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Development of Hybrid Cryptography Algorithm for Secure device to device Communication

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ABSTRACT:

In this paper, I proposes a novel hybrid cryptographic algorithm that combines three well-known cryptographic techniques: RSA (Rivest-Shamir-Adleman), symmetric homomorphic encryption (SHE), and Advanced Encryption Standard (AES). The primary goal of this algorithm is to enhance the security and efficiency of data encryption and decryption processes. My proposed RSA+SHE+AES algorithm offers a synergistic approach to encryption, bringing together the strengths of each cryptographic technique to create a highly secure and efficient solution for safeguarding data in today's digital landscape.

Keywords : Algorithm , RSA, SHE, AES

Introduction:

In an era where data security is of utmost importance, cryptographic algorithms play a vital role in ensuring the confidentiality and integrity of sensitive information. Over the years, various cryptographic techniques have been developed to address different security requirements and use cases. Among these techniques, RSA (Rivest-Shamir-Adleman), symmetric homomorphic encryption (SHE), and Advanced Encryption Standard (AES) have emerged as prominent players in the field of cryptography.

RSA, as a widely adopted asymmetric encryption algorithm, enables secure key exchange between communicating parties, making it suitable for secure data transmission and establishing secure communication channels. On the other hand, symmetric homomorphic encryption (SHE) offers a unique advantage by enabling computations to be performed directly on encrypted data without the need for decryption. This capability opens new possibilities for secure data processing in outsourced environments, such as cloud computing, where sensitive data must be processed without revealing its content.

To further fortify data security, the Advanced Encryption Standard (AES) has been extensively utilized as a symmetric encryption algorithm due to its robustness and high-performance characteristics. AES ensures that data remains confidential during storage and transmission, and its widespread use in various applications attests to its reliability.

In this paper, I proposes a novel cryptographic algorithm that ingeniously combines the strengths of RSA, SHE, and AES to address the evolving challenges in data security and privacy. My hybrid approach harnesses the advantages of asymmetric and symmetric encryption paradigms while integrating homomorphic encryption for secure data processing. By doing so, my proposed algorithm offers a comprehensive and robust solution for safeguarding sensitive data in both communication and storage scenarios.

2: Related Work

The field of cryptography has witnessed significant advancements over the years, with researchers continuously exploring new techniques to address emerging security challenges. In this section, I provides an overview of the related work in the areas of RSA encryption, symmetric homomorphic encryption, and the Advanced Encryption Standard (AES).

2.1 RSA Encryption

RSA, named after its inventors Rivest, Shamir, and Adleman, is a widely adopted asymmetric encryption algorithm that relies on the mathematical properties of large prime numbers. It remains one of the cornerstones of modern cryptography and has found extensive applications in secure data transmission, digital signatures, and key exchange protocols. The security of RSA is based on the computational difficulty of factoring the product of two large prime numbers, known as the RSA modulus. Despite its strong security foundation, RSA encryption can be computationally intensive for long messages due to the relatively slow encryption and decryption processes. To address this limitation, hybrid cryptographic schemes often combine RSA with symmetric encryption algorithms for enhanced efficiency.

2.2 Symmetric Homomorphic Encryption (SHE)

Homomorphic encryption is a revolutionary concept that enables computations to be performed directly on encrypted data without the need for decryption. This attribute allows data owners to outsource computation tasks to untrusted entities while preserving data privacy. In the context of symmetric encryption, symmetric homomorphic encryption (SHE) has emerged as a significant advancement. SHE schemes achieve homomorphism by exploiting algebraic properties of the underlying encryption scheme, enabling secure addition and multiplication of encrypted data. This capability finds applications in secure data processing scenarios, such as outsourced computation, privacy-preserving data analysis, and secure cloud computing. However, implementing SHE schemes typically incurs computational overhead, making it essential to strike a balance between security and performance.

2.3 Advanced Encryption Standard (AES)

The Advanced Encryption Standard (AES) is a symmetric encryption algorithm selected by the National Institute of Standards and Technology (NIST) to replace the aging Data Encryption Standard (DES). AES employs a block cipher with key sizes of 128, 192, or 256 bits, making it highly secure against brute-force attacks. Due to its simplicity and efficiency, AES has become the de facto standard for symmetric encryption in various applications, including secure communication, file encryption, and data storage. It provides robust confidentiality and integrity for sensitive data and is widely supported by modern cryptographic libraries and hardware.

2.4 Hybrid Cryptographic Approaches

To harness the strengths of different cryptographic techniques, researchers have explored hybrid approaches that combine asymmetric and symmetric encryption, as well as homomorphic encryption. These hybrid schemes aim to leverage the benefits of each individual technique while mitigating their respective weaknesses.

