

# Technique for Detecting Memory Errors in JPEG2000 Standard

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**ABSTRACT**— the fast growth of image compression has greatly elevated to diminish memory size without lowering the quality of an image. This paper imparts adaptive memory compensation errors in JPEG2000. Furthermore, we use algorithmic techniques such as Discrete Wavelet Transform to satisfy memory consumption and propose Huffman coding, MQ-Coding for adjusting the memory errors. The Huffman coder can be used to shrink and store large amount of input in a memory. These techniques do not wish any additional memory can minimize the memory requisite having the less computation complexity with larger size and power consumption. The proposed architecture is to use Set Partitioning in Hierarchical Trees in extension with Discrete Wavelet Transform. It is used to increase the image condition as well as the compression rates. By this method, memory errors can be eliminated. The image quality can be increased. It decreases the coefficient value and increases the quality of the image.

**KEYWORDS**—Adaptive Error Control Coding, JPEG, JPEG2000, MQ-CODER, SPIHT

## I. INTRODUCTION

The most widely used image compression standards in compensating memory errors are JPEG and JPEG2000. JPEG has hardly lesser compression performance than JPEG2000 [1]. JPEG is based on DCT and JPEG2000 is based on DWT. In JPEG2000, each sub-band is spitted into rectangular blocks, called code-blocks. DWT affords less computational complexity in comparison with DCT [2]. JPEG2000 surpasses JPEG in terms of compression ratio. JPEG2000 algorithm presents excellent results,

better image quality in connection with JPEG [3]. Set partitioning in hierarchical trees (SPHIT) is also most widely used compression algorithm. It can also be united with DCT and DWT for good compression efficiency. It gives better image quality [4]. Block truncation coding (BTC) algorithm were also used for color image compression which administers good image quality but cannot reduce memory errors [5]. Hence, JPEG2000 will be sufficient to operate SRAM beneath low-power mode which is a DWT based image compression technique can also compensate memory errors [6]. An effective way of decreasing memory power is voltage scaling. About 35% powers retaining is possible in the subsequent JPEG2000 when memory achieves at Scaled voltages [7]. This paper presents technique about error control coding schemes such as adaptive error control coding, single error correction double error detection (SECDED). Random errors and burst errors are replaced by these codes. These proposals are most suitable for SRAM [8]. For immense performance JPEG2000 architecture, a QCB (quad code block) based DWT method is recommended to accomplish high parallelism in the JPEG2000 for compressing the memory size [9]. In JPEG2000, if we precede still images like pictures, Huffman encoding is comfortable. But if we enforce the JPEG2000 for video transmission, Huffman-encoder is not acceptable because videos are transmitted at frames/sec. So if the clock frequency is steep, then the dynamic images can be handled. For this case, JPEG based on entropy coder will be long enough [1]. For JPEG2000 architecture, it uses an economical 2-D DWT that is capable of enumerating four coefficients per clock cycle [10]. Memory is the main part to store large number of images and videos.

In JPEG2000, the most powerful block is Huffman coder which alone consumes about 70% of the long-term processing time for compression of image to lower memory failures. These approaches do not require any additional memory, have less circuit overhead, eliminates the power with only a small shrinking in image quality. Because of this, the comprehensive memory requirements can be reduced to only 8.5% as compared with conventional architecture.

II. RELATED WORK

A. SRAM failure Analysis

In this paper, we evaluate SRAM failures generated by voltage scaling. The voltage scaling is an impressive way of eliminating memory power. In JPEG2000 about 25% to 35% power retaining is possible when the memory works at scaled voltages [7]. But voltage scaling precedes SRAM memory failures specifically in scaled technologies. SRAM failure rate is overwhelmed by threshold voltage (Vt). SRAM failures include [13]:

1. Read stability failure (arises during a read access, when current flows from the pre charged bit line).
2. Read latency failure (occurs during a read access, when the cell declines to pull down one of the bit lines).
3. Write latency failure (appears during a write access, when the high voltage storage node cannot be dragged below the trip point).
4. Minimum hold voltage (develops during the time when SRAM cell is not achieved).

The JPEG2000 can attain at low voltages. It is used to store more documents. It has high compression ratio but attempts memory losses due to low voltage operation. The three main factors that devote overall SRAM failure rates [14]:

- i) Read upset - occurs during read cycles because of irregular voltage sharing at the read node.
- ii) Write access - occurs due to high drop or increase in the read and write current.
- iii) Read access - occurs when the scaled voltage is dropped drastically.

