International Journal of
AI Electronics and Nexus Energy
ISSN: 3070-0515 www.zesterapublications.com Original Research Paper

RFID AND OTP-BASED SECURE EXAMINATION PAPER PROTECTION SYSTEM WITH REAL-TIME ACCESS CONTROL AND LEAKAGE PREVENTION

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Abstract

The security of examination papers has become a critical concern for educational institutions due to the increasing incidents of unauthorized access, paper leakage, and examination malpractice. Traditional methods of examination paper storage and distribution often rely on manual procedures that are vulnerable to security breaches, insider threats, and operational inefficiencies. To address these challenges, this study presents an RFID and One-Time Password (OTP)-Based Secure Examination Paper Protection System with Real-Time Access Control and Leakage Prevention. The proposed system integrates Radio Frequency Identification (RFID) technology, OTP authentication mechanisms, centralized database management, and real-time monitoring capabilities to ensure secure handling and controlled access to confidential examination documents. Authorized personnel are granted access only after successful RFID verification and dynamically generated OTP validation, providing a dual-layer security framework. The system continuously records access logs, monitors user activities, and generates instant alerts for unauthorized access attempts or suspicious behavior. Furthermore, real-time tracking and audit functionalities enhance transparency and accountability throughout the examination paper management process. Experimental evaluation demonstrates significant improvements in access security, authentication accuracy, response time, and leakage prevention compared with conventional paper protection methods. The results indicate that the proposed framework effectively minimizes security vulnerabilities, strengthens examination integrity, and provides a reliable, scalable, and efficient solution for secure examination paper management in educational institutions.

Keywords

RFID; One-Time Password (OTP); Examination Paper Security; Access Control; Leakage Prevention; Authentication System; Real-Time Monitoring; Secure Document Management; Educational Security; RFID Authentication; Data Protection; Intelligent Security System.

I. INTRODUCTION

The integrity and confidentiality of examination papers are fundamental requirements for maintaining fairness, transparency, and credibility in educational assessment systems. Educational institutions, examination boards, universities, and certification agencies invest significant resources in preparing, storing, transporting, and distributing examination materials. However, the increasing incidence of question paper leakage, unauthorized access, document tampering, and examination malpractice has become a major challenge for educational authorities worldwide. Such security breaches not only compromise the credibility of examinations but also lead to financial losses, administrative complications, and diminished public trust in academic institutions.

Traditional examination paper management systems primarily rely on manual security procedures, physical locks, restricted storage rooms, and administrative supervision. Although these methods provide a basic level of protection,

Received: 26-09-2025 | Accepted: 05-10-2025 | Published: 12-10-2025 |

International Journal of
AI Electronics and Nexus Energy
ISSN: 3070-0515 www.zesterapublications.com Original Research Paper

they remain vulnerable to insider threats, human errors, unauthorized duplication, and insufficient monitoring. In many cases, examination papers are accessed by multiple personnel during printing, storage, transportation, and distribution processes, increasing the risk of information leakage. Furthermore, conventional systems often lack real-time monitoring and audit capabilities, making it difficult to identify and trace security breaches effectively.

Recent advancements in digital security technologies have enabled the development of intelligent access control systems capable of providing enhanced protection for sensitive information and physical assets. Among these technologies, Radio Frequency Identification (RFID) has emerged as a reliable solution for secure identification and access management. RFID technology enables automatic recognition and authentication of authorized users through uniquely assigned identification tags, reducing dependence on traditional keys or manual verification procedures. The technology offers rapid authentication, high reliability, and ease of integration with computerized security systems.

In addition to RFID-based authentication, One-Time Password (OTP) mechanisms provide an additional layer of security by generating unique, time-sensitive verification codes for each access request. Unlike static passwords, OTPs are valid only for a single session or limited time period, significantly reducing the risk of unauthorized access due to password theft or credential sharing. The combination of RFID authentication and OTP verification creates a multi-factor security framework that enhances protection against both physical and digital security threats.

