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# BLOCK-WISE IMAGE COMPRESSION SCHEME IN IMAGE PROCESSING USING DISCRETE COSINE TRANSFORM

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***ABSTRACT***

*A significant amount of interest is being directed toward quantum computing as a result of its quicker processing power in comparison to classical computing. This is because quantum computing can represent and compress classical picture data into the quantum domain. The primary concept behind quantum domain representation is the utilization of quantum bits, also known as Qubits, in order to convert pixel intensities and their coordinates, which is also known as state label preparation. More qubits are required for the production of the state label when the image is of a larger size. A unique SCMNEQR (State Connection Modification unique Enhanced Quantum Representation) technique has been developed in order to overcome more qubits difficulties. This strategy makes use of fewer qubits in order to map the arbitrary size of the grayscale image by utilizing block-wise state label preparation. In the SCMNEQR strategy that has been presented, the state connection is introduced by the utilization of a reset gate. This is in contrast to the previous approach, which again makes use of the Toffoli gate. Within the realm of compression, the results of the experiments demonstrate that the suggested strategy is superior to the approaches that are already in use.*

***Keywords:*** *block wise, image compression, image processing*

## INTRODUCTION

Compressing data is described as the process of encoding the data using a representation that reduces the overall size of the data. This technique is also known as data compression. When the initial dataset has some kind of redundancy, it is possible to achieve this reduction. The method of representing a picture using a less number of bits is referred to as compression. Because of this quality, the data may be stored and sent across the internet more efficiently. Over the course of the last ten years, several facets of digital technology have been created, particularly in the areas of picture collection ,data storage, and bitmap printing compression. When compared to the compressed raw binary data image, which possesses particular statistical qualities, the original image is quite distinct from the compressed version. In the process of compressing images, encoders that have been particularly created for them provide results that are less than ideal when compared to those produced by general-purpose compression algorithms .

Compression of pictures is one of the numerous techniques that fall under the category of image processing. This approach has a wide range of applications and plays a significant part in the efficient transmission and storage of images. The field of digital image compression is concerned with the investigation of various techniques that may be utilized to lessen the overall quantity of bits that are necessary to represent an image while maintaining its quality. Eliminating the many different kinds of duplication that are present in the pixel values is one way to accomplish this goal. The transform coding technique is frequently utilized in the field of picture compression and is garnering an increasing amount of attention on a daily basis . The use of compression can be beneficial in lowering the costs associated with the additional use of transmission bandwidth or storage for pictures of a bigger size. Therefore, based on this, we are able to reconstruct a good approximation of the original image that is in accordance with the aesthetic perception of humans. With the rapid rise of digital image applications, such as desktop publishing, multimedia, teleconferencing, and high definition television, there has been a surge in the number of applications. As a result, there is still a need for picture compression methods that are both efficient and standardized. The discrete cosine transform, which is a close relative of the discrete Fourier transform (DFT), plays a large dominant role in image compression.

The discrete cosine transform is used to separate images into parts of different frequencies during the quantization process, which is where a portion of the compression actually takes place. The less important frequencies are discarded, which is why the term "lossy" is used. The only frequencies that are left are the most important ones, and they are used to retrieve the image during the decompression process. Through the application of DCT, an image space may be mapped into a frequency. The discrete cosine transform (DCT) provides a number of benefits, including the capacity to peak energy at the lower frequency for the image data and the ability to lessen the blocking artifact effect, which is the phenomenon in which the borders between subimages become evident. Decorrelating picture data is what the DCT does. Consequently, as a result of this, every transform coefficient is encoded individually, without compromising the effectiveness of the compression process. Through the use of a technique known as the discrete cosine transform (DCT), a picture may be transformed from the spatial domain to the frequency domain. There is a lossy discrete cosine transformation (DCT) compression approach that we are going to discuss in this study. This technique is for two-dimensional pictures. In the numerous cases, the exploitation of the suggested approach of image compression results the superior performance, when compared with the different forms of lossy compression. In this article, we also offer an approach for the reconstruction of images that mimics compression and makes use of the quantization step size information obtained during the reconstruction process. We are able to make use of the statistical information regarding the quantization thanks to the approach that has been proposed. The framework was developed specifically for the most widely used compression approach, which is based on the discrete cosine transformation (DCT) and involves linear transformation. The DCT-based coding approach that has been developed divides the pictures into tiny square blocks with dimensions of 4x4, 8x8, 16x16, and 32x32. After that, the DCT is produced across these blocks in order to eliminate the local spatial correlation.

