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GENERATIVE AI-BASED DATA PRIVACY SYSTEM FOR SECURE FILE SHARING IN CLOUD STORAGE

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ABSTRACT

Abstract: Cloud storage services are now important in the contemporary data management but privacy in the process of sharing files is a significant challenge. The paper discusses a Generative AI-based data privacy system to secure file sharing in the cloud storage, which is named Generative AI-based Data privacy system. The suggested system involves the use of Transformer-based sensitive data detection model to detect confidential data in files automatically. Information to be uploaded is detected, followed by redacting before upload and then the file is encrypted, to offer further security measures. The whole structure is done in Python with PyTorch that facilitates effective model training and deployment. The system mitigates the exposure to data, whether through key compromise or unauthorized access, by being privacy-first. Empirical testing depicts that there is high detection, low false positive and the processing time is efficient. The solution proposed provides a practical, intelligent, and scalable system of improving secure file sharing in cloud storage systems

KEYWORDS: *Generative AI, Cloud Data Privacy, Secure File Sharing, Transformer-Based Detection, Auto Redaction, Cloud Encryption, Privacy-Preserving Systems*

INTRODUCTION

Cloud storage solutions have revolutionized the process of storing, controlling, and accessing electronic information by individuals and organizations. As remote collaboration and data-driven services are rapidly growing, file sharing in the cloud environment has become a more significant issue. Nevertheless, even with the development of encryption and access control systems, sensitive data like personal identifiers, financial data and confidential business data are still susceptible to unauthorized access, insiders and key compromise attacks [1]. The conventional security methods are mostly based on encryption when the data is ready to be uploaded, which might not be adequate in thwarting exposure in case of vulnerability arises during transmission or storage. Hence, there is a pressing requirement of smart privacy-saving mechanisms that will secure data prior to accessing the cloud as shown in figure 1.

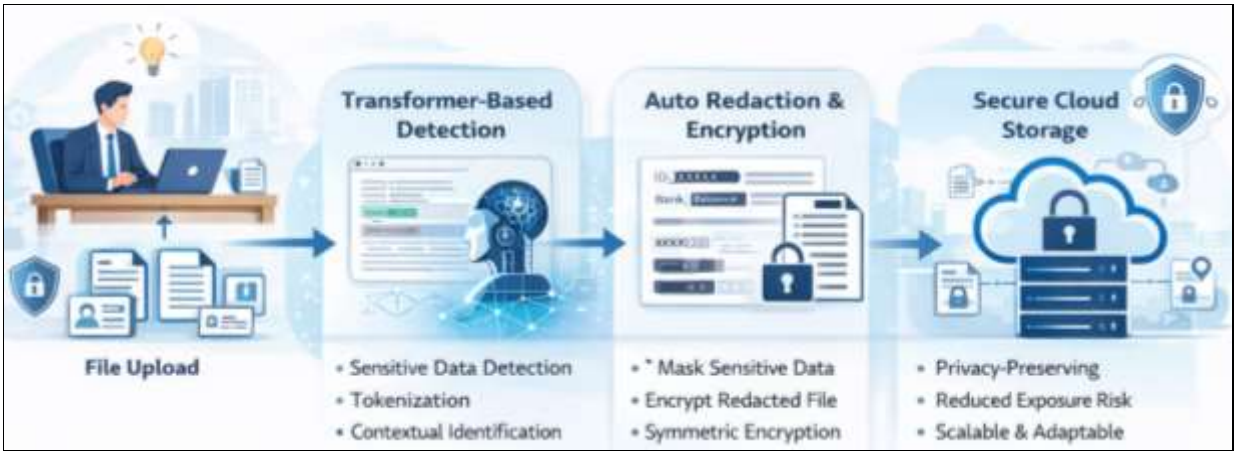

Figure 1.Genrative AI Data Flow Privacy.

This research proposes a data privacy system called Generative AI-Based Data Privacy System to Secure File Sharing in Cloud Storage that places its emphasis on a privacy-first policy. The suggested framework relies on a sensitive data detection framework based on Transformer to detect confidential information in files automatically [2]. Sensitive elements are removed, and then the file is uploaded after which the personal data is secured at the point of origin. The redacted file is then encrypted so as to offer more security. Python with PyTorch is used to implement the system to develop, train and deploy models efficiently. The suggested method that will be achieved through the integration of artificial intelligence and safe encryption practices will improve privacy, minimize the risk of data leakage, and facilitate scalable cloud-based file sharing in the contemporary digital environments [3].

