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Privacy-Enhanced File Hosting With Multi-Factor Authentication and QR-Code-Based Access Tracking

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ABSTRACT: File sharing is essential for digital communication, but existing methods face security risks like unauthorized access and data breaches. Traditional systems often lack strong authentication and encryption, making them vulnerable to attacks. This project enhances file security by integrating secure authentication, encryption, and QR code-based access control. Users authenticate with Two-Factor Authentication (2FA) before uploading files, which are encrypted and linked to a QR code. The recipient scans the QR code to retrieve the file, with decryption keys securely shared via email. Expiry time and scan limits further enhance security, ensuring a reliable and protected file-sharing system.

KEYWORDS: Privacy-Enhanced File Hosting, Multi-Factor Authentication (MFA), QR-Code-Based Access Tracking , Secure File Sharing, Data Security, Cloud Storage Security, User Authentication, Access Control, Encryption, Cybersecurity

I. INTRODUCTION

File sharing plays a crucial role in digital communication, enabling seamless data exchange. Traditional methods face security threats like unauthorized access, data interception, and weak encryption. Lack of strong authentication mechanisms increases the risk of breaches and cyber attacks. Secure file sharing requires encryption, authentication, and controlled access mechanisms. This project enhances security using encryption, Two-Factor Authentication (2FA), and QR code-based access control

1.1 Need for Privacy-Enhanced File Hosting System

- Increasing use of cloud storage services
- Risk of unauthorized file access
- Need for secure file sharing
- Protection of confidential information
- Requirement for strong user authentication

1.2 Challenges in Existing Systems

- Weak password-based authentication
- Lack of privacy protection
- Vulnerability to cyberattacks
- Unauthorized file downloads
- Poor access monitoring mechanisms

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II. RELATED WORK

Several existing file hosting systems provide cloud storage and sharing functionalities. Traditional systems mainly depend on password-based authentication methods, which are vulnerable to hacking and phishing attacks. Some cloud storage platforms implement encryption techniques, but they may still lack proper authentication and access tracking features.

Recent research works focus on secure authentication mechanisms such as OTP verification, biometric authentication, and encryption-based cloud storage systems. Multi-Factor Authentication has become an effective approach for improving account security and preventing unauthorized access.
However, many existing systems still face limitations such as:

- Lack of complete privacy protection
- Weak access control mechanisms
- Limited authentication security
- Inadequate user activity tracking

The proposed system overcomes these limitations by integrating secure authentication, encrypted storage, and user access monitoring.

III. METHODOLOGY

3.1 User Registration

- Users create accounts using username, email, and password
- Passwords are securely stored using encryption techniques
- Email verification is performed during registration
- User information is maintained in a secure database

3.2 Multi-Factor Authentication

- Users enter login credentials
- OTP is generated and sent to registered email/mobile
- User must verify OTP successfully
- Authentication is completed only after all verification steps
- Enhances account security and prevents unauthorized access

3.3 Secure File Upload

- Authenticated users can upload files securely
- Files are encrypted before storage
- File metadata is stored in the database
- Supports secure cloud-based file management

3.4 Secure File Access and Download

- Only authorized users can access files
- Access permissions are verified before download
- Files are decrypted only for authenticated users
- Prevents unauthorized file sharing and leakage

3.5 Access Tracking and Monitoring

- Records user login and file access activities
- Maintains logs for uploads and downloads
- Helps identify suspicious activities
- Improves accountability and system monitoring

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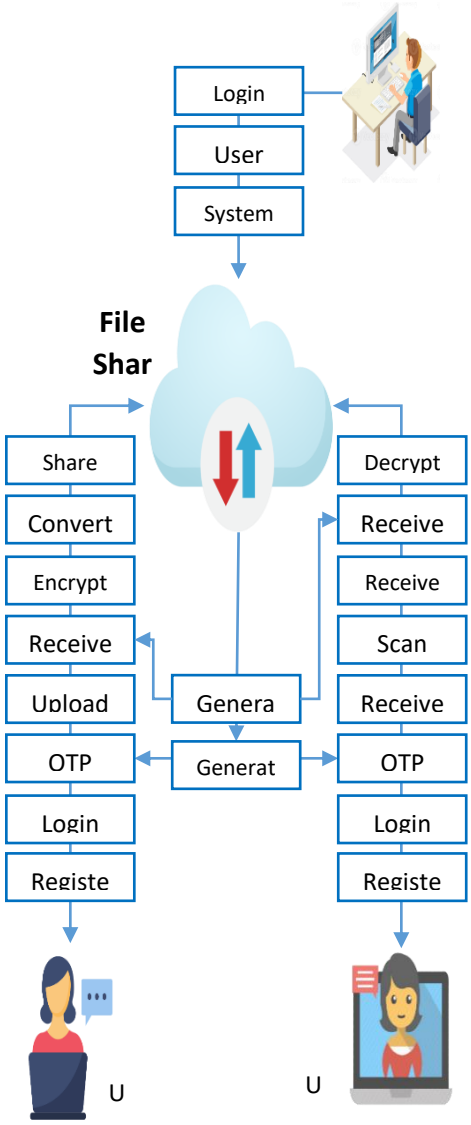
IV. SYSTEM ARCHITECTURE



V. SYSTEM MODULES

5.1 End User

This module defines two types of users: Admin and User.

