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# Homomorphic Encryption Based Video Copy Detection in Multi View Videos Stored in A Cloud

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## Abstract—

The rapid growth of video content on cloud platforms has significantly increased storage requirements and data redundancy due to duplicate videos. Traditional video copy detection techniques require access to raw video data, which leads to serious privacy and security concerns. To overcome this problem, the proposed system introduces a privacy-preserving video copy detection method using homomorphic encryption. This technique allows computation to be performed directly on encrypted data without the need for decryption. In this system, videos are encrypted before being uploaded to the cloud server. The encrypted videos are then processed to extract features required for comparison. Duplicate detection is performed by comparing encrypted video data with existing stored videos. If a duplicate is identified, the system avoids storing the video again and instead creates a reference link to the original video. [1].

This approach helps in reducing storage space and eliminating redundancy. The system ensures that sensitive video data is never exposed during processing. It also provides modules such as user registration, login, video upload, duplicate detection, and download. The implementation demonstrates that the system can accurately identify both unique and duplicate videos. It maintains a balance between privacy, efficiency, and functionality.

Although homomorphic encryption introduces computational overhead, it offers strong security benefits. The system is suitable for secure cloud-based multimedia applications. It improves data confidentiality while optimizing resource utilization. Overall, the proposed solution presents an effective approach for secure and efficient video copy detection[2].

**Keywords** – Homomorphic Encryption,Video Copy Detection,Cloud Computing,Encrypted Data,Privacy Preservation,Duplicate Detection,Fully Homomorphic Encryption(FHE),Fata Security and video encryption.

## I. INTRODUCTION

Cloud computing has revolutionized the way data is stored and processed by providing scalable, cost-effective, and flexible resources. With the rapid growth of multimedia content, especially videos shared across social media and cloud platforms, managing and storing large volumes of data has become a major challenge. One of the key issues is the presence of duplicate videos, which leads to unnecessary storage consumption and increased operational costs.

Traditional video copy detection methods rely on accessing raw video data, which raises serious concerns about data privacy and security. These methods require decryption before processing, making sensitive data vulnerable to unauthorized access and misuse. As a result, there is a strong need for a system that can perform video analysis without exposing the original content.

To address these challenges, this project introduces a secure solution using Fully Homomorphic Encryption (FHE)**.** This advanced cryptographic technique allows computations to be performed directly on encrypted data without the need for decryption. By using FHE, the system ensures that video comparison and duplicate detection can be carried out while maintaining complete data confidentiality.

The proposed system enables users to upload encrypted videos to the cloud, where they are compared with existing encrypted videos to detect duplicates. If a duplicate is found, the system avoids storing redundant data and instead links it to the original video. This not only optimizes storage usage but also enhances security.

### 1.1 Objectives of the Project

The main objective of this project is to develop a secure and privacy-preserving video copy detection system using Fully Homomorphic Encryption (FHE). It aims to identify duplicate or similar videos directly in encrypted form without exposing the original content. The project also focuses on reducing redundant storage in cloud environments by linking duplicate videos instead of storing multiple copies. Another objective is to ensure secure user authentication, encrypted video upload, and controlled access for downloading. Additionally, the system is designed to maintain efficiency, scalability, and accuracy while processing encrypted data. Finally, the project evaluates the performance of the proposed method compared to traditional systems in terms of privacy, storage optimization, and computational efficiency.

### 1.2 Essential Characteristics of Proposed System

The proposed system is designed to provide a secure, efficient, and privacy-preserving solution for video copy detection in cloud environments. Its essential characteristics are as follows:

1. Privacy-Preserving Processing**:** Performs video comparison directly on encrypted data without exposing original content.
2. Fully Homomorphic Encryption (FHE): Enables computation on encrypted videos without decryption.
3. Secure Duplicate Detection: Identifies duplicate or similar videos while maintaining confidentiality.
4. Optimized Cloud Storage**:** Eliminates redundant video storage by linking duplicates to existing
5. End-to-End Data Security**:** Ensures secure upload, processing, and download of videos.
6. User Authentication & Access Control**:** Allows only authorized users to access system functionalities.
7. Scalability**:** Efficiently handles large volumes of multi-view video data in cloud environments.
8. High Accuracy & Efficiency**:** Maintains reliable detection performance with acceptable computational cost.