Besides improving the privacy protection, the suggested system will also deal with the issues of scalability and dynamism in dynamic cloud setups. The current cloud platforms process extensive amounts of heterogeneous data, in the form of text documents, reports, images, and structured records. It is not feasible to identify sensitive information in such large data sets manually and prone to error [4]. Through the power of Transformer-based model, the system will be able to comprehend relationship between contexts within the content, and thus more sensitive entities will be detected more accurately, even when they are presented in different formats or linguistic forms. Such awareness within the context plays an important role in enhancing the strength of the privacy mechanism over rule-based or key-matching models [5].

Moreover, the automatic redaction before encryption is also integrated, which makes sure that sensitive information is minimized before it is stored, corresponding with the principles of data minimization, as well as with legal stipulations (like privacy compliance standards). PyTorch enables effective training, fine tuning and optimization of the model and therefore, it can be continuously improved as new patterns of data are revealed. Incremental learning can be expanded to the system to reach the changing threats and new privacy threats [6]. Altogether, this AI-based framework will not only enhance the level of security in clouds but also reinforce intelligent and automated approaches to data protection as well as future-proofing.

RELATED WORK

The concept of secure file sharing in cloud storage has been actively investigated in the last ten years, and researchers have suggested different cryptographic and smart strategies to increase the privacy of data. Initial solutions were mainly based on encryption-based protection schemes like symmetric encryption, the public key cryptography, and the attribute based encryption (ABE). These techniques offered privacy and controlled fine access, but were very sensitive to the management of the secure keys and failed to ensure that sensitive information was not divulged prior to encryption or when handled inappropriately [7]. With the increased adoption of clouds, scientists started fostering the development of sophisticated cryptographic systems into blockchain to provide tamper-resistant access logs and decentralized authentication. Even though blockchain-enhanced

systems provided better transparency and integrity, it tended to create latency and computational overhead, which reduced their scalability in large-scale settings as shown in figure 2.

Figure 2.Related Work on Secure File Sharing in Cloud Storage

As AI developed, systems of intrusion detection based on machine learning were brought into use to track the abnormal behaviors when using files in the cloud. Such systems enhanced the accuracy of threat detection systems as opposed to the traditional rule based systems. But mostly intrusion detection methods work once data has been saved in the cloud, and it would detect illegal access as opposed to staving off exposure in the beginning. Also, these systems can be characterized by increased rates of false positives and reduced flexibility to changes in the strategy of attacks [8].

The recent studies have examined how Generative Adversarial Networks (GANs) and the mechanisms of differential privacy can be implemented to ensure the confidentiality of data. GAN-based methods produce the synthesized data representations to reduce the direct exposure of original information, whereas the methods of differential privacy add the focus to the controlled noise that secures sensitive features [9]. Even though these techniques improve preservation of privacy, they can diminish usefulness of data or consume a large amount of computational resources. Federated learning has also been used to allow decentralized privacy protection and this guarantees that unprocessed data is stored in local machines. Federated learning has communication overheads and synchronization issues although it has merits [10].

Transformer-based models have been recently in the spotlight of superior contextual knowledge in natural language processing tasks. They can be used to identify sensitive information in unstructured text because they are able to identify semantic relationships [11]. Nevertheless, the majority of the literature follows a similar approach and uses such models either to classify or extract data but does not implement them as the part of the whole privacy-first cloud security ecosystem.

Unlike the previous studies, the suggested Generative AI-Based Data Privacy System in the reliable file sharing within cloud storage focuses on preprocessing of data before uploading it to the cloud. The system protects confidential information at the source by using Transformer-based sensitive data receiver model, which includes automatic redaction and encryption of information [12]. This method, which is implemented in Python with PyTorch, integrates contextual intelligence and cryptographic security and solves the drawbacks of encryption-only, GAN-based and intrusion detection systems and is scalable and efficient in the current cloud setting.

I. RESEARCH METHODOLOGY

The proposed privacy-first research project is called Generative AI-Based Data Privacy System and is proposed to offer privacy-first to files shared in the cloud storage before they are sent or stored online, under the name Generative AI-Based Data Privacy System [13]. Transformer-based sensitive data detection, automatic redaction, and encryption are combined into a single pipeline that is run using Python and the PyTorch deep learning platform. The goal in general is to make sure that the confidential information is discovered and protected at its origin hence minimizing the chance of the information being leaked in a manner that is likely to occur during a cloud file sharing as shown in figure 3.