To satisfy memory errors we use algorithmic distinct techniques such as DCT, IDCT in JPEG and DWT, IDWT in JPEG2000 [6]. But JPEG2000 is effective in balancing memory errors.

B. JPEG2000

JPEG2000 is the current still image compression standard advanced by ISO/IEC JTC. Some of the important features of JPEG2000 include: numerous resolution illustration, region of interest coding. JPEG2000 has a much larger algorithmic complexity. In JPEG2000, the main process is encoding. During the process of encoding, an image is divided into data matrices [11]. In JPEG2000, DWT is a sub band transform which converts images from the spatial domain to the frequency domain [15]. The 2-D DWT disintegrates a tile into LL, LH, HL and HH sub bands. Then LL band

can be further, decomposed into upcoming resolution in a bipartite fashion [9]. Four-level DWT decomposition, which outcomes in 13 sub bands has shown in Fig.1. [10] The JPEG2000 is mainly used to compress more data with the help of Discrete Wavelet Transform without affecting the quality of an image. The Set Partitioning in Hierarchical Trees can also be used in addition with DWT.

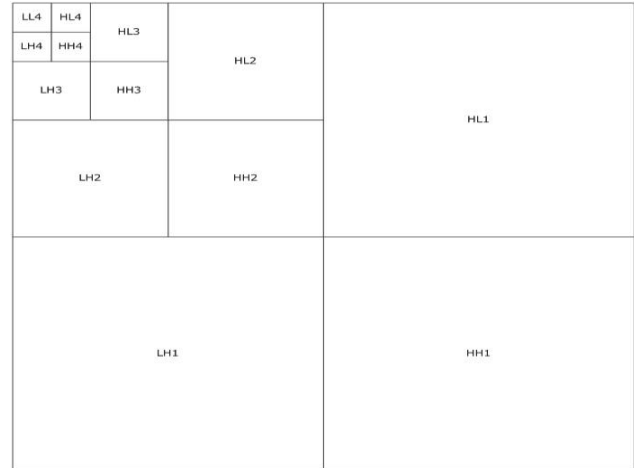


Fig. 1 Four-level DWT decomposition of image

The process called quantization in which the sub band samples caused by the DWT are diagrammed onto the quantization basis for coding [11]. Generally, it is used to transmit in terms of coefficient values. In JPEG2000, the Huffman coder is the main block which encompasses a larger computation time. In order to neglect computation time Tier-1 size is greatly lowered which uses context-based arithmetic coding to encode per code block into independent bit-stream [5]. The Huffman algorithm utilizes a wavelet transform to accomplish the sub band patterns which are to be quantized. It uses Post-compression rate distortion optimization (PCRD-opt) algorithm for reducing memory errors in JPEG2000. The basic principle of Huffman coder is: when coding, it collects a set of quantization coefficients together within the code block. To develop embedding, a fractional bit-plane coding method is used. Huffman coding, which is convenient for scalability and for efficient rate control, is literally one of the main features of JPEG2000. Under this fractional coding method, one bit Plane is further decayed into three passes in accordance with coefficient's significant positions. While browsing from the top bit plane, all-zero bit planes are skimmed. Huffman encodes each of the bit-plane into any of the three coding passes. The three coding passes are significant propagation pass, magnitude refinement pass and clean up pass. Each bit of the code-block is promoted by one of these three passes, it transmits data to MQ-pair to encode the bit has shown in Fig.2.

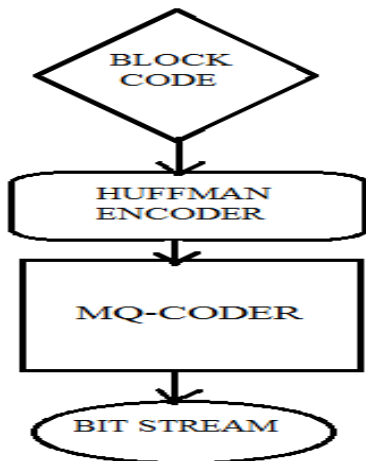


Fig. 2 Information flowing between Huffman Coder and MQ-Coder

The adaptive binary arithmetic coder formerly called as MQ-CODER is used in JPEG2000 standard. The MQ-CODER employs a probability model for its encoding mechanism. This model has been carried out as a finite state machine (FSM) of 47 states. It consists of the following algorithms: [11]

- i) CODEMPS algorithm (if the most probable symbol has involved, the CODEMPS algorithm is performed).
  - ii) CODELPS algorithm (if the least probable symbol has involved, the CODELPS algorithm is performed).
- Another most significant block is the rate control. Rate control is answerable for developing layer bit-rate targets. This can be done by two processes:
- i) The preference of the quantized step size.
  - ii) The choice of subset of coding to incorporate the code stream.