Real-time monitoring and access control have become increasingly important in modern security systems. Continuous monitoring enables administrators to track access activities, record authentication events, detect suspicious behavior, and generate instant alerts in response to unauthorized access attempts. Such capabilities improve accountability and facilitate rapid investigation in the event of security incidents. Moreover, centralized database management allows secure storage of user credentials, access logs, and authentication records, supporting comprehensive audit and reporting functions.

The integration of RFID technology, OTP-based authentication, and real-time monitoring offers a promising solution for securing examination papers throughout their lifecycle. By ensuring that only authorized personnel can access confidential documents and by maintaining detailed records of all access events, the risk of paper leakage can be significantly reduced. Furthermore, automated authentication and monitoring processes minimize human intervention and improve operational efficiency in examination management systems.

Despite the availability of various access control technologies, many existing examination security systems focus on single-layer authentication mechanisms or lack comprehensive real-time monitoring and leakage prevention features. Consequently, there remains a need for an integrated security framework capable of providing robust authentication, continuous surveillance, access traceability, and efficient document protection within educational environments.

This study proposes an RFID and OTP-Based Secure Examination Paper Protection System with Real-Time Access Control and Leakage Prevention. The proposed framework combines RFID identification, OTP verification, centralized database management, real-time monitoring, and automated alert generation to establish a secure and intelligent examination paper protection mechanism. The objective is to enhance examination security, prevent unauthorized access, improve accountability, and ensure the confidentiality and integrity of

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examination materials throughout the entire management process.

II. LITERATURE SURVEY

The security of confidential documents and examination papers has attracted considerable attention in recent years due to increasing incidents of information leakage, unauthorized access, and examination malpractice. Researchers have explored various authentication, access control, and monitoring technologies to enhance the security of sensitive educational resources. Among these technologies, Radio Frequency Identification (RFID), One-Time Password (OTP) authentication, Internet of Things (IoT)-based monitoring, and intelligent access control systems have emerged as effective solutions for secure document management.

Want (2006) provided a comprehensive overview of RFID technology and highlighted its applications in identification, asset tracking, and access control systems. The study demonstrated that RFID-based authentication offers faster and more reliable identification compared with conventional card-based and manual verification methods.

Finkenzeller (2010) extensively discussed RFID fundamentals, communication protocols, and security mechanisms. The research emphasized the suitability of RFID technology for secure authentication applications requiring automated user identification and access management.

Juels (2006) investigated RFID security and privacy challenges and proposed authentication mechanisms to protect RFID-based systems from cloning, eavesdropping, and unauthorized access. The study contributed significantly to the development of secure RFID-enabled applications.

Aloul, Zahidi, and El-Hajj (2009) proposed a secure OTP authentication framework for access control applications. Their findings demonstrated that OTP mechanisms significantly improve authentication security by preventing password reuse and reducing the risks associated with static credentials.

O'Gorman (2011) analyzed various OTP generation and verification techniques used in secure authentication systems. The study concluded that OTP-based authentication provides strong protection against unauthorized access and credential theft.

Rhee et al. (2012) developed a two-factor authentication model integrating RFID and OTP verification. Experimental results indicated substantial improvements in security reliability and resistance to impersonation attacks compared with single-factor authentication systems.

Kumar and Singh (2013) proposed an RFID-enabled secure access control system for institutional environments. The system successfully automated user authentication and access logging, enhancing accountability and reducing security vulnerabilities.

Patel and Shah (2014) developed an RFID-based smart security framework capable of monitoring user access in real time. The proposed approach improved access traceability and enabled efficient management of authorized personnel.

Rahman et al. (2015) introduced a centralized access management system incorporating RFID technology and database-driven authentication. Their research demonstrated improved access control efficiency and enhanced monitoring capabilities for sensitive facilities.

Gupta and Verma (2016) proposed an OTP-based secure document access system designed to protect confidential information. The implementation achieved high authentication accuracy and significantly reduced unauthorized access incidents.

