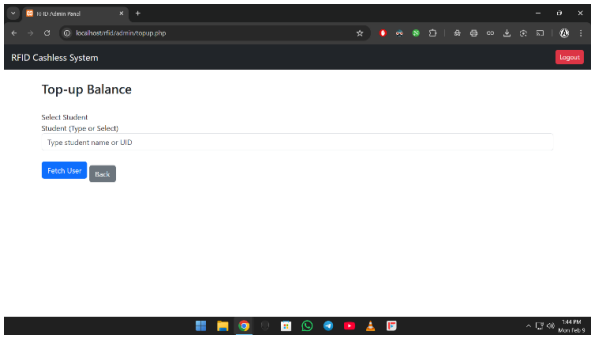

Figure 6: Balance Top-up Page

VII. RESULT & DISCUSSION

The system was successfully implemented and tested using RFID cards and ESP32. Transactions were processed quickly with minimal delay, demonstrating the efficiency of the system.

The results show:

- Faster transaction speed compared to cash systems
- Accurate and real-time transaction tracking
- Improved user convenience
- Effective centralized monitoring

The system proved to be reliable and suitable for campus environments.

VIII. CONCLUSION

The Smart Campus Cashless Payment System successfully demonstrates the use of RFID and IoT technologies for secure and efficient payment processing. The system reduces dependency on cash, improves transaction speed, and provides real-time monitoring through a centralized dashboard.

This solution enhances campus efficiency and offers a scalable approach for modern digital payment systems.

IX. FUTURE WORK

The proposed system can be further enhanced by integrating additional security features such as PIN-based authentication or biometric verification to prevent misuse of RFID cards. A mobile application can also be developed to allow users to check balances and transaction history in real time.

Future improvements may include cloud-based deployment to enable remote access and scalability across multiple campuses. Integration with online payment gateways can allow users to recharge their accounts digitally.

Additionally, support for multiple terminals and advanced analytics using AI can improve system efficiency and provide better insights into user behavior and transaction patterns.

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