IMPROVING FRACTAL IMAGE COMPRESSION USING TINY BLOCK SIZE PROCESSING ALGORITHM AND QUANTUM SEARCH ALGORITHM

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Abstract - The beginning of Internet era and telecommunication, lead to lot of research in an image compression. The image compression is needed for minimization of storage place and proper transmission of data. Fractal image compression (FIC) is a broadly approved technology due to its potential high compression ratio, fast decompression times and multi resolution properties. But, FIC suffers from high computational cost and time. Several techniques have been developed to speed up the fractal image compression, but reducing the intrinsic computational complexity of FIC is still an open problem. The new approach is proposed in which Grover’s quantum search algorithm (QSA) is used to overcome this complexity and to square-root speedup along with Tiny Block Size (TiBS) algorithm for image compression.

Index terms - Image Compression, Fractal Image Compression (FIC), Grover’s Quantum Search Algorithm (QSA), Tiny Block-Size Processing Algorithm (TiBS).

I. INTRODUCTION

Fractal image compression (FIC) was firstly Started with Michael Barnsley and was refined by A. Jacquin[1]. FIC is the lossy compression technique, based on fractal geometry. Though lossy image compression, results in loss of some information after compression, but it gives more significant reduction in file size than obtained with lossless compression. Therefore, FIC has enjoyed continued development due to its high Compression ratio, very fast decompression and the retrieved image is of good quality [2]. The main reason behind changing images to fractal data is that fractal codes requires less memory to store than the memory required to store the original bitmap image [3].

Fractal image compression is based on blocks, that helps in detecting and coding the existing self-similar parts in the image. The FIC algorithm begins with partitioning the complete image into a number of smaller blocks. If some parts of the image be similar to the other parts of same image, then these self-similar parts are named as fractal and these fractals are used for image compression. FIC algorithms transforms these fractals directly into mathematical records called as “fractal codes” which are used to repeat the encoding process. Fractal encoding is mostly used to convert the image into fractal codes, which are actually resolution independent. In decoding side, reverse process takes place in which a set of fractal codes are converted to image [4]. So FIC is an efficient technique for image storage as well as image transmission.

However, The major inconvenient of the fractal image compression algorithm, is its high computational complexity in searching local self-similarities in natural image. In recent years, many pre-processing tools or approximation methods have been proposed, for speeding up FIC are wavelet transform based FIC (wavelet-FIC)[5], discrete cosine transform based FIC (DCT-FIC)[6], Huber fitting plane based FIC (Huber-FIC)[7], least absolute derivation based FIC (LAD-FIC)[8], least square regression and fitting plane based FIC (LSR-FP-FIC)[9]. Though, existing FIC approaches solve most of the essential problems but the intrinsic computational complexity of FIC is still not reduce.

II. GROVER’S QUANTUM SEARCH ALGORITHM (QSA)

L. Grover [10]-[12] opportunely invented Grover’s quantum search algorithm (QSA), in order to reduce the computational complexity. QSA is based on quantum mechanics which is able to attain square-root speedup over existing algorithms. This method is successful in searching local self-similarities with surety in only attempts by the handling quantum bits. C. Zalka [13] proved that Grover’s QSA is precisely most favourite in search problems. When this Grover’s QSA is applied to FIC, will severely reduce the time complexity of FIC and also maintain the retrieved images quality without sacrificing compression ratio [14].

![Fig. 1. A brief illustration of the QAFIC](image-url)
The three key steps of Quantum Search Algorithm based Fractal Image Compression (QAFIC) are partition and transformation, quantum representation of classical image and search optimal fractal code with Grover’s QSA. In Partitioning and transformation the image is first partitioned into a number of overlapping domain blocks and number of non-overlapping range blocks. Range block are usually four times smaller than the domain block [15]. All domain blocks are contracted into the same size with range blocks by a spatial contraction. Then isometry operations are applied to all domain blocks to get better quality of retrieved images. Finally, to adjust its contrast and brightness an affine transformation is performed on each domain block.