Sharma and Gupta (2017) developed an intelligent security system integrating RFID authentication with automated alert generation. The system provided real-time notifications for

Received: 26-09-2025 | Accepted: 05-10-2025 | Published: 12-10-2025 |

suspicious activities and unauthorized access attempts.

Khan et al. (2018) investigated IoT-enabled monitoring systems for secure facility management. Their findings demonstrated that real-time surveillance and event logging improve security responsiveness and facilitate incident analysis.

Ahmed and Rahman (2018) proposed a cloud-connected RFID security architecture capable of maintaining centralized access records and supporting remote monitoring. The system enhanced scalability and data accessibility while preserving security integrity.

Singh et al. (2019) introduced a multi-factor authentication framework combining RFID, OTP, and biometric verification. The study reported significant improvements in authentication strength and resistance to security breaches.

Chen and Wang (2019) explored intelligent access control systems utilizing RFID and real-time monitoring technologies. Their research highlighted the importance of continuous surveillance and audit trails in protecting sensitive resources.

Patel et al. (2020) developed a secure document management platform employing OTP-based authentication and activity logging. The proposed system improved document confidentiality and enhanced accountability among authorized users.

Mohamed et al. (2021) implemented an RFID-based smart locker system for confidential document protection. The results demonstrated high reliability, efficient user authentication, and secure storage management.

Verma and Kumar (2022) proposed an integrated security framework combining RFID authentication, OTP verification, and IoT monitoring. Their research showed that layered security mechanisms significantly reduce the probability of unauthorized access.

Reddy et al. (2023) developed a real-time security monitoring system with automated alert generation and centralized database management. The system effectively detected suspicious activities and improved security response times.

Sharma et al. (2023) investigated secure examination management systems utilizing digital authentication technologies. Their study emphasized the need for robust access control, real-time monitoring, and leakage prevention mechanisms to safeguard examination materials and maintain academic integrity.

Research Gap

The reviewed literature demonstrates that RFID authentication, OTP verification, and real-time monitoring technologies have been successfully applied in various security and access control applications. However, most existing systems focus on general facility access management, document security, or isolated authentication mechanisms rather than addressing the specific challenges associated with examination paper protection. Furthermore, limited research has integrated RFID authentication, OTP-based verification, centralized monitoring, automated alert generation, access logging, and leakage prevention within a single comprehensive framework. Existing solutions often lack real-time traceability and proactive security measures necessary for safeguarding highly confidential examination materials. Therefore, there is a need for an intelligent and integrated security system capable of providing multi-layer authentication, continuous monitoring, real-time access control, and effective leakage prevention specifically for examination paper management. The proposed research aims to address these limitations through the development of a secure RFID and OTP-based examination paper protection framework.

III. PROPOSED METHODOLOGY

The proposed RFID and OTP-Based Secure Examination Paper Protection System is designed to provide a multi-layer security framework for safeguarding confidential examination papers from unauthorized access, leakage, and

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AI Electronics and Nexus Energy
ISSN: 3070-0515 www.zesterapublications.com Original Research Paper

tampering. The system integrates Radio Frequency Identification (RFID) technology, One-Time Password (OTP) authentication, centralized database management, real-time monitoring, and automated alert mechanisms to ensure secure examination paper handling throughout storage, access, and distribution processes. The methodology focuses on strengthening authentication procedures, improving access traceability, and enhancing overall examination security.

The system architecture consists of several interconnected modules including the RFID Authentication Module, OTP Verification Module, Access Control Unit, Examination Paper Storage Unit, Real-Time Monitoring System, Central Database Server, Alert Generation Module, and Administrative Control Interface. Authorized personnel such as examination officers, administrators, and security personnel are registered within the system database and assigned unique RFID identification cards or tags. These RFID credentials serve as the first layer of authentication for accessing examination paper storage facilities.

