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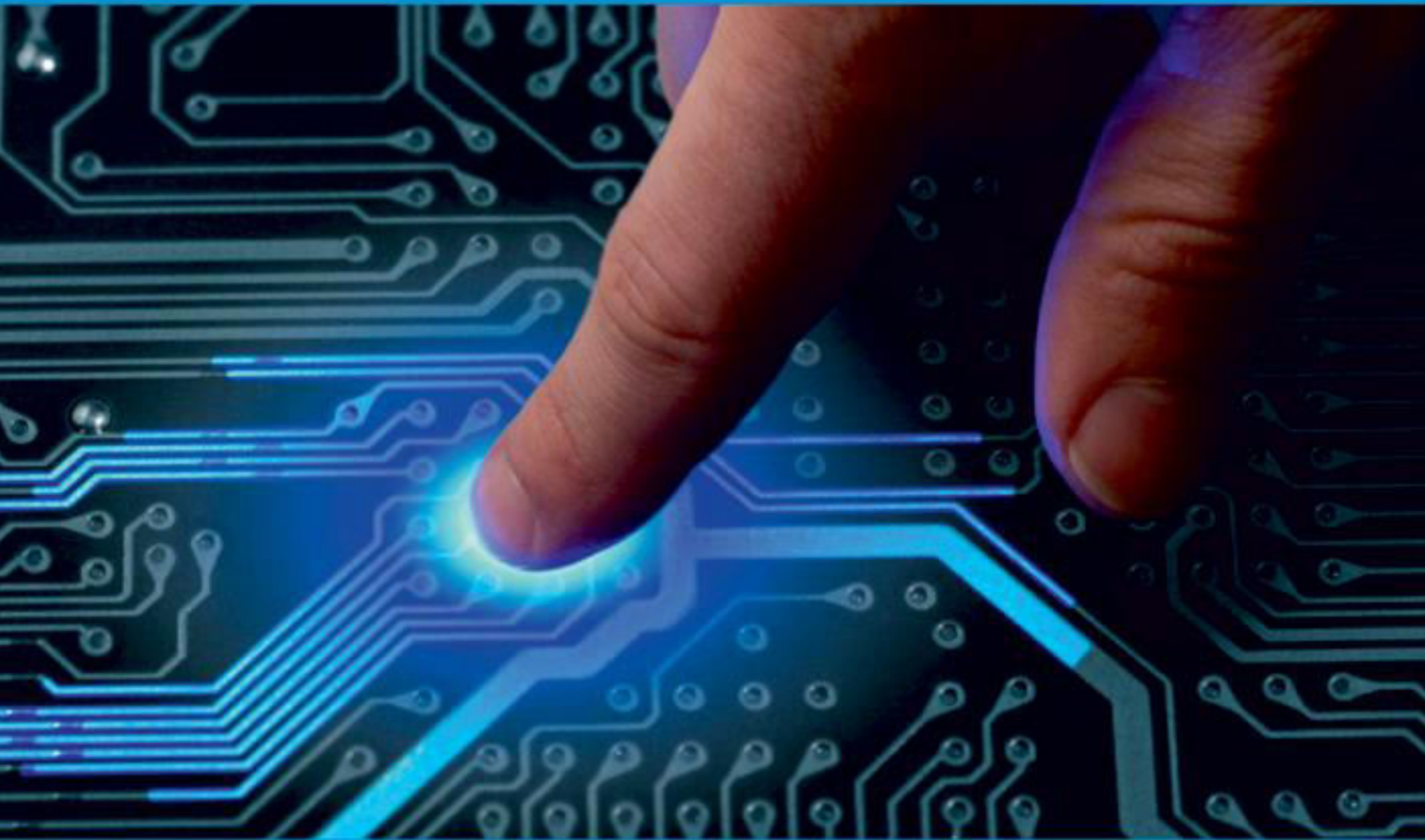

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Improved Lossless CFA Image Compression Based on Modified Golomb Rice Coding for Wireless Capsule Endoscopy

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ABSTRACT: This research aims to make a VLSI circuit that uses a hardware-oriented lossless colour filter array (CFA) picture compression method. A unique lossless CFA image compression technique based on JPEG-LS is suggested for good performance, low complexity, and low memory needs for VLSI implementation. A previous study found that a JPEG-LS encoder uses a context table that takes up more than 81 per cent of the available space on the chip. The suggested algorithm by JPEG-LS uses an image compression method that doesn't use the context technique or its memory. This keeps the chip size small while still giving an excellent performance.

KEYWORDS: VLSI, Color Filter Array, Low Complexity, High performance

I. INTRODUCTION

Recently, wireless capsule endoscopy offers a comfortable and effective way to identify digestive system illnesses. Because the capsule endoscope is ingested, wireless signal size and frequency are limited. Capsule endoscopy needs a lot of energy to transmit images of the digestive tract wirelessly. Due to size and energy restrictions, wireless capsule endoscopy requires a low-complexity, low-memory, low-power solution. Wireless capsule endoscopy uses lossless picture compression to save energy and space. CCD and CMOS image sensors use colour-filter-array (CFA) formats, where each pixel carries only one colour Red (R), Green (G), or Blue (B) (B). CFA photos have one-third of the data of RGB images, so they compress better. The Bayer CFA is commonly used in CMOS image sensors, so it will be used to build the lossless CFA image compression technique.