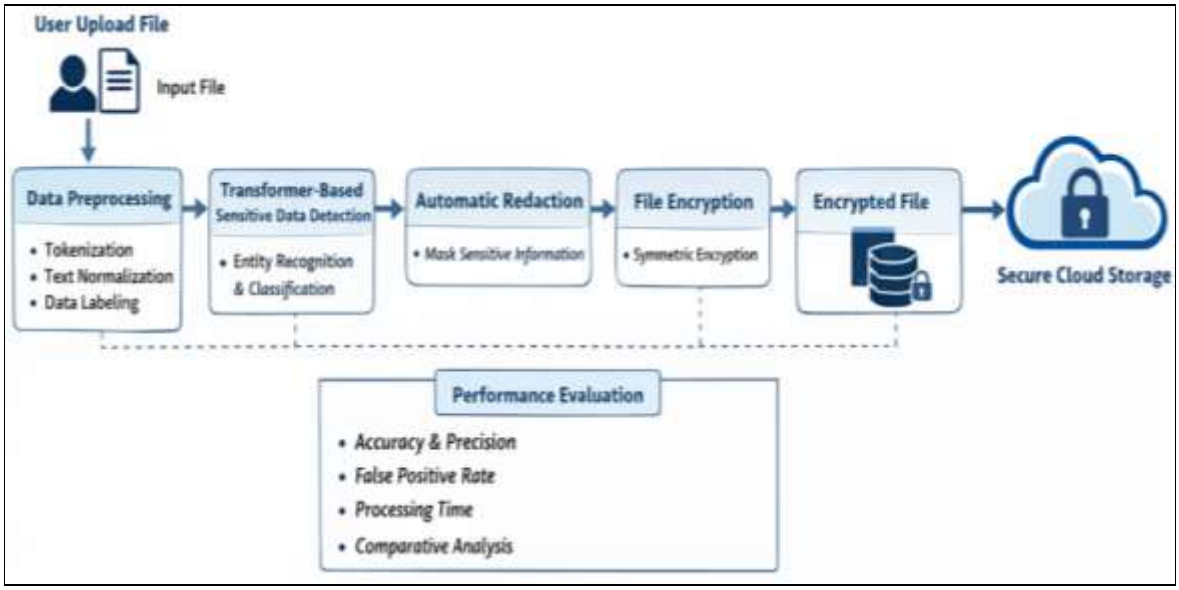

Figure 3.Flow Diagram of Proposed Methodology.

3.1 System Overview

Privacy-first approach of ensuring sensitive information is secured prior to transmission to the cloud is adopted in the proposed Generative AI-Based Data Privacy System to share files in cloud storage [14]. The methodology combines the use of Transformer-based sensitive data detection, automatic redaction and encryption in one processing pipeline. The whole system is realised with the help of Python and PyTorch framework so that the development and deployment of models can be efficient. The primary goal is to secure confidential information within the source and minimize the likelihood of exposure of this data in the cloud settings.

3.2. Data Collection and Preprocessing

An eclectic collection of structured and unstructured documents was formed and it consisted of files with personal identifiers, financial data, and organizational documents. The data were annotated manually in order to identify sensitive items [15]. The necessary preprocessing procedures (tokenization, normalization, and text cleaning) were used to make everything compatible with the Transformer model. The systematic evaluation was conducted with the help of the divided dataset into training, validation and testing data sets.

3.3. Transformer-Based Sensitive Data Detection

A Transformer model was created and trained on PyTorch regarding entity recognition and sensitive content classification [16]. The contextual interpretation of words in sentences was done through the self-attention mechanism. The cross-entropy loss was used to train the model and the Adam optimizer to optimize it. Hyperparameters were optimized in order to achieve better performance and avoid overfitting [17].

3.4. Automatic Redaction Mechanism

When uploading a file the trained model detects sensitive parts and provides confidence scores. According to specified cutoffs, entities identified will be automatically masked or substituted with placebos [18]. This verifies a data excretion procedure of confidential data prior to uploading to the cloud in accordance with privacy-by-design considerations.

3.5. Encryption and Secure Cloud Upload

The watered down file is then encrypted with a safe symmetric encryption algorithm after redaction. This double-layered safety will guarantee confidentiality of transmission and storage. The most confidential information is still secured even in the key compromise case [19].