C. JPEG

The most widely used image compression standard in today’s world is JPEG. It has lower compression performance than JPEG2000 but has large PSNR value than JPEG2000 [3]. Because of simple architecture and ease of simple performance, it is still very attractive. SRAM errors can be compensated in JPEG implementation. An algorithmic technique such as 2D-DCT is used to check SRAM errors generated by voltage scaling. The three main features include the following[1]:

- i) The number of sign expansion bits is resolved in the quantization step.
- ii) Two neighboring AC coefficients after diagonal scan have comparable values.
- iii) Coefficients parallel to larger frequencies have lesser values.

The JPEG based image compression boosts PSNR (peak signal to noise ratio) execution but scale down less SRAM errors as compared with JPEG2000 [14]. This is extensively used compression standard in today’s era. In JPEG, the buffer operates as a memory for data storage. The block diagram has shown in Fig.3.

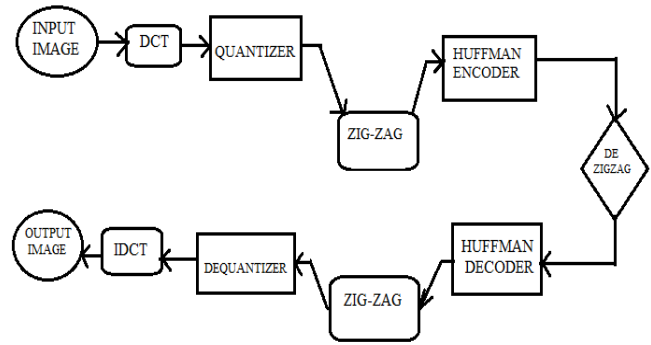


Fig. 3 Block diagram of JPEG

In general, DC coefficient which is concealed in differential order by decreasing the DC coefficient of the preceding block and concealing the divergence using the Huffman table in JPEG; the rest of the AC coefficients are encoded using other Huffman table. During the process of Quantization, every coefficient in the 8\*8 DCT matrixes is divided by the corresponding quantization value [6]. Zigzag scanning is used to regulate the 8\*8 quantized coefficients into one spatial vector in which low frequency coefficients are placed forward to high frequency coefficients [1]. The lossy coding method is JPEG which results in some loss of particulars and inaccessible distortion [6]. It has large PSNR value but reduced compression ratio than JPEG2000.

D. Adaptive ECC

Here we use adaptive single error correction and double error detection schemes where the stronger codes can be borrowed from weaker but longer codes. We use three different SECDED codes: (72, 64), (39, 32) and (22, 16). Amidst all these, (22, 16) is the strongest code with an area expansion of 37.5% followed by (39, 32) with the area extension of 21.9% and (22, 16) with an area increase of 12.5% [14]. The main condition of these codes is that the parity generator matrix of the shorter code (stronger) can be taken out from the parity generator matrix of the longer code (weaker). This can be employed to develop the hardware that can be shared for the multiple codes. The parity generator matrix of (72, 64) with (39, 32) code is of 8 rows (approximately equal to the number of parity bits). The first half of code (column 1 to 32) omitting the seventh row can be used to develop the parity Matrix of (39, 32) code since the seventh row subsists of all zeros [14].

These adaptive error control coding schemes offers the little circuit overhead and no further data storage is desired for these codes. Similarly, the parity matrix of (22, 16) can be borrowed from the matrix of (39, 32) code by getting into an account the first 16 columns and descending the all zero row. Error correction code (ECC) techniques have been used to promote memory reliability. Especially, the Hamming codes and odd-weight column codes in the section of single error correction and double

error detection (SEC-DED) codes are commonly used [8]. The overall bits computation is neglected by check bit pre-computation at the time of write operation of memory despite employing the error locator and double error detection code, which corresponds with those of extended Hamming code.

