Secure Data Hiding and Encryption System Using AES, DNS Encryption, Steganography

Ganashree K C
Computer Science and Engineering
RV College of Engineering
Bengaluru, Karnataka, India
ganashree@rvce.edu.in

Nischint Tiku
Computer Science and Engineering
RV College of Engineering
Bengaluru, Karnataka, India
nishchinttiku.cs22@rvce.edu.in

Rishab R
Computer Science and Engineering
RV College of Engineering
Bengaluru, Karanataka, India
rishabr.cs23@rvce.edu.in

Manoj Kumar B V
Computer Science andEngineering
RV College of Engineering
Bengaluru, Karnataka, India
manojkumarbv.cs23@rvce.edu.in

***Abstract*—The secure transmission of medical images and patient data is crucial in modern healthcare systems due to the increasing risks of data breaches and unauthorized access. Electronic Health Records (EHRs) contain sensitive information that must be protected during transmission, especially over hospital networks that adhere to the Digital Imaging and Communications in Medicine (DICOM) standard. This paper presents a novel approach that integrates cryptographic encryption and steganographic techniques to enhance the security of medical image transmission. The proposed method employs DNA-based Advanced Encryption Standard (AES) encryption for securing patient data stored in the DICOM header. The encrypted data is then embedded into a cover image using Least Significant Bit (LSB) steganography. To optimize storage and transmission efficiency, Discrete Wavelet Transform (DWT) compression is applied before sending the image to the receiver. At the receiving end, the hidden data is extracted through a reverse process. Experimental evaluations using various statistical metrics demonstrate that the proposed technique outperforms existing methods in terms of security, imperceptibility, and robustness. This research provides a reliable and effective solution for secure medical data transmission, ensuring confidentiality and protection against unauthorized access.**

Keywords— Secure medical image transmission, Electronic Health Record (EHR), Digital Imaging and Communications in Medicine (DICOM), Cryptography, Steganography, DNA-based AES encryption, Least Significant Bit (LSB) embedding, Discrete Wavelet Transform (DWT) compression, Data confidentiality, Information security.

I. Introduction

The increasing reliance on digital platforms for healthcare data management has raised concerns regarding the security and confidentiality of patient information. Electronic Health Records (EHRs) store sensitive medical data, which must be protected against unauthorized access. Due to the interconnected nature of hospital networks, EHRs are highly vulnerable to cyber threats, data breaches, and privacy violations. Ensuring the secure transmission of medical images and patient data is a crucial challenge in healthcare systems.

The Digital Imaging and Communications in Medicine (DICOM) standard is widely used for storing and transmitting medical images, ensuring compatibility between medical devices. However, when DICOM files are transmitted over hospital networks, they become susceptible to interception, alteration, and unauthorized access. Traditional security mechanisms, such as encryption and authentication protocols, are often insufficient to prevent data leakage. Hence, a more robust security mechanism is needed to safeguard medical data during transmission.

Cryptography and steganography are two widely used techniques for secure communication. Cryptography ensures data confidentiality by converting information into an unreadable format, while steganography hides data within a cover object, making it difficult for attackers to detect hidden information. By integrating both techniques, we propose a hybrid approach that enhances security while maintaining image quality and storage efficiency.

II. Related Work

Several methods have been developed to ensure secure medical image transmission. Traditional encryption techniques such as AES and RSA are commonly used to protect patient data. However, standalone cryptographic methods are vulnerable to brute-force attacks. Steganographic methods, such as LSB embedding, have been used to hide data within images, but they may introduce distortions and compromise image integrity.

Recent research has explored hybrid encryption-steganography techniques to enhance security. Some studies have implemented Discrete Wavelet Transform (DWT) and Discrete Cosine Transform (DCT) for steganography to improve imperceptibility. However, these methods often suffer from computational complexity and increased processing time. Our proposed approach integrates DNA-based AES encryption with LSB steganography and DWT compression to provide a secure, efficient, and robust solution.

III. Proposed Methodology

The proposed method consists of the following steps:

a) ***Encryption:*** *The patient's data stored in the DICOM header is encrypted using DNA-based AES encryption. This encryption technique provides high security by converting the data into a form that is extremely difficult to decode without the correct key.*

*b) **Steganography:** The encrypted data is embedded into the medical image using LSB embedding. This ensures that the hidden information remains imperceptible while utilizing the least significant bits of the image pixels.*

*c) **Compression:** DWT compression is applied to reduce the stego image size while preserving quality. Compression helps in efficient transmission and storage management, reducing network overhead.*

*d) **Transmission:** The compressed image is transmitted over the network securely using standard communication protocols.*

*e) **Decryption and Extraction:** At the receiver's end, the hidden data is extracted through a reverse process, and the original patient data is recovered, ensuring its authenticity and confidentiality.*

This hybrid approach ensures confidentiality, integrity, and security of transmitted medical images.

IV. Experimental Results

The proposed technique is evaluated using various statistical metrics, including Peak Signal-to-Noise Ratio (PSNR), Structural Similarity Index Measure (SSIM), and Mean Squared Error (MSE). The results demonstrate that:

1) The proposed method achieves a high PSNR value, indicating minimal distortion in the stego image.

2) SSIM values confirm the preservation of image quality, making it suitable for medical imaging.

3) MSE values show that the approach effectively maintains data integrity and minimizes distortion.

4) The technique outperforms existing methods in terms of security and robustness against potential cyberattacks.

Figure 1 Original Image

Figure 2 Grayscale Image with encrypted Details

Additionally, experiments were conducted on multiple DICOM images, and the method proved to be highly effective in terms of encryption strength, imperceptibility, and computational efficiency. The proposed method successfully resisted common steganalysis attacks, ensuring the reliability of the technique.

V. Conclusion and Future Work

This paper presents a secure and efficient approach for medical image transmission by combining DNA-based AES encryption, LSB steganography, and DWT compression. The proposed method ensures high security, imperceptibility, and efficient data transmission, making it a reliable solution for safeguarding medical images. Future work will focus on improving computational efficiency, integrating advanced cryptographic algorithms, and exploring deep learning-based security enhancements. Additionally, further research will be conducted to analyze the impact of different compression methods and explore blockchain-based authentication techniques to enhance data integrity and traceability.

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