Information Storage using Quantum entangled states: Image Optimization

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Abstract — Quantum registration is another pattern in computational hypothesis, and there are a few helpful properties like Entanglement in a quantum mechanical framework. We have proposed a methodology, Store in a quantum framework data on the structure and substance of the basic image. Consider a variety of n qubits that we propose to use to accumulate our memory. In this investigation, we give a short review with the ultimate goal of how entangled states can be useful for the storage and recovery of quantum images. We examine the properties and convenience of the tripartite Greenberger - Horne - Zeilinger and W states to store the shapes that may comprise of three vertices. We also suggest methods for storing shapes that exceed three vertices.

Keywords* — *W states, Quantum Entanglement, Greenberger-Horne-Zeilinger, Image Storage and retrieval

I. INTRODUCTION

In current years classical processing is switched to quantum photo processing. Quantum picture processing is an stylish method to conquer the troubles of its classical counter parts. Image storage, retrieval and its processing on quantum machines is an rising place. Although quantum machines do now not exist in physical truth but theoretical algorithms developed based totally on quantum entangled states offers new insights to process the classical pics in quantum area.

Hypothesis of quantum mechanics was provoked by disappointment of established material science that was seen toward the end of nineteenth and mid twentieth hundreds of years.

Quantum mechanics has been linked to computer science, communication information theory and digital signal processing in recent years. For example
Shor's has shown that on a quantum computer, integer factoring can be done in polynomial time. Another major application of the quantity factorization algorithm of Shor [1] is to break public key cryptosystems of RSA. Visual information storage, processing and recovery are first - request assignments for analysts in the picture handling discipline and related zones, for example, pattern recognition and artificial intelligence.

For traditional memory device, memory cells are hardware – independent [2] which means that each storage location can be stored in a classic memory device. In terms of hardware, memory cells are independent of each other, and this means that a reality, which is independent of all other memory locations can be assigned to each storage location. This article has four different sections: in section 2, Basics of Quantum. In section 3, methodology is explained. Proposed work is clarified in segment four pursued by experimental results and analysis. At last, we offer a couple of finishing up comments.

II. BASICS OF QUANTUM

2.1 *Scientific representations of a traditional bit and a classical qubit*

Information is saved and manipulated in the form of bits in Classical Computation. A classical bit's mathematical structure is pretty simple. Defining two ' logical ' values, traditionally labeled as { 0, 1 }, and related these values to two different outcomes of a classical measurement, is sufficient. So in a scalar space, a classic bit ' lives. '

Records are stored, manipulated and measured in qubit form in quantum computation. A qubit is a body entity that is described through Quantum Mechanics laws. Easy examples of qubits include two orthogonal polarization of a photon (e.g. horizontal and vertical), the alignment of a (spin-1/2) nuclear spin in a magnetic area or states of an electron orbiting an atom. A qubit can be represented as a vector $|\Psi\rangle$ mathematically in a two - dimensional complex vector area with an internal product associated with it, so $|\Psi\rangle \in H^2$. For this statement, we check with this kind of vector territory as a two-dimensional Hilbert space H^2. The notation$|\rangle$, which is a ket, is part of the Dirac notation, a widespread and very handy typography in Quantum Mechanics, which in reality is much more than just notation. A qubit $|\Psi\rangle$ might be written in standard structure as

$$|\Psi\rangle = \alpha\,|p\rangle + \beta\,|q\rangle \qquad (1)$$

Wherein the complex coefficients α and β fulfill the normalization situation $|\alpha|^2 + |\beta|^2 = 1$ and $\{|p\rangle, |q\rangle\}$ is an arbitrary foundation spanning H2. The choice of $\{|p\rangle, |q\rangle\}$ is frequently$\{|0\rangle, |1\rangle\}$. These are the state of the computational basis for the qubit vector area and form an orthogonal basis. Thus in widespread is a coherent superposition of the base states $|p\rangle$ *and* $|q\rangle$ and can be organized in countless ways through different values of the complicated coefficients α and β subjects to the constraint of normalization. In evaluation, classical computers measure bit values using the most convenient one base, { 0, 1 } and the only two viable states are those corresponding to size results 0 or 1.

It is also possible to prepare a qubit through a density operator (the density matrix is regularly used in the literature). For this reason, using one representation or the alternative depends on the device's residences to be studied, both representations are equivalent. A qubit's density operator is commonly referred to as$\hat{Q}$.

A bra, another symbol ⟨| from the notation of Dirac. Alternatively, it is written as $|\Psi\rangle^{\dagger}$, the complex conjugate transposes. As an example, let us set

$|\Psi\rangle = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$ for the computational basis$\{|0\rangle, |1\rangle\}$.