E. SPIHT

Set Partitioning in Hierarchical Trees (SPIHT) is an advanced version of EZW. Here DWT and SPIHT Algorithm along with Huffman encoder are used for more compression and to get increased image quality. In this method, more (wide-sense) zero trees are conveniently found and illustrated by partitioning the tree root from the tree, so, making compression more valuable. SPIHT does not follow a special method to satisfy with it [16]. An actual algorithm used by SPIHT is based on the recognition that there is really no need to figure out all the coefficients. The main task of the sorting passes in each of the iteration is to prefer the coefficient value. This is the significant part of the algorithm used by SPIHT. Image data through the wavelet decomposition, the coefficient of the distribution is alternated into a tree. In this, each coefficient has sub bands namely LH1, HL1 and HH1. The set of coordinates of coefficients is used to perform set partitioning method in SPIHT algorithm as shown in Fig.4. The Set Partitioning in Hierarchical Trees is mainly used to increase the compression ratio and also used to improve the quality of the image.

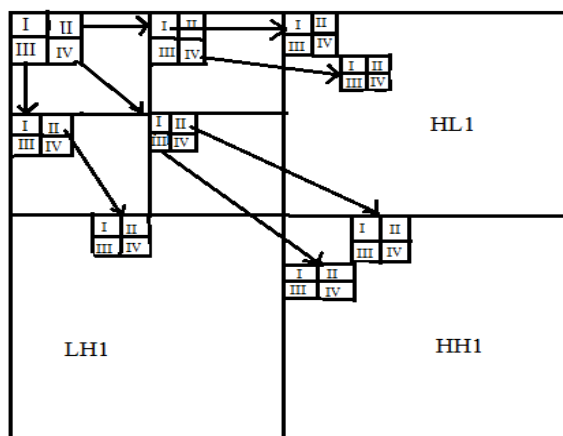


Fig. 4 Spatial Orientation Trees in SPIHT

III. RESULTS AND DISCUSSION

In the following results we analyze the operation of Discrete Wavelet Transform. By using this transform, large amount of data can be compressed with a small reduction in image quality. The original image is shown in Fig.1. Furthermore, the original image is partitioned into sub bands.



Fig 1.Original Image

Now the original image is partitioned into four blocks. It is having Approximate detail, Horizontal detail, Vertical detail and Diagonal detail. It is shown in Fig.2.

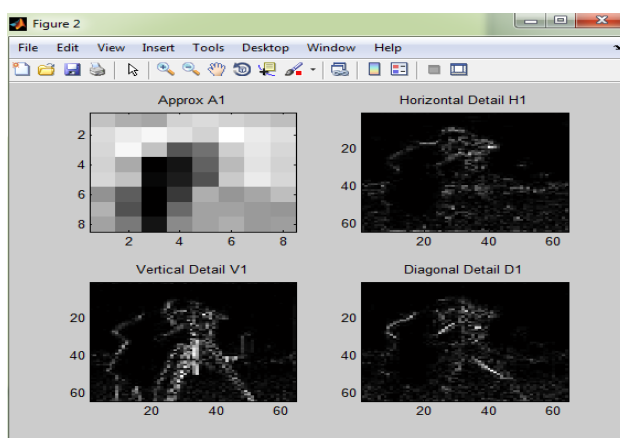


Fig 2.Four-Level DWT

After the DWT compression, the image is divided into 13 sub bands. In this low frequency bands are having large amount of information as compared with other sub bands. Mainly, it is used to compress the image with a small reduction in image quality. It is shown in Fig.3.

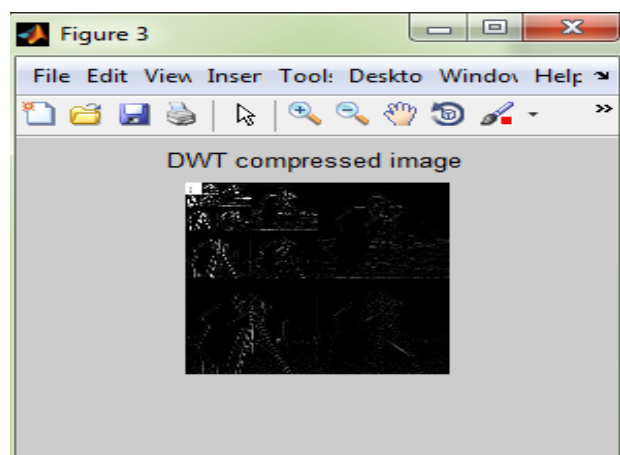


Fig 3.Image after DWT Compression

When the compression is over, the Square Error Image

is calculated. By finding this, the quality value of an image is known. It is shown in Fig.4. From the figure, we can find that the quality value of an image is 100. Hence, there is no Squared Error Image.