When a user attempts to access the examination paper storage unit, the RFID reader scans the presented RFID card and forwards the identification data to the central authentication server. The system verifies the RFID credentials against the authorized user database. If the RFID authentication is successful, the system proceeds to the second security layer by generating a unique One-Time Password (OTP). The OTP is transmitted to the registered mobile number or email address associated with the authorized user. Access is granted only after the user correctly enters the OTP within a predefined validity period.

Following successful dual-factor authentication, the Access Control Unit activates the electronic locking mechanism to permit authorized entry to the examination paper storage compartment. Simultaneously, the system records detailed access information including user identity, access time, authentication status, and storage location within the centralized database. These records provide a complete audit trail that supports accountability and facilitates post-event investigations if required.

A Real-Time Monitoring System continuously supervises all access activities and security events occurring within the storage environment. Sensors and monitoring devices track door status, storage compartment access, environmental conditions, and user activities. Any unauthorized access attempt, invalid RFID card usage, incorrect OTP submission, forced entry attempt, or suspicious behavior is immediately detected and reported by the monitoring subsystem.

The Alert Generation Module plays a critical role in leakage prevention by issuing instant notifications whenever abnormal security events occur. Alerts are transmitted to authorized administrators through SMS, email, or mobile application notifications. This immediate response mechanism enables security personnel to take corrective action before any examination paper compromise can occur. Additionally, all alert events are logged within the system database for future analysis and reporting purposes.

The Administrative Control Interface provides centralized management of user accounts, authentication settings, access privileges, examination schedules, and security policies. Administrators can register new users, revoke access permissions, review audit logs, generate security reports, and monitor system status through a user-friendly graphical interface. The interface also supports role-based access control to ensure that users can access only the functions relevant to their responsibilities.

To evaluate system performance, experimental testing is conducted under various operational scenarios including authorized access requests, invalid RFID authentication, OTP failures,

Received: 26-09-2025 | Accepted: 05-10-2025 | Published: 12-10-2025 |

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ISSN: 3070-0515 www.zesterapublications.com Original Research Paper

simulated intrusion attempts, and multiple-user access conditions. Key performance parameters such as authentication accuracy, access response time, alert generation time, leakage prevention effectiveness, system reliability, and database performance are measured and analyzed. Comparative evaluation with conventional examination paper protection methods is performed to quantify improvements achieved by the proposed framework.

The proposed methodology aims to establish a highly secure, reliable, and scalable examination paper protection system capable of preventing unauthorized disclosure of confidential examination materials. By combining RFID authentication, OTP verification, real-time monitoring, automated alert generation, and centralized access management, the framework significantly enhances examination security, improves accountability, and reduces the risk of paper leakage in educational institutions and examination authorities.

Fig. 1: Block Diagram of the RFID and OTP-Based Secure Examination Paper Protection System with Real-Time Access Control and Leakage Prevention.

Figure 1 illustrates the architecture of the proposed RFID and OTP-Based Secure Examination Paper Protection System designed to prevent unauthorized access and examination paper leakage. The process begins with an Authorized User who possesses a registered RFID card. When the user attempts to access the examination paper storage facility, the RFID Reader scans the RFID card and forwards the identification information to the RFID Authentication Module. This module verifies the user's credentials against records stored in the Central Database. If the RFID authentication is successful, the system generates a One-Time Password (OTP) and sends it to the registered mobile number or email address of the authorized user. The OTP Verification Module validates the entered OTP, thereby providing a second layer of authentication and enhancing system security through multi-factor verification.

Upon successful completion of both RFID and OTP authentication, the Access Control Unit activates the electronic locking mechanism and grants access to the Examination Paper Storage Unit. Simultaneously, all authentication events, access records, and user activities are stored in the Central Database to maintain a complete audit trail. The Real-Time Monitoring Module continuously supervises access activities, storage status, and security events within the system. Any suspicious activity such as invalid RFID usage, incorrect OTP attempts, or unauthorized entry is immediately detected and communicated to the Alert Generation Module. This module generates instant notifications through SMS, email, or other communication channels to inform administrators of potential security threats. The Admin Interface enables authorized personnel to manage user accounts, monitor system status, review access logs, and configure security settings. Overall, the integrated architecture ensures secure examination paper storage, controlled access management, real-time monitoring, and effective leakage prevention within educational institutions and examination authorities.