FPGAs are reprogrammable power systems. System memory capacity and access bandwidth determine the functioning and configuration speed of FPGAs. Bitstream compression reduces bitstream size, relieving memory restrictions. Bitstreams compressed in memory hold more configuration data. Using fewer bits reduces memory access time. C.R. measures bit stream compression. bitstream compression ratio. Digital technologies like digital T.V., internet access, big data storage, and video calls require significant storage and transmission capacity [1]. Data compression uses fewer bits. Significant file compression reduces storage and transmission expenses. File compression eliminates redundancy. Video transmission with a reasonable data loss can be done using lossy compression. Bank datasets need lossless compression. It's been studied for 50 years. Golomb coding is lossless data compression. It can compress extensive data while allowing decompression. Golomb codes reduce complexity and computational load.

II. RELATED WORK

In [2] BTC, fuzzy choice, digital half-toning, and block division compress images. Variable-block-size partitioning boosts image quality and compression. Huffman packs 8 parts. Low-cost, low-power BTC modules power wireless sensor networks. Golomb-Rice and prediction condense level data. Proposed 0.18-m CMOS VLSI. Massive 6,400-gate, 60,000-m2 core. 100MHz/3.11mW. Compared to JPEG, JPEG-LS, and fixed-size BTC, this study lowered gate counts by 20.9%.

In [3] Compression and size reduction reduce memory usage, bandwidth, and internet nodes. Image compression uses algorithms. FPGAs and other dedicated processors speed up deployable device circuits and algorithms. This paper discusses the hardware and software implementation of stereoscopic photo compression using least significant bit of watermarking for embedded processors and Internet-connected devices. In [4] Lossless, low-latency, low-power ECG

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compression reduces data, avoids wireless transmission, and extends battery life. Run-length Coding compresses ECG signals by using signal distribution and heartbeat correlation. FPGA and the MIT/BIH ECG database validated the hardware. In [5] Lossless, low-latency, low-power ECG compression improves battery life. We propose a run-length coding technique for lossless ECG compression using duplicate data encoding and heartbeat correlation. FPGA and the MIT/BIH ECG database were used to validate the design.

In [6] A CCSDS-compliant DWT module. The system allows satellite-based variable-width push-broom image scanning. DWT uses 9/7 filters and float/integer transforms. An 88.51MHz FPGA contains a DWT hardware accelerator. 10,000 lines per sec. Telematics is designed. Hardware/software co-verification checks design. 8 test images compressed at 8:1 average, 48dB PSNR. In [7] this study describes capsule compression. It simplifies endoscopic YUV colour space. Encoder, RGB-YUV, DPCM. DPCM doesn't need extra buffer memory to store one image row, and the Golomb-Rice algorithm is simple and hardware-implementable. The lossless compression is 68.1%.

In [8] YCgCo-based capsule endoscopy image compression is described. Energy compression and endoscopic images are used. The compression algorithm produces high-quality images (52dB PSNR) (over 80 percent). Simple quantization and an integer-based forward transform are used. perfect for power-limited capsule endoscopes. In [9] Capsule endoscopy, noninvasive. Endoscopy capsule hardware and batteries fail. Endoscopic image reduction reduces power and bandwidth. DCT-capsule endoscopy is described. Endoscopic films and images were analyzed. Adders and shifts convert YEF lossless. Quantization boosts compression. Transform-coding provides 85% compression and 52 dB PSNR. In [10] Wireless capsule endoscopy uses YLMN, a raster-order prediction model, and a context-adaptive Golomb-Rice encoder. First, reversible colour change is proposed. Each colour component is independently encoded using a raster-order prediction model and a Golomb-Rice encoder. TSMC's 65-nm CMOS decreases gate count and memory by 71%..

III. METHODOLOGY

Compression reduces communication and storage costs. It encodes source message data. Compressed bit streams use less memory for configuration data. Using fewer bits reduces memory access time. Bitstream compression measures efficiency (C.R.). Comp When lossy compression isn't allowed or we don't know, we use lossless image compression. Lossless techniques are vital for transmitting and preserving medical data because lossy compression of diagnostic medical images is illegal, and medical image size and number are rising rapidly. Some picture compression advances aren't enough. Apps need good visuals.

