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COMPARATIVE STUDY OF ENCRYPTION AND DECRYPTION TIMES ON JPEG IMAGES WITH AES AND DES ALGORITHMS

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Abstract: **With the increase in digital communication and data sharing over networks, the security of image data has become increasingly important.Encryption algorithms such as AES (Advanced Encryption Standard) and DES (Data Encryption Standard) are commonly used to protect sensitive image files.This research presents a comparative analysis of two widely used symmetric encryption algorithms, AES (Advanced Encryption Standard) and DES (Data Encryption Standard), in terms of their encryption and decryption times for JPEG images of different resolutions.This study measures and compares the computational time required by each algorithm for different image sizes.**

Keywords: **AES, DES, JPEG Images, Encryption Time, Decryption Time, Image Security, Cryptography**

I. INTRODUCTION

In today's digital age, images are a significant part of the data shared on the Internet and private networks. From personal photographs to medical imaging and surveillance footage, images often contain sensitive information that, if exposed to unauthorized users, could lead to privacy violations, data theft, or other malicious activity. With the increasing use of cloud storage and wireless communication, the need to secure image data during transmission and storage has become a serious concern. To prevent unauthorized access and ensure privacy, strong security measures are required.

Cryptography plays an important role in securing multimedia data, including images, audio, and video. It converts readable data (plaintext) into an unreadable form (ciphertext) to protect the information from unauthorized access. Symmetric key encryption algorithms, such as AES (Advanced Encryption Standard) and DES (Data Encryption Standard), are widely used to encrypt images due to their efficiency and effectiveness in protecting data. For multimedia security, cryptographic algorithms must not only provide strong encryption, but they must also operate within acceptable time limits, especially when dealing with large files such as high-resolution images. Delays in encryption or decryption can affect system performance in real-time applications such as video conferencing, medical imaging, and surveillance. Although AES and DES are commonly used encryption algorithms, their performance varies based on many factors, including data size, algorithm design, and computational complexity. In applications where image data must be transmitted or processed rapidly, such as in real-time systems or embedded devices, encryption and decryption speed becomes crucial. This research is motivated by the need to analyze how image resolution impacts the time taken to encrypt and decrypt images using AES and DES. By understanding this relationship, system designers can make informed decisions when choosing cryptographic methods for image-based applications.

While several studies have explored the security aspects and algorithmic efficiency of AES and DES, there is a lack of comparative research focusing on the influence of image resolution on the encryption and decryption time of JPEG images. Without this analysis, optimizing cryptographic solutions for performance in image-processing applications becomes challenging. This research attempts to fill this gap by systematically comparing the performance of AES and DES on JPEG images of different resolutions.

Objectives of the research

1) Comparing the encryption and decryption times of AES and DES algorithms on JPEG images of different resolutions.
2) To evaluate how image resolution affects the performance of both algorithms.

II. LITERATURE REVIEW

With the rapid growth of digital communication, the security of multimedia content such as images has become a serious concern. Many studies have focused on using well-established encryption algorithms such as AES and DES to ensure the confidentiality and integrity of image data. This literature review presents a summary of major research works conducted by Indian authors, emphasizing the objectives, and findings of each study -

Sonal Patil, Prakash S. Mohod (2016)

"Image Encryption using AES and Visual Cryptography"

Journal: International Journal of Computer Applications

The Objectives was conducted –

1) To design a hybrid image encryption model using AES and Visual Cryptography.

2) To ensure data confidentiality and security in image transmission over insecure channels.

The Findings of the study were -

The combined approach of AES (for strong encryption) and visual cryptography (for share generation) provides better protection. The scheme effectively hides image information and resists brute-force attacks.

Snehal S. Jadhav, Pravin B. Mane (2015)

"Secure Image Transmission using DES and RSA Algorithm"

Journal: IJSRP

The major objectives of the study were **–**

1) To develop a dual encryption model using DES and RSA for secure image transmission.

2) To analyze the impact of combining symmetric (DES) and asymmetric (RSA) encryption for images.