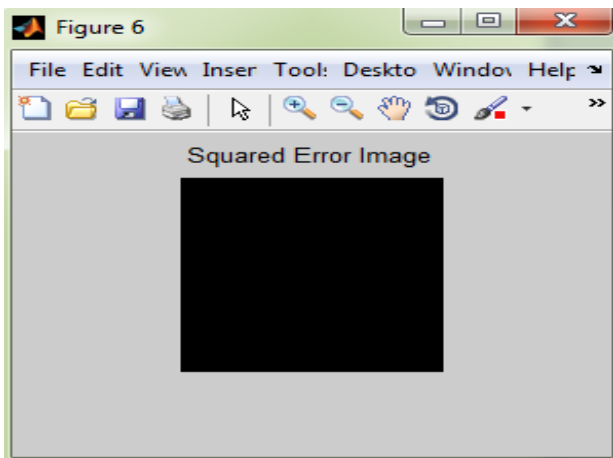


Fig 4.Squared Error Image

After finding the quality value of an image, the graph of compressed image should be known. By plotting the graph of an original image, it is easy to find the compressed value of an image. It is shown in Fig.5.

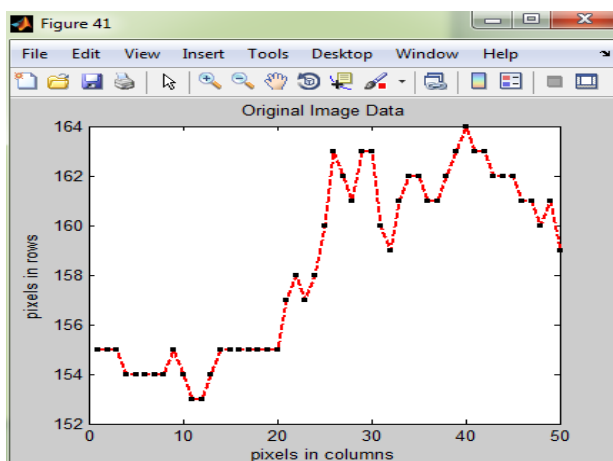


Fig 5.Graph of Original Image

Now the graph of an original image is known. But to store more data we have to compress the image. Hence the graph of the compressed image has to be plotted. It is shown in the following figure. DWT is mainly used to compress more data without affecting the quality of an image. Hence it is shown in Fig.6.

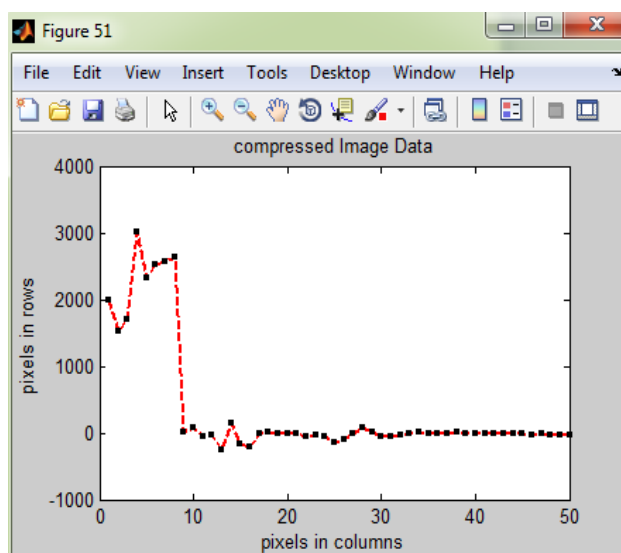


Fig 6.Graph of Compressed Image

To improve the quality of an image, we have to use SPIHT technique. By this, the compression rate and image quality can be increased. It is shown in Fig.7. In this we can find quality percentage in terms of BPP.

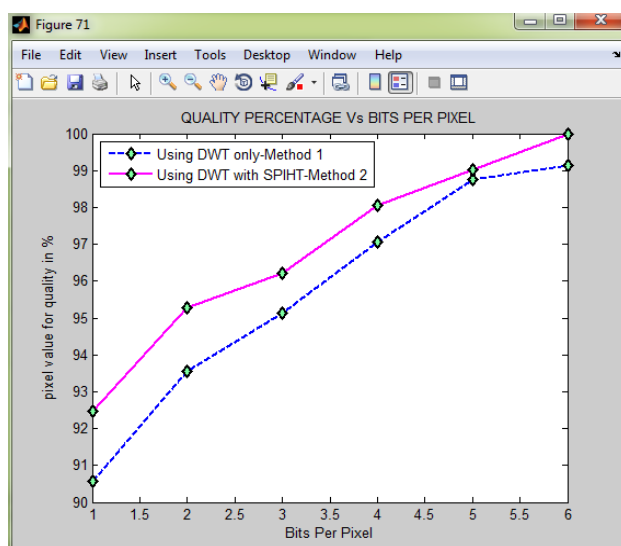


Fig 7.Performance Comparison

After calculating the quality value, compression ratio has to be measured. The compression value is approximately 94. It is shown in Fig.8.