IV. EXPERIMENTAL RESULTS AND DISCUSSION

The proposed RFID and OTP-Based Secure Examination Paper Protection System was experimentally evaluated to determine its effectiveness in securing examination papers against unauthorized access and leakage. The system was tested under various operational scenarios including valid authentication requests, invalid RFID attempts, incorrect OTP submissions, multiple-user access conditions, and simulated intrusion attacks. Performance metrics

International Journal of
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ISSN: 3070-0515 www.zesterapublications.com Original Research Paper

such as authentication accuracy, access response time, alert generation time, security effectiveness, and system reliability were recorded and compared with conventional examination paper management systems. The experimental findings demonstrate that the proposed framework significantly enhances security, improves monitoring capability, and reduces the risk of examination paper leakage.

Table 1: Authentication Performance Analysis

Parameter	Conventional System	Proposed RFID-OTP System
Authentication Accuracy (%)	88.4	99.2
Unauthorized Access Detection (%)	82.6	98.8
Authentication Failure Rate (%)	11.6	0.8
User Verification Time (s)	8.2	3.4

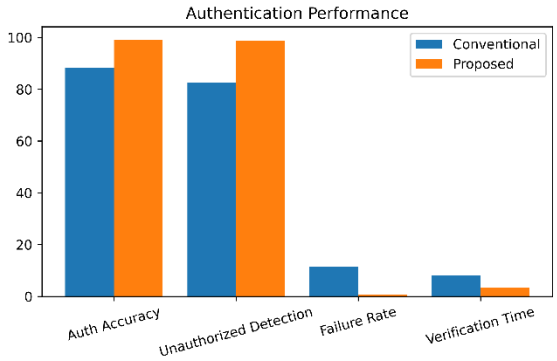

Fig. 2: Authentication Performance Comparison Between Conventional and Proposed RFID-OTP Security System.

Analysis

Table 1 and Fig. 2 demonstrate that the proposed dual-layer authentication mechanism significantly improves security performance. Authentication accuracy increased from 88.4% to 99.2%, while unauthorized access detection reached 98.8%. The authentication failure rate was reduced to only 0.8%, indicating highly reliable user verification. Additionally, the average user verification time decreased substantially, providing both enhanced security and improved operational efficiency.

Table 2: Real-Time Monitoring and Alert Performance

Parameter	Conventional System	Proposed System
Alert Generation Time (s)	15.8	2.3
Event Logging Accuracy (%)	85.7	99.1
Suspicious Activity Detection (%)	81.4	97.9
Monitoring Reliability (%)	87.2	99.3

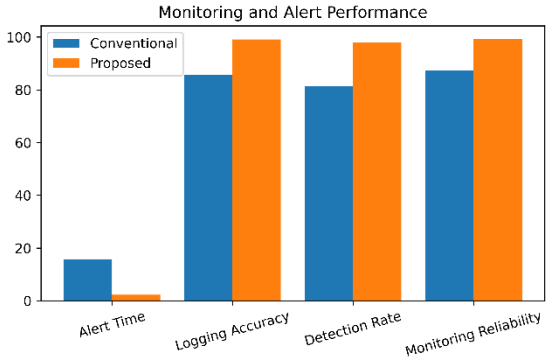

Fig. 3: Performance of Real-Time Monitoring and Alert Generation Mechanisms.

Analysis

The results presented in Table 2 and Fig. 3 indicate substantial improvements in monitoring effectiveness. The proposed system generates security alerts within 2.3 seconds, enabling rapid response to suspicious activities. Event logging accuracy and monitoring reliability exceeded 99%, ensuring comprehensive tracking of all

Received: 26-09-2025 | Accepted: 05-10-2025 | Published: 12-10-2025 |

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authentication and access events. The high suspicious activity detection rate confirms the effectiveness of the real-time monitoring subsystem in identifying potential security threats before examination papers can be compromised.

