IMAGE AND VIDEO ENCRYPTION USING DNA WITH QUANTUM WALK ALGORITHM.

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Introduction:

1. In the modern digital era, the rapid advancement of technology and widespread use of the internet have led to an enormous increase in the generation and sharing of multimedia data such as images and videos. Ensuring the security and privacy of this data during storage and transmission has become a major concern. Cyber threats, unauthorised access, and data breaches make it essential to develop strong and efficient encryption techniques.
2. Traditional cryptographic methods are effective for text data but may not be fully suitable for multimedia data due to its large size, high redundancy, and real-time processing requirements. To address these limitations, advanced approaches like DNA computing and quantum-based algorithms are gaining attention in the field of information security.
3. DNA computing is a bio-inspired technique that uses the principles of biological DNA sequences for data encoding and encryption. It offers high storage capacity, parallel processing ability, and increased complexity, making it difficult for attackers to decode the information. On the other hand, the Quantum Walk Algorithm, inspired by quantum mechanics, enhances randomness and unpredictability in the encryption process, providing an additional layer of security.
4. This project combines DNA-based encryption with the Quantum Walk Algorithm to develop a robust system for securing image and video data. The integration of these technologies improves encryption strength, ensures data confidentiality, and protects against modern cyber threats.
5. The main aim of this project is to design an efficient, secure, and reliable method for multimedia encryption, enabling safe transmission and storage of sensitive data in various applications such as communication systems, healthcare, defence, and cloud storage.

Objectives:

1. To develop a quantum-walk-based scrambling system for generating unpredictable pixel permutations.
2. To implement DNA encoding/decoding with dynamic rule selection for strong confusion and diffusion.
3. To integrate SHA-256 hashing for chaotic seed generation and high key sensitivity.
4. To evaluate encryption strength using entropy, NPCR, and UACI.
5. To ensure efficient and scalable performance for colour image encryption.

Methodology:

1. To develop a quantum-walk-based scrambling system for generating unpredictable pixel permutations.
2. To implement DNA encoding/decoding with dynamic rule selection for strong confusion and diffusion.
3. To integrate SHA-256 hashing for chaotic seed generation and high key sensitivity.
4. To evaluate encryption strength using entropy, NPCR, and UACI.
5. To ensure efficient and scalable performance for colour image encryption.
6. Convert binary pixel values into DNA bases (A, T, C, G).
7. Perform operations like XOR, complement, and substitution based on chaotic rules.
8. Decode the DNA strands back to pixel values.
9. Encrypted Image Formation: Reconstruct the encrypted image from the transformed pixel matrix.
10. Decryption: Apply the reverse process using the same key and rule sets.
11. Security Evaluation: Compute entropy, NPCR, and UACI for verifying randomness and resistance to differential attacks.

Result and Conclusion:

1. The proposed system for image and video encryption using DNA computing and the Quantum Walk Algorithm was successfully implemented and tested. The results showed that the encrypted images and video frames were highly distorted and unrecognizable, ensuring strong data confidentiality.
2. The algorithm demonstrated high randomness and sensitivity to input changes, making it resistant to various cryptographic attacks, such as brute-force and statistical analysis, while histogram analysis indicated a uniform distribution.
3. The decryption process accurately reconstructed the original data without significant loss, proving the reliability and efficiency of the method. Overall, the project concludes that integrating DNA computing with the Quantum Walk Algorithm provides a secure, efficient, and robust solution for multimedia data protection, ensuring safe transmission and storage and offering strong potential for real-world applications such as secure communication, healthcare, and cloud security.

Project Outcome & Industry Relevance:

1. The project successfully developed a secure encryption system for images and videos using DNA computing and the Quantum Walk Algorithm, ensuring high data protection, reliability, and efficiency. The outcome demonstrates improved security through enhanced randomness, strong encryption, and accurate data recovery, making it suitable for handling sensitive multimedia information.
2. This project has strong industry relevance as data security is a critical requirement in various sectors such as cybersecurity, healthcare, defence, banking, and cloud computing. The proposed method can be applied in secure communication systems, digital media protection, and confidential data storage, helping industries safeguard information from cyber threats and unauthorised access.

Working Model vs. Simulation/Study:

1. This project is mainly developed as a simulation, where the encryption and decryption processes are tested using software instead of physical hardware. The DNA encoding and Quantum Walk Algorithm were implemented in a simulated environment to check how well they protect image and video data. The results showed that the system works effectively, providing strong security and accurate recovery of the original data.
2. Compared to a physical working model, using a simulation is easier, more flexible, and cost-effective. It allows us to test different scenarios and improve the system without needing a complex hardware setup. Even though a real-time working model could be developed in the future, this simulation clearly proves that the method is practical and can be used in real-world applications.

Project Outcomes and Learnings:

1. Developed a secure image encryption and decryption system using DNA cryptography and quantum walk-based techniques.
2. Achieved high security with strong entropy, NPCR, and UACI values.
3. Demonstrated efficient performance on images of different sizes.
4. Ensured high key sensitivity, where small changes produce completely different encrypted outputs.
5. Built a reliable and accurate model for secure multimedia data protection.
6. Gained knowledge of advanced cryptography, DNA encoding, and quantum-based algorithms.
7. Learned performance analysis techniques for evaluating encryption strength.
8. Acquired practical experience in implementing secure systems for real-world applications.

Future Scope:

The future scope of this project includes:

1. Extend the system to real-time video encryption for live streaming applications.
2. Implement the model using hardware for faster and practical real-world usage.
3. Enhance the algorithm to reduce execution time and improve efficiency.
4. Integrate with cloud security systems for secure data storage and sharing.
5. Apply the method in domains like healthcare, defence, and banking for sensitive data protection.
6. Combine with AI/ML techniques to further improve encryption strength and adaptability.
7. Develop mobile or web-based applications for easy user access and usability.
8. Explore stronger quantum-based techniques to make the system more future-proof against advanced cyber threats.