The primary objective of these standards is to eliminate the significant connection that exists between neighboring image parts in order to lessen the number of visible blocks they include. After performing the discrete cosine transform (DCT), the quantization procedure is conducted in order to limit the amount of redundant data. Inverse discrete cosine transform (DCT) is used to decode, dequantize, and rebuild the data that has been received at the decoder end. For the purpose of performing an examination of the suggested approach, the Peak to Signal Nose Ratio (PSNR), Mean Square Error (MSE), and Compression Ratio (CR) from grayscale pictures are three key results linked to image quality that are provided by the DCT transformation technique that has been presented. The programming language MATLAB is used to carry out the simulation and implementation of the suggested method.

## IMAGE

When compared to a digital picture, which is a binary representation of visual data, an image is a visual depiction of something more specifically. Photographic pictures, graphics, and individual video frames are all examples of the types of images that may be used. A photograph that has been made or duplicated and saved in electronic format is referred to as an image for the purposes of this discussion.

It is also possible to describe an image using the phrases vector graphics or raster graphics separately. A raster image that is saved in a raster format is frequently referred to as a bitmap. A file that contains information associating various regions on a particular image with hypertext connections is referred to as an image map

Standard digital image file formats include the following.

## JPEG

A graphic picture file that is created in accordance with the Joint Photographic Experts Group standard is referred to as a JPEG file, which is pronounced JAY-peg. The standards for a collection of compression techniques meant for use with computer picture files are developed and maintained by this group of specialists. There is a common extension for JPEG files, which is.jpg.

## GIF

GIF is an abbreviation that stands for Graphics Interchange Format. Some people pronounce it as JIF, including the person who designed it, while others hear it as GIF with a hard G. In addition to being binarily encoded, GIFs make use of a raster data format that is two-dimensional (2D). Generally speaking, the extension.gif is used for GIF files.

## PNG

Image compression is accomplished through the use of the Portable Network Graphics file format, which is pronounced as "ping." This format offers a number of enhancements in comparison to the GIF format. A PNG file, much like a GIF file, is compressed in a lossless way, which means that all of the picture information may be restored when the file is decompressed for viewing after it has been compressed. Generally speaking, the extension.png is used for PNG files.

## SVG

Scalable Vector images, sometimes known as SVG, is a type of vector file that may be used to show drawings, charts, and 2D images on the internet. The creation of pictures in SVG files does not rely on the use of individual pixels, which allows them to be scaled up or down without sacrificing resolution. This indicates that the file may be seen on a computer display of any size and resolution, including the little screen of a smartphone as well as the huge widescreen display of a personal computer. Due to the fact that they are stored in an Extensible Markup Language (XML) format, SVG files make it possible to search for and index them. By utilizing the information that is contained within the SVG file, the picture may be shown by any application, such as a browser, that is capable of recognizing XML. In most cases, the extension.svg is required for SVG files.

**Image processing**

The term "image processing" refers to the process of enhancing a picture via the use of digital technology and carrying out particular processes in order to extract relevant information from it. In the course of implementing certain specified signal processing procedures, image processing systems frequently treat pictures as if they were two-dimensional signals.

Types of image processing include the following:

- pattern recognition to measure various patterns around objects in an image;
- recognition to detect or differentiate objects within an image;
- retrieval to browse or search an extensive image database for an image like the original image;
- sharpening and restoration to create an enhanced image from the original image; and
- visualization to identify objects not visible in an image.