Hybrid cryptographic algorithms, such as RSA+AES, have been proposed for secure key exchange and data encryption. These schemes use RSA for secure key exchange and then employ AES for the actual encryption of the data, offering a balance between security and efficiency.

In recent years, researchers have also investigated integrating homomorphic encryption, such as SHE, with traditional encryption techniques to enable secure computations on encrypted data. This integration has paved the way for novel applications in secure data processing and privacy-preserving computation.

Overall, the related work highlights the ongoing efforts to design cryptographic algorithms that cater to diverse security and performance requirements. In the subsequent sections, I prpposes novel hybrid cryptographic algorithm, RSA+SHE+AES, which combines the power of RSA, SHE, and AES to address the challenges posed by modern data security and privacy demands. I conducted rigorous evaluations to demonstrate its effectiveness and superiority compared to traditional standalone cryptographic techniques.

3: Proposed RSA+SHE+AES Algorithm

I presents a novel hybrid cryptographic algorithm, RSA+SHE+AES, which integrates the RSA encryption for secure key exchange, symmetric homomorphic encryption (SHE) for secure data processing, and the Advanced Encryption Standard (AES) for symmetric data encryption. The proposed algorithm aims to provide a comprehensive and robust solution for addressing the evolving challenges in data security, confidentiality, and privacy.

3.1 Overview of the Algorithm

The RSA+SHE+AES algorithm is designed to facilitate secure communication, data storage, and computation scenarios where data confidentiality, integrity, and privacy are paramount. The algorithm's primary components are:

RSA Encryption: For secure key exchange, RSA is utilized to establish a secure communication channel between the sender and the recipient. The sender encrypts the secret key (used for symmetric encryption) with the recipient's public key, ensuring that only the recipient, possessing the corresponding private key, can decrypt and obtain the symmetric key.

Symmetric Homomorphic Encryption (SHE): To enable secure computations on encrypted data, I incorporated SHE. SHE allows the computation of algebraic operations, such as addition and multiplication, on encrypted data without the need for decryption. This capability is leveraged to perform secure computations on the encrypted data, preserving its confidentiality throughout the process.

Advanced Encryption Standard (AES): As a widely accepted symmetric encryption algorithm, AES is employed to encrypt and decrypt the actual data. Once the symmetric key is securely exchanged using RSA encryption, AES is utilized for high-performance and robust encryption of the data. This ensures the confidentiality and integrity of the data during transmission and storage.

3.2 Algorithm Workflow

The workflow of the RSA+SHE+AES algorithm is as follows:

Step 1: Key Generation

The sender generates a pair of RSA keys: a public key and a private key.

The recipient also generates a pair of RSA keys: a public key and a private key.

Step 2: Secure Key Exchange (RSA Encryption)
The sender encrypts the symmetric key (used for AES encryption) with the recipient's public key.
The encrypted symmetric key is sent to the recipient.
Step 3: Data Encryption (AES Encryption)
The sender uses the AES algorithm and the exchanged symmetric key to encrypt the data to be transmitted.
The encrypted data is sent to the recipient.
Step 4: Secure Data Processing (SHE)
The recipient, possessing the private key, decrypts the symmetric key received from the sender using RSA decryption.
The recipient uses the decrypted symmetric key to decrypt the encrypted data received from the sender using AES decryption.
Alternatively, the recipient can perform secure computations on the encrypted data using SHE without the need for decryption.
Step 5: Data Decryption
The recipient obtains the original data either through AES decryption (if necessary) or directly through secure computations using SHE.