Then $|\Psi\rangle = [\ 0 \quad 1]$ Taking the inner product yields $\langle|\Psi\rangle||\Psi\rangle\rangle = [0 \quad 1] \begin{bmatrix} 0 \\ 1 \end{bmatrix} = 1$ i.e. the inner product of $|\Psi\rangle$ with itself is unity. [3][4]

2.2 Quantum Measurement

Dimension consistent with the policies of quantum mechanics is a non-trivial and quite counter-intuitive system. First of all, it should be stated that the results of the measurement Taken from a quantum system are Probabilistic inherently. In different phrases, the possible consequences of such size could be distributed according to a certain distribution of possibilities, regardless of the carefulness within the education of a dimension method.

Also, when a size has been played out, a Quantum framework in unavoidably modified because of the connection with the estimation hardware, Therefore, for an arbitrary quantum gadget, it makes you feel like talking about pre - dimension and post - measurement Quantum states.

Thirdly, it wanted to define a hard and fast dimension operator for you to perform a size. This set of operators must fulfill a number of policies that allow one to calculate the actual distribution of chance as well as the quantity states of the post - dimension.

As a way to make clear these factors, let us exercise session an easy Instance. Suppose we have a polarized photon with ' horizontal ' and ' vertical ' polarization orientations. The direction of horizontal polarization is indicated by the use of a $|0\rangle$ and the path of vertical polarization is indicated by a $|01\rangle$.

Give us a chance to develop two estimation administrators $\hat{M}_0=|0\rangle\langle 0|$ and $\hat{M}_1=|1\rangle\langle 1|$ and two estimation results a_0, a_1. At that point the full detectable utilized for estimation in this analysis is $\hat{M}= a_0|0\rangle\langle 0| + a_1|1\rangle\langle 1|$.

The probabilities of obtaining results a_0 or results a_1 are given by the Quantum Mechanics rules: $p(a_0) = |\alpha|^2$ and $p(a_1) = |\beta|^2$. The corresponding quantity state after measurement is as follows: if the result is = a_0 then $|\Psi\rangle = |0\rangle$; if outcome = a_1 then $|\Psi\rangle = |1\rangle$;

It is highly feasible to assemble a complete concept of quantum measurement for quantum system representations of both vector and density matrix. Dimension idea and its QC and QIP software are open and fruitful study discipline.

2.3 Quantum Entanglement

In QC and QIP, quantity entanglement is a key idea. In addition to the mathematical structure of some entanglement states widely used in QC and QIP, we will evaluate the experiments that led to research into quantum entanglement.

In every branch of technology, the concept of correlation is deeply rooted. The following experiment is a regular and easy example: we guess we have balls, one dark and one white, and containers. In the event that we put a ball in every compartment and, at that point close to every holder, we want to carry out simplest one test, this is, to open one container, as a way to recognize which of the balls is in every box. In other phrases, by one dimension, beginning one container and seeing which ball become stored in it; we attain two portions of facts, namely the coloration of the ball saved in both containers. Using various measurement procedures, the quantum system can be tested for inherent confusion. It was discovered that it is either an incomplete theory during the development of Quantum Mechanics as a physical theory.

A pure state $|\Psi\rangle$ is called separable if it can be written as $|\Psi\rangle = |A\rangle \otimes |B\rangle$ otherwise it is entangled. An example for pure separable state is $|\uparrow\uparrow\rangle = |\uparrow\rangle \otimes |\uparrow\rangle = |00\rangle$.

An example for pure entangled states is the Bell states that are well known. The singlet state is one of them: $|\text{singlet}\rangle = 1/\sqrt{2}(|\downarrow\uparrow\rangle - |\uparrow\downarrow\rangle) = 1/\sqrt{2}(|01\rangle - |10\rangle)$.

2.4 Werner State

A werner state is a N X N dimensional bipartite state that is invariant under the unitary U $\otimes$ U for any Unitary U.

In our terminology, we consider a pair of $\frac{1}{2}$ spin particles in an impure singlet, consisting of a singlet fraction x and a random fraction (1-x) for impurity:

$$P^{W=x|singlet\rangle}\langle singlet| + \frac{1}{4}(1-x)1 \qquad (2)$$

Where 1 is the identity matrix.

III. METHODOLOGY

In this article, we focus on straight double images (those pictures with only two brightness levels, black and white). Basically, by thresholding any dim level image, such images may be acquired. While limited in application, such pictures are of intrigue since they are moderately direct to prepare and accordingly give a helpful beginning stage to presenting Entanglement with regards to picture handling.