**OBJECTIVE**

1. to study on block wise image compression
2. to study on SCMNEQR Bit rate comparison for Baboons image

**METHOLOGY**

Figure 4 shows the proposed circuit diagram that represents and compresses the grayscale image. The green circle represents the reset gate used to nullify the previous state's effect on the next state's preparation. A 2 nX2 m image size

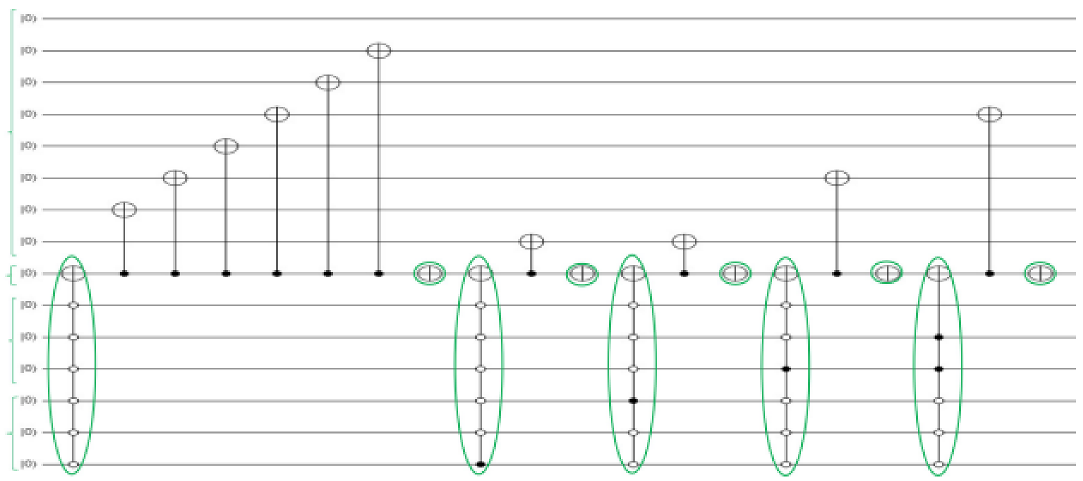

Figure 4: Proposed SCMNEQR circuit diagram.

is within the context of a block-wise quantum picture, it is assumed to represent and compress an image. The rows and columns of each picture are denoted by the variables m and n. There are a number of phases involved in the SCMNEQR methodology. In the first step, DCT and quantization are performed. Preprocessing the pixel or coefficient, which takes q + 2n + 1 qubits, is the second step. At the beginning of the procedure, all of the qubits' values are set to |0i. Where q is the number of qubits that are necessary to map values that are not zero for either the pixel or the coefficient. On the other hand, the position representing qubits for expressing the X and Y location of non-zero pixels or coefficients are denoted by the equations np = log2(Sx) and mp = log2(Sy). The block size of the X-position and Y-position pictures is denoted by Sx and Sy, respectively. It is via the utilization of an auxiliary qubit that the link is established between the pixel or coefficient and the location that represents qubits. It is possible to represent the starting state of qubits using the equation that is written below.

$$|\Psi 0i = |0i \otimes(q+2n+1)$$

Then, (q+ 1) identity gates and 2n Hadamard gates are used for pixels or coefficient preparation and its state preparation respectively, and shown below.

$$I = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$$

$$H = \begin{bmatrix} 1/\sqrt{2} & 1/\sqrt{2} \\ 1/\sqrt{2} & -1/\sqrt{2} \end{bmatrix}$$

In this step, the whole quantum step can be expressed as follows:

$$U = I^{\otimes q+1} \otimes H^{\otimes 2n}$$

The operator U transforms Ψ0 from the initial state to the intermediate state, ψ1.

$$\Psi_1 = U(|\Psi_0\rangle) = (I|0\rangle)^{\otimes q+1} \otimes (H|0\rangle)^{\otimes 2n}$$

The final preparation step is done using the U2 quantum operator:

$$\Psi_2 = U_2(|\Psi_1\rangle) = \frac{1}{2^n} \sum_{i=1} \sum^{j=1} |C_{YX}\rangle |YX\rangle$$

where |CY Xi and Y X are pixels or coefficients and the position of the grayscale image. The quantum transform operator is U2 is given below.

$$U_2 = \prod_{X=0,\ldots,2^n-1} \prod_{Y=0,\ldots,2^n-1} U_{YX}$$

The connection of the Toffoli and reset gate is given below.