The computational complexity of quantum representation is several orders of magnitude smaller than the value of the computational complexity of searching self-similarities. To represent all of the domain blocks and range blocks as quantum states, there is need to execute quantum bits. Grover’s QSA is used to search the most similar domain block for each range block under the criterion of minimum matching error. Therefore, while calculating the computational complexity of the complete algorithm, it is possible to avoid the computational complexity of quantum representation.

Grover’s QSA searches the best matching domain block for each range block and parameters required to retrieve that range are stored. Thus recording parameters of this searching gives the compression result which consist of optimal affine scalar parameters, serial number of the best matching domain block, and serial number of the isometric operations. In decoder side, number of repetitive operations is performed in order to recover the original image.

III. TINY BLOCK SIZE PROCESSING ALGORITHM (TiBS)

Tiny block-size processing algorithm (TiBS) is used for energy-efficient image compression and communication in wireless networks [16]. TiBS is a lossy compression with very low complexity. The TiBs encoder does not use DCT or DWT, since DCT or DWT is computationally complex. This algorithm operates on blocks of 2x2 pixels in which each block is encoded independently, based on three stages: uniform scalar quantization, self-adaptive pixel removal, and variable-length coding [17]. In this technique, the self-adaptive pixel removal part is more important than the quantization stage. Suppose quantization stage is not used then it will give better quality of image instead of giving energy savings.

Firstly, TiBS algorithm separate the image into 8 bit-planes, then divides the color plane into non-overlapping 2x2 blocks of pixels. If a scalar quantizer is applied to a block first, then higher compression ratios can be obtain. Quantization here acts as a rounding off of the input values to decrease the number of distinct output values to a smaller set. In SAPR method, for each block of 2×2 pixels only one pixel out of four pixels is removed. This method removes that pixel which induces the smallest block distortion between original and decompressed image and its place is inserted into the LSBs of the three remaining pixels. Finally, the spatial correlation among the remaining pixels is saved, so as to search the missing pixels at the decoder side. TiBS will enhance the compression ratio of Fractal images and also reduce the effects which might occur due to the lossy nature of normal Fractal Image Compression (FIC).

IV. PROPOSED METHODOLOGY

In the proposed method TiBS is combined with QAFIC in order to enhance the compression ratio with low losses in the image.

The input image ‘X’ is given to TiBS encoder for image compression with less distortion. The output of TiBS encoder is given to quantum accelerated Fractal Image encoder to reduce intrinsic computational complexity and to maintain the quality of retrieved
images. At output will get the compressed stream ‘Y’. The compressed stream ‘Y’ given as a input to Quantum accelerated Fractal image decoder and its output given to TiBS decoder for decompression. The decompressed Output image ‘Z’ is performance evaluated with Input image ‘X’ by determining compression ratio, Peak Signal to Noise Ratio(PSNR), Minimum mean square error(MMSE) and Time.

RESULTS AND CONCLUSION

![Original Image](image1)

(a) input image

![Decompressed Image](image2)

(b) Decompressed image using QSA

![Decompressed Image](image3)

(c) Decompressed image using QSA+ TiBS

Table 1: Comparative Results Based on Compression ratio, time, PSNR, MMSE

<table>
<thead>
<tr>
<th>Technique</th>
<th>Compression Ratio</th>
<th>Encoding Time(s)</th>
<th>Decoding Time(s)</th>
<th>PSNR (dB)</th>
<th>MMSE (dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>QSA</td>
<td>69.958</td>
<td>9.670</td>
<td>0.338221</td>
<td>50.6908</td>
<td>0.1149</td>
</tr>
<tr>
<td>QSA+TiBS</td>
<td>81.3623</td>
<td>9.6308</td>
<td>0.398729</td>
<td>59.8358</td>
<td>0.0661</td>
</tr>
</tbody>
</table>

Table 1 shows the result of QSA algorithm and combination of TiBS and QSA with respect to compression ratio, PSNR, MMSE and time required for compression and decompression. The use of QSA along with TiBS algorithm is found to improve compression ratio, PSNR and MMSE greatly with slender improvement in time. The combination of TiBS and QSA gives better results than the individual QSA. The method can be modified for video compression.

REFERENCES


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Improving Fractal Image Compression using Tiny Block Size Processing Algorithm and Quantum Search Algorithm

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