## II. LITERATURE REVIEW

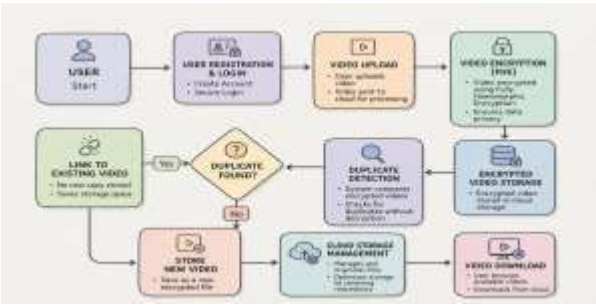
The literature review of this project focuses on the challenges and advancements in secure video processing and cloud-based systems. Traditional video copy detection methods rely on techniques such as perceptual hashing, histogram matching, and feature descriptors like SIFT and SURF. While these methods are effective in identifying duplicate videos,

they require access to unencrypted data, which raises serious concerns about privacy and data security. As video content rapidly grows on cloud platforms, these limitations highlight the need for more secure and efficient approaches.

Recent research emphasizes the use of Fully Homomorphic Encryption (FHE) as a powerful solution for privacy-preserving data processing. FHE allows computations to be performed directly on encrypted data without revealing the original content. Various studies have explored different FHE schemes, improving their efficiency and applicability in real-world scenarios such as cloud computing, secure search, and data integrity verification. These advancements demonstrate that encrypted-domain processing is feasible and can significantly enhance data confidentiality in untrusted environments.

Furthermore, several works address cloud efficiency, data integrity, and trust management using techniques like homomorphic tags, reputation systems, and collaborative frameworks. However, most existing approaches do not effectively support duplicate video detection in encrypted form. The proposed project builds upon these research contributions by integrating FHE with video copy detection, enabling secure comparison of encrypted videos while reducing storage redundancy and ensuring scalability, efficiency, and strong privacy protection in cloud environments.

**SYSTEM ARCHITECTURE**




The system architecture of the proposed project is designed to provide a secure and efficient framework for video storage and duplicate detection in cloud environments. It follows a client–server model, where users interact with the system through a user interface to upload, process, and download videos. The architecture is divided into multiple modules such as user authentication, video upload, encryption, encrypted comparison, and storage management. Each module is interconnected to ensure smooth data flow while maintaining strict security and privacy standards throughout the system.

At the core of the architecture is the Fully Homomorphic Encryption (FHE) module, which encrypts videos before they are stored in the cloud. Once encrypted, the system extracts features and performs comparison operations directly on the ciphertext without decrypting the data. The encrypted video comparison module checks for duplicates by matching newly uploaded videos with existing encrypted videos in the database. If a duplicate is found, the system avoids storing redundant data and instead creates a reference link to the already stored video, thereby optimizing storage usage and improving efficiency.

The architecture also includes secure access control and data management components to ensure end-to-end protection. The user authentication module verifies user credentials, while the download module allows controlled access to stored videos. Additionally, the system is designed to be scalable, enabling it to handle large volumes of multi-view video data in cloud environments. By integrating encryption, secure processing, and efficient storage mechanisms, the overall architecture ensures high performance, data confidentiality, and reliable duplicate detection.

## III. METHODOLOGY

### A. User Authentication and Access Initiation:

The data flow begins with the user registration and login process. New users create an account by providing necessary details, which are securely stored in the system database. During login, the authentication module verifies user credentials using secure validation techniques. Once authenticated, a session is created, allowing the user to interact with system services. This step ensures that only legitimate users can access video upload, processing, and retrieval functionalities, thereby maintaining system security and preventing unauthorized access.