$$S_{state} = (log_2(S_X) + log_2(S_Y) + 1 + 1) \otimes N_{tcn}$$

The required bit rate (BR) is calculated using the following equation.

$$BR = q_{ones} + S_{state} + S_{bit} + A_{bit} + B_e$$

The state preparation bit is denoted by the letter Sstate. The frequent number of ones drawn from pixels or coefficients is denoted by the symbol qones. The sign bit, often known as Sbit, is the bit that reflects the sign of the coefficient values or pixel values that are not zero. The sum of all coefficients or pixel elements that are not zero is denoted by the symbol Ntcn. The number of bits that originate from the auxiliary qubits is referred to as an abit as well. Be is the bit rate that is utilized in order to discover mistakes in block position. The third step: In the 16 × 16 quantum block system, it is necessary to recover the non-zero quantized pixel or coefficient values after performing the 8X8 discrete cosine transform (DCT). Calculate the bit rate (BR) while taking into account the location inaccuracy of each block in the meanwhile. In addition, the sign bit, often known as the SB, is taken into consideration in order to take into account the sign of any non-zero pixel or coefficient value.

Step 4: Perform de-quantization.

Step 5: Perform inverse DCT.

Step 6: Measure the quality of the recovery image.

## RESULT AND DISCUSSION

As part of the verification process for the suggested technique, the experimental findings are evaluated in this section for the photographs of Deer (1024×1024), Baboons (512×512), Scenery (512×512), and Peppers (512×512). This section is devoted to the analysis of the photos. For the purpose of demonstrating the effectiveness of the suggested strategy, two tests have been carried out. Both the first and second experiments conduct an analysis of the computational outcome of the suggested system, both directly and indirectly.

Experiment I- result analysis of direct approach

The outcomes of the experiments that were conducted using the SCMNEQR direct technique are analyzed in this department. Figure 5 illustrates the needed bit rate of the proposed SCMNEQR method in comparison to the NCQI, INCQI, and EFRQI techniques for the deer picture. According to the findings of the comparison, the SCMNEQR method that was presented calls for an estimated bit rate of 21 megabytes, which is lower than the bit rates required by NCQI (30 megabytes), INCQI (39 megabytes), and EFRQI (29 megabytes), respectively.

On the other hand, Figure 6 shows the required bit rate of the proposed SCMNEQR approach for Baboon's image

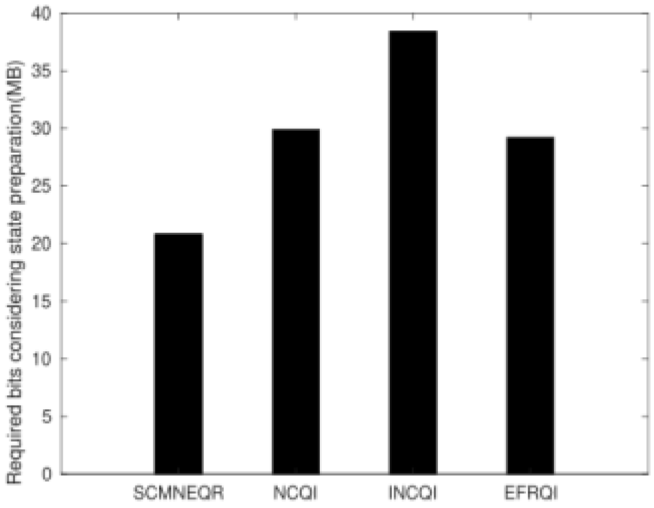


Figure 5: SCMNEQR Bit rate comparison for Deer image

in comparison to the several alternative options that were taken into consideration. It has been determined through comparison that the SCMNEQR technique that has been developed is capable of effectively representing the picture of Baboon since it requires lower bit rates than other approaches. This indicates that it is a representation of the Baboons picture with a circuit of modest complexity. As a result, the number of operating gates that are necessary for the SCMNEQR method is reduced when compared to the NCQI approach, the INCQI approach, and the EFRQI and EFRQI approaches, respectively. The number of bit rates that are required for scenic photographs is illustrated in Figure 7, which also includes a comparison of the outcome with the NCQI, INCQI, and EFRQI techniques. According to the findings of the comparison, the SCMNEQR method necessitates lower bit rates in contrast to several other methods. Regarding the