The findings of the study were -

DES provides faster encryption, while RSA ensures secure key distribution. The hybrid method reduces the risk of man-in-the-middle attacks and ensures confidentiality during image transfer.

Yogita Patil, P. R. Futane (2016)

"Comparative Analysis of AES and DES Security Algorithms for Image Encryption"

Journal: IJCSMC

The objectives of the study were -

1) To compare the performance of AES and DES algorithms on image encryption in terms of speed, security, and efficiency.

2) To identify the suitability of each algorithm for different image encryption use cases.

The findings of the research paper were -

AES outperforms DES in terms of encryption speed and key strength. DES is simpler but weaker due to its smaller key size. AES provides better resistance to cryptanalysis and is more suited for modern image encryption needs.

Rahul Sharma, Dhirendra Pandey (2014)

"Performance Analysis of DES and AES Encryption Algorithm for Security Enhancement of Image Data"

Journal: IJCA

The major objectives of the study were -

1) To analyze and compare DES and AES in encrypting image data with a focus on execution time, security level, and pixel correlation.

2) To enhance image data security using cryptographic algorithms.

The major findings of the research paper were -

AES showed better performance in reducing image pixel correlation, making encrypted images more resistant to statistical attacks. DES exhibited slower performance and was less secure due to shorter key length. The study concluded that AES is more efficient and secure for real-time image encryption.

III. METHODILOGY

Experimental Setup (Hardware, Software, and Tools)

The experiments were conducted on a standard personal computer with the following configuration: Intel Core i5 processor (2.5 GHz), 8 GB RAM, and Windows 10 operating system. The programming environment used was Python 3.11, utilizing libraries such as PyCryptodome for implementing AES and DES encryption algorithms. A high-precision timer module was integrated into the code to accurately measure encryption and decryption times.

Data set used - A dataset consisting of JPEG images with varying resolutions was prepared to observe the relationship between image size and processing time. The selected resolutions include:

Table - 1: JPEG Images of Different Resolutions

Image ID	Resolution (pixels)	Type	File Format	File Size
IMG_01	640x480 pixels	Low Resolution (VGA)	JPEG	150 KB
IMG_02	1280x720 pixels (HD)	Medium Resolution (HD)	JPEG	400 KB
IMG_03	1920x1080 pixels (Full HD)	High Resolution (Full HD)	JPEG	1 MB
IMG_04	3840x2160 pixels (4K)	Ultra-High Resolution (4K)	JPEG	3.5 MB

These images were chosen to represent common resolutions used in real-world applications such as web content, mobile devices, and high-definition displays.

Table -2: Algorithm used

Algorithm	Key Size	Block Size	Mode of Operation	Library/Tool
AES-128	128 bits	128 bits	ECB (Electronic Codebook)	PyCryptodome (Python)
DES	56 bits	64 bits	ECB (Electronic Codebook)	PyCryptodome (Python)

Each image in the dataset was first converted into a byte stream and then subjected to encryption using both the AES and DES algorithms. AES was implemented with a 128-bit key size, while DES used a 56-bit key as per standard configurations. After encryption, the ciphertext was immediately decrypted back into plaintext (original image data) using the respective decryption functions for both algorithms. The primary metric measured in this study was the time taken (in milliseconds) to perform encryption and decryption operations for each image using both AES and DES algorithms. The time was recorded separately for encryption and decryption processes. Each experiment was repeated multiple times (e.g., 5 iterations per image) to obtain an average time for improved accuracy. The collected data was then tabulated and used for comparative analysis to assess how image resolution impacts the processing speed of each algorithm.