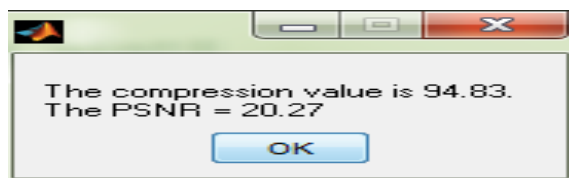


Fig 8.Compression Value and PSNR

Now the compression ratio and bits per pixel has to be measured. The graph is shown in Fig. 9 of the following

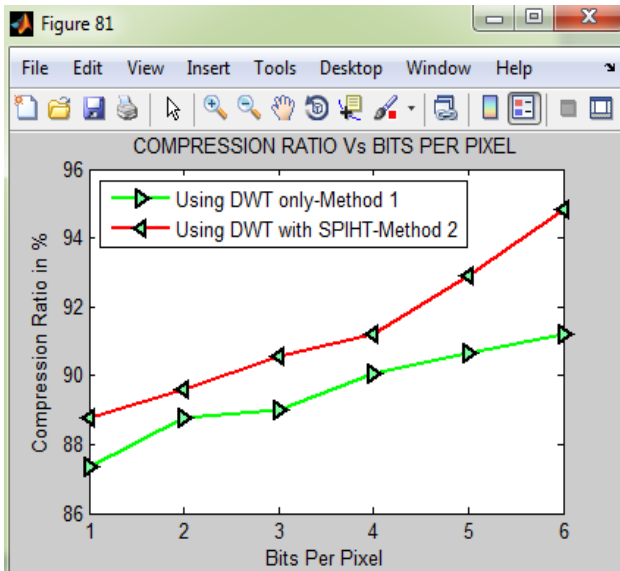


Fig 9.Compression Ratio vs. Bits per Pixel

For improving the compression ratio, we have to find PSNR value of an image. From the graph, the PSNR value is approximately 20. It is shown in Fig. 10.

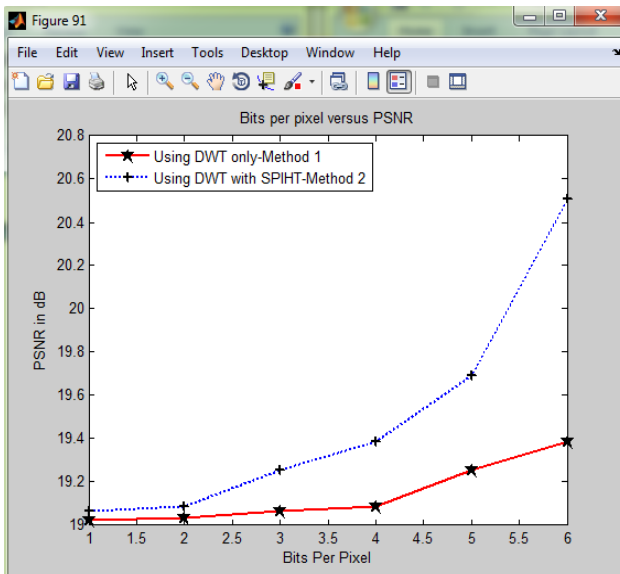


Fig 10.BPP vs. PSNR

#### IV. CONCLUSIONS

In this paper, we granted different compression schemes such as DCT in JPEG and DWT in JPEG2000 for detecting memory errors. JPEG2000 is widely used as it surpasses JPEG. We also used Adaptive error control coding algorithm to reduce memory failures generated by aggressive voltage scaling. Huffman coding is used to shrink more data. Even though compression is succeeded by the usage of DWT, it has less amount of reduction in image quality. Because in JPEG2000, there is some loss in quality of image. So SPIHT compression method can be used to boost the quality of the image in addition with

DWT which provides; high image quality and better compression ratio.

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