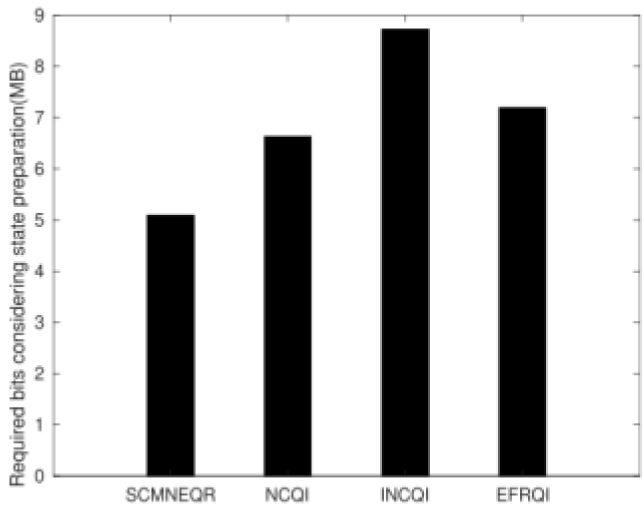


Figure 6: SCMNEQR Bit rate comparison for Baboons image

On the other hand, in contrast to the SCMNEQR technique, the NCQI and EFRQI methods require bit rates that are modest. As shown in Figure 8, the needed number of bit rates for the scenery image is presented, and a comparison is made between the result and the existing

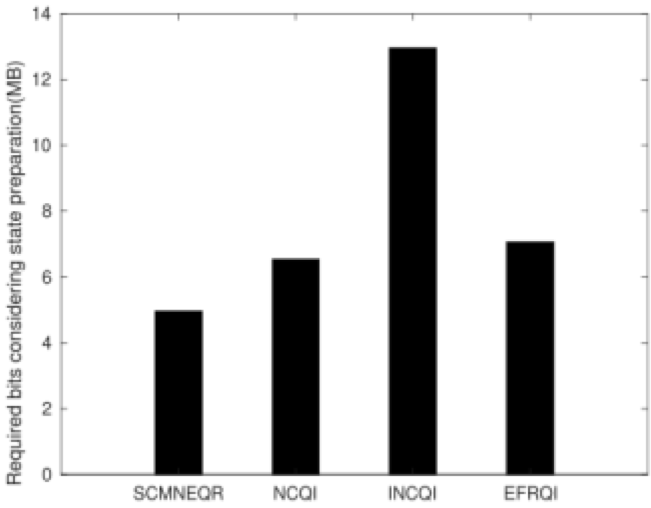


Figure 7: SCMNEQR Bit rate comparison for Scenery image

getting closer. The findings of the comparison show that the SCMNEQR technique is more effective in representing the picture that is contained within the quantum processor when compared to the INCQI, NCQI, and EFRQI approaches, respectively. In light of the fact that the SCMNEQR technique that was presented has an effective design, the result is anticipated.

Experiment II- result analysis of indirect approach

Figure 9 presents the comparative result of the rate-distortion curve (RDC) of the suggested SCMNEQR technique in comparison to the DCT-INCQI, DCT-NCQI, and DCT-EFRQI approaches, respectively. In comparison to previous approaches, the comparative result demonstrates that the SCMNEQR strategy that was suggested achieves a superior result across the board in terms of the quantization factor. In the meanwhile, the DCT-NCQI technique is the only one that draws the exact same number of PSNR values while drawing the same amount of bit rate. On the other hand, in comparison to the SCMNEQR method, the DCT-EFRQI and DCT-INCQI approaches also need for a greater quantity of RDC. Because of