3.1 Proposed methodology of Storage Information

We aim to store records in a quantum gadget about the shape and content material of an easy image. Do not forget that we suggest using the n qubits array. Within the array, each qubit can be related to parameters, a and b, which are some simple factors in the 2 dimensional image grid. It is therefore possible to use such an array to store visible information. Before records are entered in the array, Each qubit is assumed to be initialized to state $|0\rangle$. Therefore, by the following expression, the initial reminiscence kingdom is given.

$$|\Psi\text{initial}\rangle = \otimes_{i=1}^{n} |01\rangle_{i(a,b)} \qquad (3)$$

We need to track the position and state of some basic items that can be delineated on our framework as components accumulations. Broadening the traditional parallel image formalism to qubits, we are going with a white factor on the network with qubit nation$|0\rangle$, $\rangle$, at the same time with dark comparing to country $|1\rangle$However, a few expansions of the established methodology are basic so as to exploit the novel places of Entanglement.

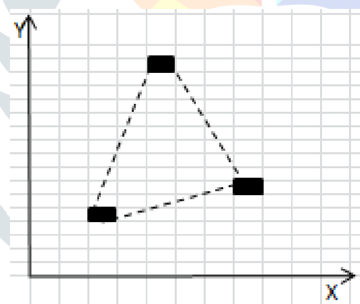


Fig 1: *qubit cluster solitary triangle in a simple storage strategy*.

Inside the established system, vertex positions relate to qubit state $|1\rangle$ and the triangle picture might be direct remade. Be that as it may, the utilization of Entanglement among vertex places gives an increasingly productive strategy.

An easy instance wills suffice to give an explanation for the standards of such a quantum garage device. Believe we need to store a triangle type in our qubit array. In this case, by setting the related qubit to each vertex of the triangle on the matrix, we can speak to each vertex of the triangle to$|1\rangle$. Such a framework is shown in Fig. (1)

By applying Grover's quantum search set of rules to the array, the right vertex positions can then be retrieved. We could assume that looking for a n - qubit array for a $|1\rangle$ could take steps about O(n) using a classic set of rules. But, Grover's quantum search set of rules can reap the sort of task in about O($\sqrt{n}$) steps due to its use of Quantum Mechanics. For three vertices stored within the array, software of Grover's seek set of rules would require about $\sqrt{}$(n/3) ventures to recuperate the information determining the areas of the vertices of the triangle. The image of the triangle is then all around truly reproduced from these records

Nevertheless, assume we prefer to store in the exhibit two triangles. We could continue with a basically traditional approach as before, setting up the qubits related to triangle vertices in the state $|1\rangle$ as well $|0\rangle$. In any case, recuperation of information on vertex position by applying Grover's request estimation won't reveal anything about which vertices have a spot with triangles. In the cluster about which vertex directs to which triangle is located, we need to store additional data. Entanglement could be used for this situation to build non - local connections between the qubits that put away the vertex areas of a similar triangle. Consider the maximally entangled tripartite state again.

$$|W\rangle = \frac{|001\rangle + |100\rangle + |010\rangle}{\sqrt{3}} \qquad (4)$$

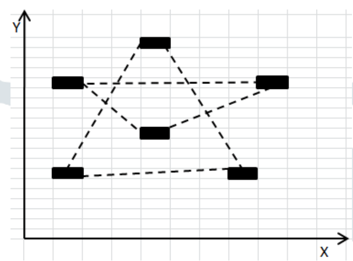
Suppose we've got two qubits in the state first $\alpha_0|0\rangle + \alpha_1|1\rangle$ and the second in the state $\beta_0|0\rangle + \beta_1|1\rangle$. The joint state of the two qubits is by the tensor product of the two:

$$\alpha_0\beta_0|00\rangle + \alpha_0\beta_1|01\rangle + \alpha_1\beta_0|10\rangle + \alpha_1\beta_1|11\rangle \qquad (5)$$

Entanglement can be hired to establish non - local correlation between the qubits that store the same triangle's vertex area. Suppose the associated vertex qubits {a, b, c} in werner state are stored by our array of qubit. The qubit array's memory status

$$|\Psi 1\text{triangle}\rangle = \otimes_{i=1\ i\neq a,b,c}^{n} |0\rangle_i \otimes \frac{|001\rangle + |100\rangle + |010\rangle}{\sqrt{3}} \qquad (6)$$

Fig. 2: *When placing two particular shapes in a cluster, intertwining (represented by dashed lines) between vertices of similar shape is used to recognize them from each other.*



Input of a second square in the array with corresponding vertex qubits {a,b,c } yields memory status

$$|\Psi 2\text{triangle}\rangle = \otimes_{i=1\ i\neq a,b,c,d,e,f}^{n} |0\rangle_i \otimes |W\rangle_{a,b,c} \otimes |W\rangle_{d,e,f} \qquad - \ (7)$$

We have to retrieve the information, Therefore, which particle is confined to the maximum satellite position the square vertices and which triangle they belong to.