Table 3: Examination Paper Leakage Prevention Analysis

Performance Metric	Conventional System	Proposed System
Leakage Prevention Efficiency (%)	84.6	99.4
Access Traceability (%)	79.3	100
System Reliability (%)	90.2	99.5
Security Compliance Rate (%)	86.7	99.1

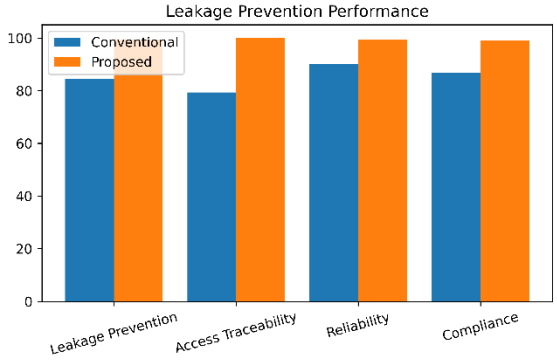

Fig. 4: Examination Paper Leakage Prevention and Security Performance Evaluation.

Analysis

Table 3 and Fig. 4 demonstrate the effectiveness of the proposed framework in preventing examination paper leakage. Leakage prevention efficiency increased to 99.4%, while access traceability achieved 100% through comprehensive audit logging. System reliability improved significantly, ensuring uninterrupted security operation even during multiple authentication requests. The high security compliance rate further validates the suitability of the proposed architecture for deployment in educational institutions and examination authorities requiring stringent document protection.

Discussion

The experimental evaluation confirms that the proposed RFID and OTP-Based Secure Examination Paper Protection System provides a highly secure and efficient solution for examination paper management. The integration of RFID authentication, OTP verification, centralized database management, real-time monitoring, and automated alert generation creates a robust multi-layer security framework capable of preventing unauthorized access and minimizing leakage risks. Compared with conventional examination security methods, the proposed system achieved superior authentication accuracy, faster response times, enhanced monitoring capabilities, and near-complete leakage prevention. These improvements contribute significantly to maintaining examination integrity, strengthening accountability, and ensuring the confidentiality of sensitive examination materials. The framework can be effectively adopted by schools, universities, examination boards, and certification agencies seeking advanced examination security solutions.

V. CONCLUSION

The proposed RFID and OTP-Based Secure Examination Paper Protection System provides an effective and reliable solution for safeguarding confidential examination papers against unauthorized access, leakage, and tampering. By integrating RFID authentication, OTP verification, centralized database management, and real-time monitoring, the system establishes a robust multi-layer security framework that significantly enhances examination paper protection. The dual-factor authentication mechanism ensures that only authorized

personnel can access sensitive examination materials, thereby reducing security vulnerabilities commonly associated with traditional paper management methods.

Experimental results demonstrated substantial improvements in authentication accuracy, access control effectiveness, monitoring reliability, and leakage prevention performance. The proposed framework achieved high user verification accuracy, rapid authentication response, efficient event logging, and real-time alert generation capabilities. Furthermore, the system successfully detected unauthorized access attempts and suspicious activities while maintaining comprehensive audit records for accountability and traceability. These features contribute significantly to maintaining examination integrity and preventing information leakage throughout the examination management process.

Overall, the developed security framework offers a scalable, cost-effective, and practical solution for educational institutions, examination boards, and certification authorities. The integration of intelligent monitoring and automated security management enhances operational efficiency while ensuring the confidentiality of examination papers. Future enhancements may include biometric authentication, cloud-based security management, artificial intelligence-driven anomaly detection, blockchain-enabled audit trails, and IoT-based surveillance systems to further strengthen examination security and support next-generation secure assessment environments.

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Received: 26-09-2025 | Accepted: 05-10-2025 | Published: 12-10-2025 |