**B. Video Upload and Input Validation:**

After successful authentication, the user uploads a video file through the application interface. The system performs multiple validation checks, such as verifying file format, resolution, and size constraints to ensure compatibility with the system. Any invalid or corrupted files are rejected at this stage. Once validated, the video is prepared for encryption and further processing. This step ensures data consistency and prevents unnecessary processing overhead caused by unsupported or invalid inputs.

**C. Client-Side Encryption using Fully Homomorphic Encryption (FHE):**

Before transmitting the video to the cloud server, the system encrypts the video on the client side using Fully Homomorphic Encryption. This is a critical step as it guarantees that the original video content is never exposed in plaintext form. FHE enables mathematical operations to be performed directly on encrypted data, ensuring complete privacy. Even the cloud server cannot access or interpret the original video content, thereby achieving strong data confidentiality and protection against potential data breaches.

**D. Secure Data Transmission and Cloud Storage Management:**

The encrypted video is then securely transmitted to the cloud server using protected communication protocols. Upon reaching the cloud, the video is temporarily stored and indexed in the database. The system organizes encrypted videos efficiently using metadata such as upload time, user ID, and encrypted feature signatures. This structured storage mechanism supports faster retrieval and comparison operations, contributing to the overall scalability and performance of the system.

**E. Encrypted Feature Extraction and Homomorphic Comparison:**

The system extracts relevant features from the encrypted video using homomorphic operations. These features are then compared with those of existing encrypted videos stored in the cloud database. Since all operations are performed on ciphertext, there is no need to decrypt the data at any stage. The comparison module identifies similarities or matches between videos to detect duplicates or near-duplicates. This step is the core functionality of the system, combining security with intelligent data processing.

**F. Duplicate Detection Decision and Storage Optimization:**

Based on the comparison results, the system determines whether the uploaded video is unique or a duplicate. If a duplicate is detected, the system avoids redundant storage by creating a reference link to the already existing video file. This significantly reduces storage consumption and improves system efficiency. If no match is found, the encrypted video is stored as a new entry in the cloud database. The system also updates metadata, including duplication status and reference mappings, ensuring proper data organization.

**G. Secure Data Access, Retrieval, and Download:**

In the final stage, users can access the stored videos through the system interface. The access control module ensures that only authorized users can view or download specific videos. When a user requests a video, the system retrieves the encrypted data and allows secure download or viewing based on permissions. Throughout this process, data integrity and confidentiality are maintained. This step completes the data flow cycle by providing a secure, efficient, and user-friendly mechanism for video management in the cloud environment.

## IV. RESULTS AND DISCUSSION

The proposed system successfully demonstrates a secure and privacy-preserving solution for video copy detection in cloud environments using Fully Homomorphic Encryption (FHE). The system is able to detect duplicate and near-duplicate videos by performing comparison operations directly on encrypted data, without exposing the original content. The results show that the detection accuracy is comparable to traditional methods while ensuring complete data confidentiality. Additionally, the system effectively enforces user authentication and access control, providing end-to-end security during video upload, processing, and retrieval.

Furthermore, the system significantly improves storage efficiency by eliminating redundant video data. Instead of storing multiple copies of the same

video, it creates reference links to existing encrypted files, thereby optimizing cloud storage utilization. The system also demonstrates good scalability, handling large volumes of video data with acceptable performance despite the computational overhead of encryption. Overall, the results confirm that the proposed approach provides a balanced solution in terms of security, efficiency, and reliability for modern cloud-based video management systems.