3.2 Storage Retrieval

As soon as a photo records are stored in the qubit array, it is perfect miles to retrieve these records in an effort to reconstruct the photo reliably. Recovery of facts is accomplished with the help of the way measurements are performed on the array. Assume that we store a triangle in the exhibit as the state $|W\rangle_{a,b,c.}$

Information referring to relationships for the picture between one memory vicinity and another can be retrieved from the array with the help of enforcing the operator of the measurement projection.

$$\widehat{M}_{abc} = |00 \ldots 0\rangle |W\rangle_{abc,abc} \langle W| \langle W 00 \ldots 0| \ - \qquad (8)$$

Where $|00 \ldots 0\rangle$ follows up on all qubits not having a place with the Werner State. Since any werner state comprises of a sound superposition of $|000\rangle$ and $|111\rangle$, the qubit exhibit has the type of an intelligible superposition. The qubit cluster has the type of a reasonable superposition

$$|\Psi 1\text{triangle}\rangle = (1/\sqrt{3})(\otimes_{i=1\ i\neq a,b,c}^{n} |0\rangle_i \otimes \frac{|001\rangle + |100\rangle + |010\rangle}{\sqrt{3}} \qquad (9)$$

$$|\Psi 1\text{triangle}\rangle = \frac{1}{\sqrt{3}}\{|\Psi\text{initial}\rangle + \otimes_{i\neq a,b,c}^{n} |0\rangle_i \otimes |111\rangle_{abc}\} \qquad (10)$$

Memory condition of the qubit will comprise of rational superposition of $|\Psi\text{initial}\rangle$ and other memory state. In this way memory states identified with different pictures zone unit non-symmetrical and can't be recognized unambiguously. This recommends exploitation projection administrators can exclusively offer probabilistic outcomes for vertex area and hence the picture can't be steadfastly remade. A set of three qubits within the array is selected for dimension to search for triangles. This tripartite kingdom is then tested for infringement of tripartite states ' Seevinck - Svetlichny inequalities. Violation implies a complete entanglement of three parts. Consequently, non - violation means that the selected 3 qubits do not now form vertices of the same triangle. From these measurements it is clear to conclude the region of the triangle vertices. Presently expect that the 3 qubits chose comprise of qubits abiding inside the indistinguishable Werner state and a third that does never again. At that point the country to be tried is of the shape given in Eq. also, could now not abuse the appropriate imbalances for full tripartite entrapment. For our easy example of two triangles, determinations of the places of all six vertices calls for at ${}^{n}_{3}C.{}^{n-3}_{3}C$ different identically-organized arrays to be examined for two instances of tripartite entanglement among different qubits.

Bell type disparities for N-molecule frameworks have been inferred underneath the conviction of aggregate and fractional distinctness and give us a way of deciding if an immovable of N particles is living in a maximally trapped nation. We have picked the Seevinck– Svetlichny disparities [5][6]for developing our photograph recovery convention, all things considered imbalances have been appeared to be maximally disregarded by utilizing N-molecule Werner states. Exceptionally, a somewhat trapped tripartite state might be composed inside the shape [7]

$$\hat{Q}.^{(123)}=p_r\hat{Q}.^{(12)}\otimes\hat{Q}.^{(3)}+p_s\hat{Q}.^{(13)}\otimes\hat{Q}.^{(2)}+p_r\hat{Q}.^{(23)}\otimes\hat{Q}.^{(1)} \quad (11)$$

Where $\hat{Q}.^{(ij)}$ represent entangled states of two of the subsystem involved. Any state $\hat{Q}.^{(123)}$ that obeys $\hat{Q}.^{(123)} \neq \sum_i pi\,\hat{Q}.^{(i)}$, where all the $\hat{Q}i$ are separable into products of states of less than three parties, is fully entangled. [8]

From this information it is easy to decide the area of the triangle vertices. In alternate for no longer the usage of software program and due to the statistical nature of quantum mechanics several quantum hardware grids ought to be identically organized.

Quantum era discernment may moreover at last turned out to be shoddy enough to allow huge use in over the top impact innovation. Therefor the method of reasoning went with above can be direct utilized for putting away and recovering additional confused polygon of N viewpoints as it would do the trick to utilize N particle[9] Werner nation for putting away every polygon and to utilize the Seevinck– Svetlichny disparities for polygon recovery.

IV. Conclusion

We have built up a novel strategy for capacity and recovery of straightforward parallel pictures in entangled quantum framework utilizing werner state. Our work so far has concerned just paired pictures containing straightforward polygons. We plan to stretch out and sum up our work to dim level pictures of expanded basic multifaceted nature and present this work in a later paper.

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