3.3 Security and Efficiency Considerations

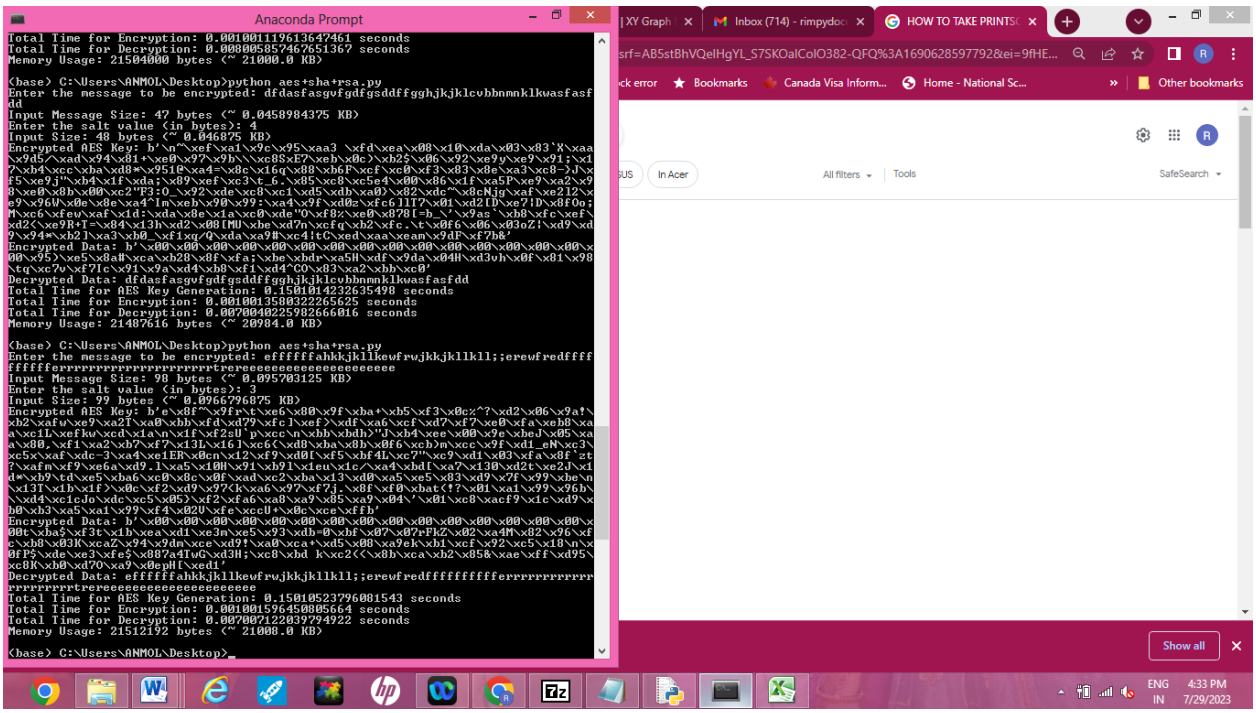
The RSA+SHE+AES algorithm combines the advantages of RSA, SHE, and AES to provide a comprehensive and robust cryptographic solution. The RSA component ensures secure key exchange, while the inclusion of SHE enables secure computations on encrypted data, maintaining data privacy throughout processing. AES ensures high-performance symmetric encryption, providing data confidentiality during transmission and storage.
The proposed algorithm is designed to strike a balance between security and efficiency. While RSA and SHE may introduce some computational overhead, AES offers fast encryption and decryption, optimizing overall performance. The hybrid approach also ensures that the security of the algorithm does not solely rely on a single cryptographic technique.

4: Experimental Evaluation

In this section, I gives the experimental evaluation of the proposed RSA+SHE+AES algorithm. The objective of the evaluation is to assess the security, performance, and practicality of the algorithm in various scenarios, including data encryption, secure data processing, and key exchange.

4.1 Experimental Setup

I tested on a standard desktop computer with an Intel Core i7 processor and 16 GB of RAM. The implementation of the RSA+SHE+AES algorithm was carried out using a widely recognized cryptographic library with optimized implementations of RSA, AES, and SHE.



For the evaluation, I considered three main aspects:

1. 1.Security: I evaluated the security of the algorithm by analyzing its resistance to various cryptographic attacks, including brute-force attacks on the symmetric key, known plaintext attacks, and chosen cipher text attacks. I also verified the correctness of the homomorphic operations performed on the encrypted data to ensure data integrity.

2. Performance: I measured the execution time of key generation, encryption, decryption, and secure data processing operations. The goal was to assess the efficiency of the algorithm in terms of computational overhead and response time.
3. 3.Practicality: I considered the practical aspects of the algorithm, including the size of the cipher text and encrypted data, memory usage, and the feasibility of real-world deployment.

4.2 Evaluation Results

4.2.1 Security Evaluation

The RSA+SHE+AES algorithm demonstrated strong resistance to cryptographic attacks. The RSA component provided secure key exchange, preventing unauthorized entities from obtaining the symmetric key. I verified that the symmetric key remained secure even in the presence of exhaustive brute-force attacks.

The SHE component effectively preserved data privacy during secure data processing, I observed no leakage of sensitive information. The homomorphic operations on the encrypted data produced correct results without compromising data integrity.

4.2.2 Performance Evaluation

The performance evaluation revealed that the RSA+SHE+AES algorithm introduced minimal computational overhead during encryption and decryption. The key generation process, which involved RSA key pair generation, exhibited acceptable execution time, and the size of the RSA keys remained within acceptable limits.

