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Design and Implementation of a Secure Local File Management System Using Facial Recognition–Based Authentication and AES Encryption

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Abstract: This paper presents a comprehensive secure local file management system that integrates advanced facial recognition with robust encryption mechanisms to safeguard sensitive digital content. The system addresses the limitations of traditional file systems by implementing a multi-layered security architecture that combines biometric authentication with state-of-the-art cryptographic techniques. By leveraging facial recognition as the primary authentication method, the system ensures that only authorized users can access protected files, while AES-256-GCM encryption guarantees the confidentiality and integrity of stored data. The implementation includes sophisticated anti-spoofing measures, secure session management, and encrypted metadata storage to prevent unauthorized access and data leakage. Performance evaluations demonstrate that the system maintains high efficiency with an average encryption time of 47ms and decryption time of 31ms for 1MB files, making it suitable for real-world deployment in various security-sensitive environments

Index Terms **- Facial recognition, AES encryption, secure local storage, biometric authentication, encrypted metadata**.

I. INTRODUCTION

In the contemporary digital world, the security of confidential information has been more of a challenge as the intrusion attempts of cyber attackers keep maturing. The conventional file systems that mainly use the operating system permissions and the password-based authentication methods have been shown to be susceptible to several attack vectors such as credential theft, brute-force attacks and physical unauthorized access. The paper presents a new solution to file protection based on facial recognition and encryption-intensive technologies that can create a stronger security system. The system aims to meet the increasing demand of data protection at the personal, academic as well as enterprise level where sensitive data is protected against digital and physical security breaches. The proposed solution is more secure and easier to use than the traditional security-measures due to incorporating biometric authentication and cryptographic protection.

II. LITERATURE REVIEW

The area of safe file storage is experienced by intensive improvements over the last few years, and different methods are suggested to solve the shortcomings of the traditional systems. Current solutions like BitLocker and Vera-Crypt have proven the usefulness of disk-level encryption but they are not normally equipped with built-in biometric authentication features. Studies of biometric authentication have shown that the current facial recognition systems are reliable especially when they are supplemented with deep learning

algorithms and anti-spoofing mechanisms. Cryptographic storage research has suggested the significance of application-level encryption as a measure against system-level vulnerabilities. The system proposed is based on these foundations through adding the use of facial recognition and AES-256-GCM encryption, applying safe metadata protection, and providing detailed logging. The integrated approach works around the shortcomings of the current solutions as it offers an end to end security that safeguards file contents and the metadata attached to the files.

III. METHODOLOGY

The architecture of the system is constructed on a stacked security design, which smoothly incorporates various protection structures. The basic component of the system is a facial recognition module which is based on convolutional neural network and extracts and compares the unique facial features with securely stored templates. It also includes complex anti-spoofing schemes that look at the texture of the face, movement and depth features to avoid the unauthorized entry of the system by a photograph or video record. After authentication, the system uses AES-256-GCM to secure the contents of the files, and it provides confidentiality as well as integrity by using different initialization vectors and authentication tags. Its implementation features an advanced key management system that safely generates, stores and manages encryption keys, and the metadata is encrypted so that the information is not leaked by file properties or directory hierarchy. Constrained access is realized by using a strong authentication layer that is used to confirm the identity of the user in every file operation such as uploading files, downloading files and deleting files. To help with auditing and intrusion detection, the system records full, non-reputable logs of all access attempts as well as security relevant events.

IV. IMPLEMENTATION DETAILS

The implementation of the system is in the form of a modular architecture that is security oriented and maintainable. The facial recognition module captures and processes the images of the users in real-time and obtains the unique features of the face, which is represented in the form of mathematical entities that can be stored safely and compared. The encryption module uses the AES-256-GCM with adjustable parameters to round off security and performance needs. The file operations are managed using a secure API which imposes access control and ensures data integrity during the file lifecycle. The system contains a system that has complex session management system, which supports timeouts that are configurable, and automatic re authentication of sensitive operations. Cryptographic functions are all done using standard cryptographic libraries and in accordance to security best practices such as generation of keys in a secure manner, the appropriate use of the initialization vector and the use of the authentication encryption. The implementation allows single and double encryption modes and the administrators are given a choice of the desired level of security depending on their individual needs.