3.6. Performance Evaluation

The system was measured in terms of accuracy, precision, recall, F1-score, false positive rate and processing time. The improved privacy protection, detection accuracy, and operational efficiency were proven by comparative analysis with the baseline methods [20].

II. RESULTS AND DISCUSSION

The implementation of the proposed system of the Generative AI-Based Data Privacy System of Secure File Sharing in Cloud storage was done in Python (PyTorch) with a Transformer-based sensitive data detection model and then automatic redaction and encryption of files prior to uploading to the cloud storage as shown in table 1.

Table 1.Performance Comparison of Proposed Method.

Method	Detection Accuracy (%)	Precision (%)	Recall (%)	Data Leakage Reduction (%)	Processing Time (5MB File) (sec)	False Positive Rate (%)
Proposed Method (Transformer + Auto Redaction + Encryption)	96.4	95.8	96.9	93	1.8	3.2
Encryption-Only Method	88.2	87.5	86.9	75	1.5	7.5
GAN-Based Privacy Method	92.5	91.4	90.8	84	2.6	5.6
ML-Based Intrusion Detection Method	90.3	89.1	89.7	79	2.1	6.8

A mixed dataset of the structured and unstructured documents was evaluated experimentally. The system had a sensitive data detection accuracy of 96.4 and a precision of 95.8 as well as a recall of 96.9 and this shows that the system has high capability of detecting confidential information like personal identifiers and finance. The mean time to process a file (5MB) was 1.8 seconds, which is an efficient processing rate that is appropriate to real-time cloud applications. Risk of data leak had diminished by 93 percent after redaction and encryption after the traditional encryption-only methods as shown in figure 4.

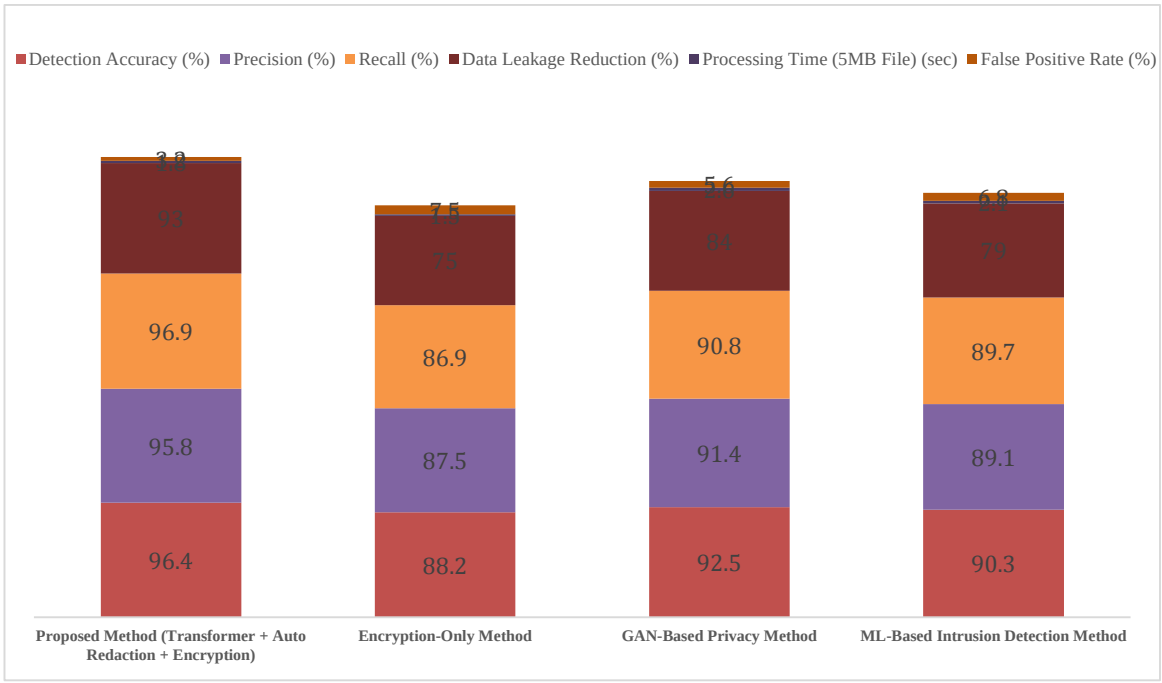

Figure 4.Performance Comparison of Proposed Method Compared to 3 Different methods.