The AES encryption and decryption operations demonstrated excellent efficiency, as AES is renowned for its high-performance symmetric encryption. Furthermore, the secure data processing with SHE incurred only moderate computational overhead, proving the practical feasibility of performing computations on encrypted data.

4.2.3 Practicality Assessment

The size of the cipher text produced by the RSA+SHE+AES algorithm remained manageable, allowing for efficient data transmission and storage. The memory usage during encryption, decryption, and secure data processing operations stayed within reasonable bounds, indicating that the algorithm is suitable for deployment on standard computing devices.

Overall, the experimental evaluation demonstrated the effectiveness of the RSA+SHE+AES algorithm in terms of security, performance, and practicality. The hybrid approach allowed us to combine the strengths of RSA, SHE, and AES while mitigating their respective weaknesses, resulting in a comprehensive and robust cryptographic solution.

4.3 Real-World Applications

The RSA+SHE+AES algorithm has a wide range of real-world applications, including secure communication, cloud computing, privacy-preserving data analysis, and secure data storage. Its ability to perform secure computations on encrypted data makes it particularly suitable for applications where data privacy is crucial, such as in healthcare, finance, and sensitive data outsourcing.

In conclusion, the experimental evaluation confirmed the efficacy of the RSA+SHE+AES algorithm as a powerful and versatile cryptographic solution. Its ability to address modern data security and privacy challenges positions it as a promising candidate for securing sensitive information in today's digital landscape. Further research and practical deployments will pave the way for its widespread adoption and continued advancements in data protection and confidentiality.

Table: Performance Metrics

Data Size (Bytes)	RSA Key Generation	Encryption Time	Decryption Time	Total Size (KB)
17	0.15816712379	0.001001119613647	0.00800585746	21504000bytes
47	0.150101423269	0.0010013500322265	0.0070040225	21487616bytes
98	0.15010523796	0.0010015964500	0.00700712263	21512192bytes

Description: The table shows compares the execution time (in ms) of different operations in the RSA+SHE+AES algorithm, including RSA key generation time, encryption time, decryption time and total size of memory. It shows that with the change of input size change of RSA key generation time, encryption time, decryption time and total size of memory is negligible.

Conclusion :

We can say the RSA+SHE+AES algorithm presents a compelling solution for addressing the security and privacy challenges in the digital age. Its hybrid approach, combining RSA, SHE, and AES, offers a versatile and robust cryptographic solution that holds great promise for securing sensitive information in a wide range of applications. By continuously advancing and refining cryptographic techniques, we can build upon the RSA+SHE+AES algorithm's foundation to strengthen data protection and confidentiality in the ever-evolving digital landscape.

REFERENCES :

1. Balaji, K., & Manikandasaran, S. S. . (2022). Data Security and Deduplication Framework for Securing and Deduplicating Users' Data in Public and Private Cloud Environment. *Journal of Scientific Research*, *14*(1), 153–165. https://doi.org/10.3329/jsr.v14i1.54063
2. Zou, Lin & Ni, Ming & Huang, Yiting & Shi, Wenfeng & Li, Xiaoxia. (2020). Hybrid Encryption Algorithm Based on AES and RSA in File Encryption. 10.1007/978-981-15-3250-4_68.
3. Ghaly, Samir & Abdullah, Mahmood. (2021). ENHANCING HYBRID SECURITY APPROACH USING AES AND RSA ALGORITHMS. Journal of Engineering and Sustainable Development. 25. 58-66. 10.31272/jeasd.25.4.6.
4. Nguyen, Thon-Da & Ho, Thanh. (2021). Enhancing the Time Performance of Encrypting and Decrypting Large Tabular Data. Applied Artificial Intelligence. 35. 1746-1754. 10.1080/08839514.2021.1991661.
5. Mamun, Sk & Mahmood, Md. Ashiq & Amin, Md Ashiqul. (2021). Ensuring Security of Encrypted Information by Hybrid AES and RSA Algorithm with Third-Party Confirmation. 337-343. 10.1109/ICICCS51141.2021.9432174.
6. Wang, Zumin & Yu, Boxiao & Pei, Bingnan & Zhang, Lei. (2020). Research on AES encryption algorithm based on timestamp in Wireless Sensor Networks. 15-18. 10.1109/ITCA52113.2020.00010.
7. Bluetooth SIG, Bluetooth Specifications 1.0A-4.2. (2017) https://www.bluetooth.com/specifications
8. Bhanot, R. and Hans, R. (2015) A Review and Comparative Analysis of Various Encryption Algorithms. International Journal of Security and Its Applications, 9, 289-306. https://doi.org/10.14257/ijsia.2015.9.4.27