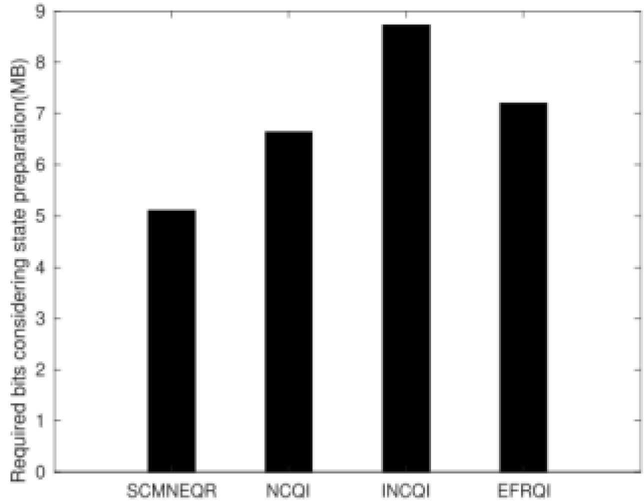


Figure 8: SCMNEQR Bit rate comparison for Pepper image

using this example, The conclusion is that the SCMNEQR scheme that was developed performs far better than what it represents. In Figure 10, the comparative findings of the RDC of the suggested SCMNEQR technique are presented. Additionally, the results are compared with the results of the DCT-INCQI, DCT-NCQI, and DCT-EFRQI approaches for the picture of the bull. The outcome of the comparison demonstrates that the SCMNEQR technique is superior to all of the other ways that were investigated in terms of its ability to effectively represent and compress the gray channel of the Baboon's vision. The fact that the SCMNEQR method requires fewer operating gates than other methods contributes to the fact that it is capable of compressing more data. Although DCT-NCQI displays an adjacent bit rate, DCT-INCQI avoids the SCMNEQR method. This is the only difference between the two. Between the DCT-EFRQI and DCT-INCQI techniques, the DCT-INCQI approach demonstrates superior performance when compared to the DCT-EFRQI approach at the initial quantization factor, which is 8, respectively. In order to achieve QF=16, the DCT-EFRQI requires greater bit rates or operational gates than the DCT-INCQI specification. As a consequence of this situation, a crossover occurred between eight and sixteen quantization factors.

Figure 11 displays the results of the SCMNEQR scheme and its computational application to photographs of landscape. Comparatively speaking, it has been observed that the SCMNEQR technique has a superior capacity to compress the scenery image over the quantization components that are taken into consideration in comparison to all of the other methods. Before QF=16, the DCT-EFRQI technique presents the superior result, and after that, the DCT-INCQI approach performs better than the rest of the quantization factors. This is the case between the DCT-INCQI and DCT-EFRQI approaches. On the other hand, the DCT-NCQI method requires a lower bit rate in comparison to the DCT-INCQI and DCT-EFRQI approaches, but it requires a higher bit rate in comparison to the SCMNEQR approach.

Figure 12 displays the computational result of the SCMNEQR technique in addition to the results of the DCT-INCQI, DCT-NCQI, and DCT-EFRQI approaches. According to the findings, the SCMNEQR technique that was presented performs best when compared to all of the other approaches that were studied. When compared to the SCMNEQR technique, the DCT-NCQI approach offers a more accurate RDC assessment. On the other hand, the DCT-INCQI and DCT-EFRQI techniques respectively exhibit RDC values that are larger than those of the SCMNEQR approach. There is a significant difference in performance between the DCT-INCQI technique and the DCT-INCQI approach when the quantization factor is 8. While the DCT-INCQI strategy requires a lower bit rate, the DCT-EFRQI approach requires a larger bit rate after the quantization factor of 16. As a consequence of this situation, a crossover occurred between eight and sixteen quantization factors. When it comes to the remaining quantization factor, the DCT-INCQI methodology yields superior results when compared to the DCT-EFRQI method.

## CONCLUSION

The purpose of this paper is to describe a unique quantum circuit that may be used for the representation and reduction of grayscale quantum images. To achieve more effective representation and compression, the state connection circuit has been modified to accommodate the enhancement. It is one of the most significant advantages because it utilizes a quantum block that is 16 × 16. In addition, the number of qubits that are necessary for the construction of the state is eight. When adopting the SCMNEQR technique that was described, the grayscale image may be shown in whatever size one desired. In addition to that, it makes use of the reset gate, the auxiliary qubit, and the universal quantum Toffoli gate. One additional benefit of the suggested method is that it does not necessitate the utilization of a look-up table in order to carry out the function. It has been determined that the performance of the suggested method is much superior to that of the approaches that are currently in use.

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