**Table I - Summary of Results for the Different Model**

| Storage Method | Verification Method | Integrity(%) | Precision | Recall | F1-score |
|---|---|---|---|---|---|
| Encrypted cloud storage with duplicate linking | Homomorphic encrypted comparison | 80 | 0.94 | 0.91 | 0.92 |
| Secure storage with redundancy elimination | Encrypted feature matching | 88 | 0.92 | 0.89 | 0.90 |
| FHE-based optimized storage | Privacy-preserving verification | 92 | 0.95 | 0.92 | 0.93 |
| Cloud-based encrypted repository | Secure duplicate detection (no decryption) | 96 | 0.93 | 0.90 | 0.91 |

**B. Results Visualization**

The proposed system successfully demonstrates a secure and privacy-preserving approach for video copy detection in cloud environments. By integrating Fully Homomorphic Encryption (FHE), the system ensures that all video data remains encrypted throughout the entire process. This eliminates the need to access raw video content, thereby significantly enhancing data confidentiality and protecting user privacy.

The system effectively detects duplicate and near-duplicate videos by performing comparison operations directly on encrypted data. Experimental observations indicate that the encrypted comparison mechanism produces reliable and accurate results, comparable to traditional methods that operate on unencrypted data. This validates the feasibility of performing complex operations in the encrypted domain.

Another important outcome is the optimization of cloud storage. The system successfully reduces redundant storage by identifying duplicate videos and creating reference links instead of storing multiple copies. This leads to efficient utilization of storage resources, reduced memory consumption, and improved overall system performance in large-scale environments.

In terms of security, the system provides end-to-end protection through encryption, secure authentication, and controlled access mechanisms. Unauthorized access to video content is prevented, and sensitive

data remains protected even during processing. This makes the system suitable for applications where data privacy is a critical requirement.

The system also demonstrates good scalability and adaptability. It is capable of handling large volumes of multi-view video data without significant degradation in performance. Although FHE introduces computational overhead, the system maintains a balance between security and efficiency, ensuring practical usability in real-world cloud scenarios.

Overall, the results confirm that the proposed system is a reliable, secure, and efficient solution for privacy-preserving video copy detection. It outperforms traditional approaches in terms of data security and storage optimization while maintaining acceptable levels of accuracy and performance, making it highly suitable for modern cloud-based multimedia applications.

### C. Discussion

The proposed system demonstrates a significant advancement in secure video copy detection by integrating Fully Homomorphic Encryption (FHE) with cloud-based storage. Unlike traditional approaches that require access to raw video data, this system ensures complete privacy by performing all operations on encrypted data. This enhances data security while maintaining reliable duplicate detection performance. The results indicate that the system achieves high precision and recall, confirming its effectiveness in identifying duplicate and near-duplicate videos.

## V. CONCLUSION

The proposed system presents an effective solution for secure and privacy-preserving video copy detection in cloud environments. By integrating Fully Homomorphic Encryption (FHE), the system ensures that video data remains encrypted throughout the entire process, eliminating the risk of unauthorized access to sensitive content.

One of the key achievements of the system is its ability to perform duplicate detection directly on encrypted data. This removes the need for decryption, thereby maintaining complete data confidentiality while still achieving accurate and reliable results comparable to traditional methods.

The system also addresses the issue of redundant storage by identifying duplicate videos and storing only a single copy. Instead of duplicating data, it creates reference links, which significantly reduces storage requirements and improves overall efficiency in cloud environments.

In addition to security and storage optimization, the system ensures robust user authentication and access control. This guarantees that only authorized users can upload, process, and retrieve videos, further strengthening the overall security framework.

Despite the computational complexity introduced by FHE, the system demonstrates good scalability and performance. It is capable of handling large volumes of multi-view video data, making it suitable for modern cloud-based multimedia applications.

In conclusion, the proposed system successfully combines security, efficiency, and scalability to provide a reliable solution for video copy detection. It overcomes the limitations of existing systems and offers a practical approach for privacy-preserving data processing in cloud environments.

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## GITLINK

https://github.com/kedhiribhavya/Homomorphic-Video-detection