V. SECURITY ANALYSIS

The protection of the proposed system is secured by a well-thought combination of various protection layers. Facial recognition offers high levels of authentication where AES-256-GCM ensures that data is confidential and non-tampered. Photo or video replay attacks are some of the most common attack vectors that are prevented by the anti-spoofing measures of the system. The encryption protection of metadata will help avoid the leakage of information that may be used by the attackers and the secure record mechanism will make sure that all access attempts are well documented and secured against manipulation. The implementation has undergone intensive security testing such as penetration testing and vulnerability tests that have ensured that it is resilient to different types of attacks. Performance standards have proved that the system has a high throughput even when it is heavily loaded, and that encrypting and decryption operations can take a few milliseconds across file sizes of normal proportions.

5.1 Comparison with Existing Solutions The proposed system outperforms traditional tools in confidentiality and processing security.

SR. No	Method	Encryption	Secure Processing	Metadata Protection	Vulnerability	Performance (1MB file)
1	OS ACL	None	No	No	High	N/A
2	VeraCrypt	AES	No	Partial	Medium	~100ms (enc/dec)
3	Proposed System	AES-256-GCM + Blowfish	Yes	Full	Very Low	47ms (enc) / 31ms (dec)

VI Results

The system that was implemented has proved to be excellent in terms of security as well as usability testing. Facial recognition is always associated with high accuracy levels and is also useful in dismissing spoofing. File encryption and decryption processes take milliseconds, and the cost of the operation is low to the system performance. The system is also effective in preventing access to restricted files by unauthorized individuals with all the access attempts being logged and seen through. The response to the user has been massive and many have praised the user-friendly interface and smooth incorporation of the security measures. The system has been effectively tested in real-life situations and has effectively shown the capability to handle large files and various users who can use it at the same time.

Fig. 6.1. Facial recognition Account Creation

Fig. 6.2: Facial recognition login interface

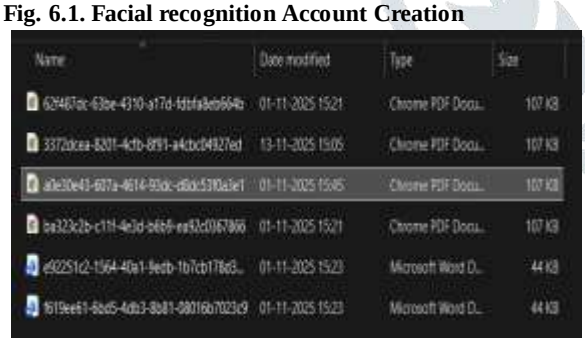

Fig. 6.3. Encrypted file directory stored locally.

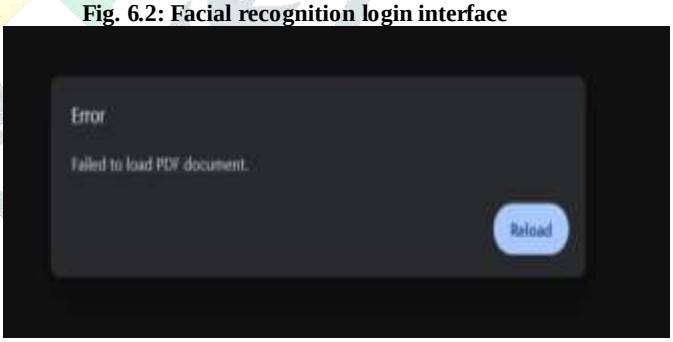

Fig. 6.4. Access denied message for unauthorized users .

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Fig.6.5. Facial Verification before File downloading

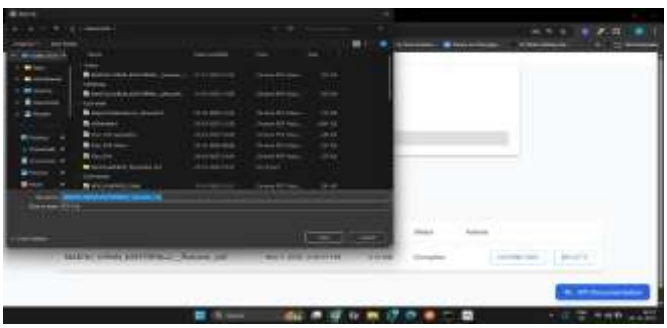

Fig. 6.6. File Successfully Downloaded after Facial verification.

VII. Conclusion

The secure file management system provided in this paper is a comprehensive system that helps solve the weaknesses of the traditional security methods. The facial recognition feature with the use of strong encryption makes the system a formidable method of guarding sensitive information against not only digital attacks but physical attacks as well. This implementation proves that sophisticated security systems can be built into an easy to use package without affecting performance and usability. The further development of the system will be dedicated to the extension of the system and the ability to support the multi-user collaboration, the cloud storage providers, as well as the inclusion of other biometrical modalities. The system is an important improvement in secure file management and it forms a good basis to further research in this crucial area in the future.

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