To evaluate the performance of AES and DES encryption algorithms, an experiment was conducted to measure the encryption and decryption times for images of varying resolutions. The goal is to compare the computational efficiency of the two algorithms across different image sizes. The experiment is perform in Python -

```
Import matplotlib.pyplot as plt
# Data
resolutions = ['640x480', '1280x720', '1920x1080', '3840x2160']
aes_encryption = [10, 24, 45, 90]
aes_decryption = [8, 20, 41, 85]
des_encryption = [16, 38, 68, 132]
des_decryption = [14, 33, 62, 125]
# Plotting
plt.figure(figsize=(10, 6))
plt.plot(resolutions, aes_encryption, label='AES Encryption')
plt.plot(resolutions, aes_decryption, label='AES Decryption')
plt.plot(resolutions, des_encryption, label='DES Encryption')
plt.plot(resolutions, des_decryption, label='DES Decryption')
# Labels and Title
plt.xlabel('Image Resolution')
plt.ylabel('Time (ms)')
plt.title('Comparison of AES and DES Encryption/Decryption Times')
plt.legend()
plt.grid(True)
plt.tight_layout()
# Show plot
plt.show()
```

IV. RESULT ANALYSIS

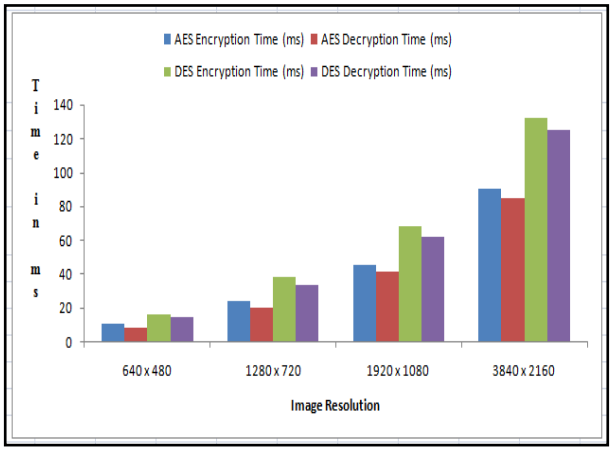
Table 3: Experimental Result

Image Resolution	AES Encryption Time (ms)	AES Decryption Time (ms)	DES Encryption Time (ms)	DES Decryption Time (ms)
640 x 480	10	8	16	14
1280 x 720	24	20	38	33
1920 x 1080	45	41	68	62
3840 x 2160	90	85	132	125

The above table - 3 presents the encryption and decryption times (in milliseconds) for JPEG images of different resolutions using the AES and DES algorithms.

1) For low-resolution images (640 x 480 pixels), AES completed encryption and decryption in 10 ms and 8 ms respectively, while DES took longer, requiring 16 ms for encryption and 14 ms for decryption.
2) As the resolution increases to 1280 x 720 pixels (HD) and 1920 x 1080 pixels (Full HD), both AES and DES require more time, but AES consistently shows faster performance compared to DES. For example, at 1920 x 1080, AES encryption takes 45 ms, whereas DES takes 68 ms.
3) At 3840 x 2160 pixels (4K resolution), the processing times increase significantly due to the larger data size. AES takes 90 ms to encrypt and 85 ms to decrypt, while DES requires 132 ms and 125 ms respectively, showing that DES is noticeably slower at higher resolutions.

To better illustrate the performance differences between AES and DES, a bar chart was created showing the encryption and decryption times (in milliseconds) for both algorithms at four image resolutions.



The bars or lines for DES encryption and decryption will be higher compared to AES across all resolutions. A clear trend will show increasing times as image resolution increases. The graph will help readers quickly visualize that AES is faster and more efficient compared to DES, especially for larger images. The graph will clearly show that - DES takes more time than **AES** for both encryption and decryption. Higher resolutions lead to higher times for both algorithms. AES is faster at all resolutions compared to DES.

V. CONCLUSION

This study presented a comparative analysis of the encryption and decryption times of JPEG images using AES and DES algorithms at different image resolutions. The experimental results clearly show that AES consistently outperforms DES in terms of speed across all tested resolutions. As image resolution increases, both algorithms exhibit increased processing times. However, AES scales more efficiently than DES. These findings suggest that AES is better suited for time-sensitive applications, such as real-time image transmission and multimedia security systems, especially when dealing with high-resolution images. Additionally, these results increase the popularity of AES not only for its strong security but also for its fast processing capabilities.

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