

WATERMARK STEGANOGRAPHY BASED ON THE NOVEL ENHANCED QUANTUM IMAGE REPRESENTATION MODEL

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Watermarking digital images is vital for copyright protection, identity verification, and source tracing. Traditional digital watermarking schemes have limitations, such as low reliability and low security, which can lead to loss or destruction of watermarks. To solve these problems, we can propose quantum imaging technology [1-4], which has become widespread in recent years. This technology utilizes the properties of quantum superposition and entanglement to enhance the security and robustness of watermarks on digital images, thereby protecting the security and privacy of digital images.

The aim of the paper is to model watermarking using the NEQR model using quantum computing, demonstrating its potential for enhanced image protection and integrity. There are various methods of image representation: Qubit Lattice [4-5], Entangled image, Real Ket, Flexible Representation of Quantum Images (FRQI) [1], Novel Enhanced Quantum Image Representation (NEQR) [2, 4].

FRQI uses normalized superposition to store all pixels of an image, the same operations can be performed on all pixels at the same time, and therefore FRQI can alleviate the computational problem of image processing. The main limitation of FRQI is that it only uses one qubit to store the grayscale information for each pixel of the image, so some digital image processing operations, such as certain complex color operations, cannot be performed based on FRQI.

The NEQR model uses a linear, independent base state of a qubit sequence to store the grayscale value for each pixel. Thus, to store a digital image using quantum mechanics, NEQR uses two intertwined qubit sequences that represent the grayscale information and positions of all pixels in the image.

In the FRQI representation, the grayscale information of an image is encoded using a single qubit, while in NEQR, the grayscale information is encoded in basis qubit states, since each basis qubit state is linearly independent, the image processing task becomes much simpler than in FRQI.

The method reduces the overall computational complexity from (24n) to (22n) [2]. It focuses on the shortcomings of the FRQI model and stores information based on a qubit sequence, which allows for a halving of the computational complexity and a 1.5-fold improvement in compression ratio.

The color scheme of an image consists of three intensity values known as RGB values of an image, the intensity of each color can vary from 0, where 0 means black and 255 means white. To encode each intensity ($2q = 255$), where q is the number of qubits needed to encode different intensities of a particular color, and to encode a position we need a different set of qubits. Since we will be representing a two-dimensional (2×2) pixel image, we will define the position of the image by its row and column, Y , X , respectively, and the color by

$$f(Y, X) = C_{YX}^{q-1} C_{YX}^{q-2} \dots C_{YX}^1 C_{YX}^0, \quad (1)$$
$$C_{YX}^q \in [0, 1], f(Y, X) \in [0, 2^q - 1].$$

Like digital watermarks, quantum watermarks aim to protect the copyright of an image and authenticate its owner by means of visible or invisible signals (mostly logos) embedded in the image container (or media). Most quantum watermarking strategies are based on FRQI for media images and watermark logos. The NEQR model [2, 4, 6], which stores color information in the ground state of a quantum sequence, uses a total of $2n+q$ qubits to represent an image, where n represents position coordinate information and q represents color information. This allows for precise manipulation of color information and makes certain image operations that were previously complex simple and convenient.

References

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ДОСЛІДЖЕННЯ МНОЖИНИ ТРИРОЗЯДНИХ ЛОГІЧНИХ ОПЕРАЦІЙ ДЛЯ МАТРИЧНОГО КРИПТОПЕРЕТВОРЕННЯ

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Основу гарантування інформаційної безпеки в інформаційно-телекомунікаційних системах становлять криптографічні методи та засоби захисту інформації. Слід врахувати, що найбільш надійний захист можна забезпечити тільки за допомогою комплексного підходу, тобто рішення задачі має являти собою сукупність організаційно-технічних та криптографічних заходів [1,2].

В основі криптографічних методів лежить поняття криптографічного перетворення інформації, створеного за певними математичними законами, з метою виключити доступ до цієї інформації сторонніх користувачів, а також з метою забезпечення неможливості безконтрольного отримання інформації з боку тих самих осіб [3].