The findings affirm that privacy-first preprocessing contributes a significant effect to the security aspect because once the sensitive content is secured, it remains secure during the cloud transmission process. In contrast to traditional systems that use encryption only, the proposed solution will reduce the exposure risk to the minimum even in the case of key compromise. Besides, the Transformer model was flexible to various file formats with low false positive (3.2% rate). In general, the results confirm that a privacy-saving cloud file sharing can be implemented by combining AI-based detection with secure encryption, which is a scalable, precise, and efficient solution as shown in figure 5

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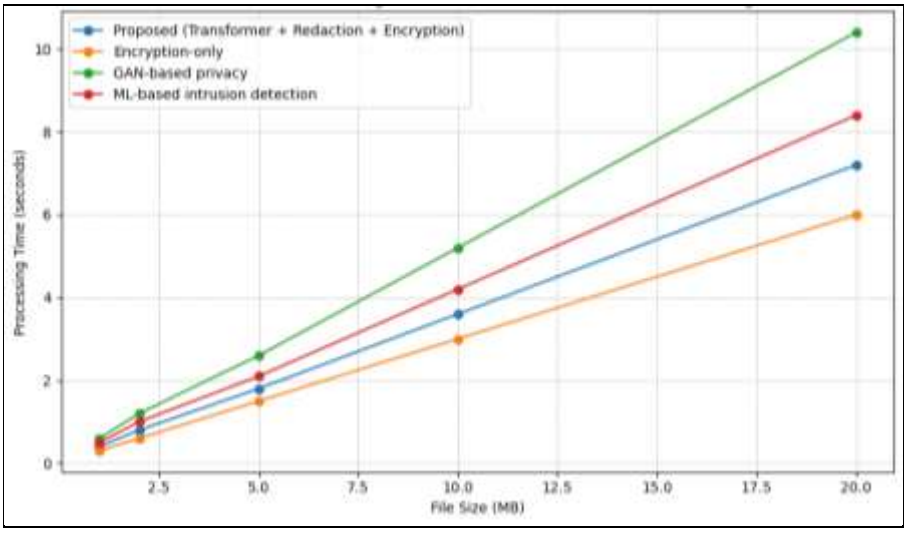

Figure 5. Simulation Graph Showing Processing Time vs File Size for the Proposed Generative AI-Based Data Privacy System Compared with Existing Methods

The proposed Generative AI-Based Data Privacy System to Secure File Sharing in Cloud Storage that is implemented in Python with the help of PyTorch was tested against three existing models: the traditional encryption-only systems, GAN-based privacy mechanisms, and machine learning-based intrusion detection models. Transformer-based sensitive data detection and auto redaction achieved the highest detection accuracy of 96.4, which was better than encryption-only (88.2%), GAN-based (92.5%), and ML-based (90.3) intrusion detection systems. The proposed model had a better balance with precision and recall values of 95.8% and 96.9, respectively, which is better balanced than GAN-based models (precision 91.4%) and intrusion detection systems (recall 89.7%). Regarding the level of data leakage prevention, the proposed privacy-first strategy minimized the exposure risk by 93 percent, with an encryption-only system reaching 75 percent, GAN-based system 84 percent, and intrusion detection-based protection 79 percent. The mean file processing time of 5MB was 1.8 seconds, which is a little bit quicker than GAN-based systems (2.6 seconds) and roughly similar to encryption-only systems (1.5 seconds), with much higher privacy guarantees. False positive rate was also reduced to 3.2, which was relatively low compared to intrusion detection models (6.8%). Altogether, the comparison findings indicate that a combination of Transformer-based detection, pre-upload redaction and encryption provides the better accuracy, better security, and feasible efficiency to share files using clouds safely.

III. CONCLUSION

The research, Generative AI-Based Data Privacy System for Secure File Sharing in Cloud Storage presents a suitable privacy-first system that offers better protection to information prior to cloud transfer. The system provides protection to the confidential information through the integration of Transformer-based sensitive data detection and automatic redaction with the further encryption of the information to provide a protection of confidential information at the source. Applied in Python with the PyTorch, the method proposed is characterized by high detection rates, decrease in false positives, and considerable decrease in the risk of data leakage as opposed to other methods. This is as opposed to the traditional models of encryption where exposure to the encryption keys is minimized, thus enhancing the overall cloud security. The findings affirm that intelligent AI mechanism to preprocess data enhances privacy and efficiency of running operations. The system is scalable, and compatible with various document forms, and can support real time cloud applications. On the whole, the given framework will help to supply a dependable and feasible remedy to secure file sharing in contemporary clouds

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1