Admin

Responsible for managing user accounts, monitoring file-sharing activities, enforcing security policies, and maintaining access logs. The admin ensures compliance with security protocols and manages expired or inactive QR codes.

User

Uploads and shares encrypted files through the system. The recipient must authenticate to scan the QR code and decrypt the file, ensuring a secure and restricted access mechanism.

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5.2 Authentication

To prevent unauthorized access, users must log in using Two-Factor Authentication (2FA), which consists of:

- **Username & Password:** Used for primary authentication.
- **OTP Verification:** A one-time password (OTP) is sent to the user's registered email or mobile number, ensuring an additional security layer before
- file access or QR code generation.

5.3 Key Generation

A unique AES encryption key is generated for each file upon upload.
This key is necessary for decryption and is securely managed within the system, preventing unauthorized access or interception during transmission.

5.4 File Encryption

Before storage, uploaded files are encrypted using AES-256 (Advanced Encryption Standard), ensuring strong encryption that prevents unauthorized decryption.
The encrypted file is then stored in a secure cloud or local server for retrieval by authorized recipients.

5.5 QR Code Generation

A QR code is generated dynamically for each encrypted file.
The QR code contains the secure file access link embedded with metadata, including the encrypted file's location and authentication requirements.
To ensure data integrity and scanning accuracy, Reed-Solomon error correction is applied to the QR code.

VI. IMPLEMENTATION

6.1 Technologies Used

- Python
- Django / Flask
- HTML, CSS, JavaScript
- MySQL
- AES Encryption
- OTP Authentication

6.2 System Setup

- Install Python
- Install required libraries
- Configure database
- Setup authentication modules
- Run web server

6.3 Sample Code

```
from cryptography.fernet import Fernet

key = Fernet.generate_key()
cipher = Fernet(key)

message = b"Secure File Data"
encrypted = cipher.encrypt(message)

print("Encrypted Data:", encrypted)
```

VII. RESULTS AND ANALYSIS

7.1 Performance

- Secure authentication achieved
- Fast file upload and download

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- Successful OTP verification
- Secure encrypted storage implemented

7.2 Observations

- Prevents unauthorized access effectively
- Improves user privacy and security
- Reduces risk of data leakage
- Provides reliable authentication mechanism

VIII. ADVANTAGES

- Ensures secure file sharing with encryption and 2FA.
- QR codes with expiry time and scan limits prevent misuse.
- Simplifies secure file sharing without manual key exchange.
- Prevents unauthorized modifications during transmission.

Can be integrated into various secure communication platforms

IX. LIMITATIONS

Dependence on Internet Connectivity
The system requires stable internet access for cloud-based operations and OTP verification.

OTP Delivery Delay
Network issues may delay OTP delivery during authentication.

Initial Setup Complexity
Configuring encryption and authentication systems may require technical expertise.

Storage Limitations
Large file storage may require additional server resources.

X. FUTURE ENHANCEMENTS

Blockchain Integration – Implementing blockchain technology to create a tamper-proof record of file transactions, ensuring transparency and security.
Biometric Authentication – Enhancing security by integrating fingerprint or facial recognition for user authentication instead of or in addition to OTP-based 2FA.
Cloud Storage Integration – Allowing users to store encrypted files on secure cloud platforms, enabling seamless access across multiple devices.
Role-Based Access Control (RBAC) – Introducing customized access permissions based on user roles to improve security in enterprise environments.

XI. CONCLUSION

In Conclusion, this project provides a secure and efficient file-sharing system by integrating AES-256 encryption, Two-Factor Authentication (2FA), and QR code-based access control. Unlike traditional file-sharing methods, which are often vulnerable to unauthorized access, interception, and weak encryption, this system ensures data confidentiality and integrity. With AES-256 encryption, files are protected from unauthorized access, while secure key transmission ensures that only intended recipients can decrypt them. The use of QR codes with Reed-Solomon error correction enhances reliability by ensuring accurate scanning, even in suboptimal conditions. Additionally, expiry control mechanisms, such as time-based expiration and limited scans, provide further security. The system ensures seamless and protected data exchange, making it an ideal solution for organizations and individuals requiring highly secure file transmission.

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