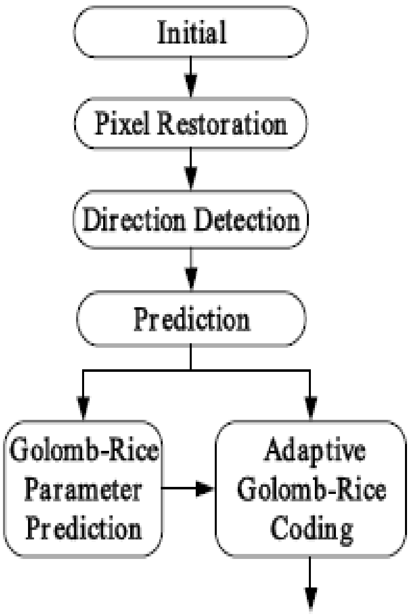

Fig.1.Flowchart of the proposed lossless CFA image compression algorithm

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Validation should focus on compression efficiency versus image quality. Existing image compression techniques prioritize efficiency over quality. Thus, we proposed lossless image compression using Golomb-Rice Coding. We retain the compression ratio for higher visual quality in reconstruction and peak signal-to-noise ratios (PSNR). We analyzed medical and natural photos to improve image quality. The Golomb-Rice (G.R.) family of codes is an infinite family of prefix codes suitable for storing exponential probability symbols. Since its symbol distribution for normal photographs is exponential, the G.R. family is used in predictive lossless image compression algorithms. The JPEG-LS method makes use of the modified G.R. family's restricted code word length. In this work, we assess G.R. and limited codeword length G.R. codes for recording actual images when the number of encoded symbols is finite and the probability distribution is not exponential.

m explains the Golomb Coding code structure. The value of m defines the variable-length coding scheme, which influences the compression efficiency. Once m is established, a database is created to map zero runs to ones. Figure 1 depicts the run length measurement. Multiples of m are classified as Ak and given the same prefix: (k – 1) one followed by zero. Each member of the group has a binary representation of zero to one (m – 1). The prefix and suffix make up the codeword.Decompression hardware complexity determines if a promising technique can be implemented on commercial FPGAs. Our investigation shows decompression algorithm complexity is not a hardware determinant. Variable-length Coding increases hardware complexity due to costly buffering circuitry. Rice-Golomb encodes the remaining code using truncated binary (other varying-length binary encodings, like arithmetic or Huffman encodings, are possible for the remainder codes, if the statistical distribution of remainder codes is not flat, and notably when not all possible remainders after the division are used). Using Rice encoding, if M is a power is 2.

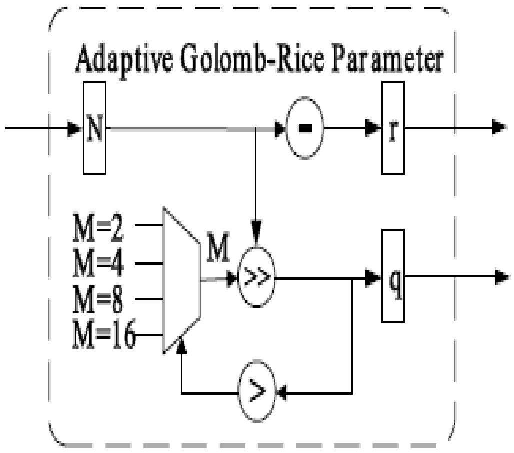

Fig.2.Architecture diagram for proposed method

IV. PSEUDO CODE

Expanding The Golomb-Rice family Rice rediscovered S.W. Golomb's 1966 family. G.R. codes encode symbols from a probabilistic alphabet (for some parameters of the exponential distribution). G.R. codes aren't optimal for a finite alphabet. k is the rank of every G.R. code. First, we encode the codeword prefix using rank k G.R. Table 2 has a non-codeword separator between the prefix and suffix. We shift I right k bits and use I's k least significant bits as the codeword. JPEG-LS and FELICS use exponential probability distributions for symbol sequences. We select a code from the family for a specific symbol and output a codeword assigned to this symbol in the selected code.

4.1 The Golomb encoder

1. k ←⌈log2(m)⌉.
2. r ← smodm.
3. t ← 2k − m.
4. Output (sdivm) using an unary code.
5. If r < t:
    a. Using a binary code, output the integer encoded in the k − 1 least significant bits of r .
6. Else:
    a. r ← r + t.

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b. Using a binary code, output the integer encoded in the k least significant bits of r .

4.2 The Golomb decoder

1. k ←⌈log2(m)⌉.
2. t ← 2k − m.
3. Let s ← the number of consecutive ones in the input (we stop when we read a 0).
4. Let x ← the next k − 1 bits in the input.
5. If x < t:
   a. s ← s × m + x.
6. Else:
   a. x ← x × 2+ next input bit.
   b. s ← s × m + x − t.

4.3 METHODOLOGY – GOLOMB CC

Golomb coding divides an input value by a parameter m into q and r. Golomb coding is unary. Golomb Coding is described by m. They are choosing m influences compression efficiency by determining variable-length Coding. A table maps zeros or ones after m is finalized. Multiples of m are grouped into Ak and given the same prefix: (k – 1) ones followed by a zero. Log2m-bit tails are on each group member. Tail is sometimes called "run length" Prefix and tail create code word. The procedure must detect data end to avoid this problem. If the final bit is a "0," an extra "1" must be inserted during encoding and deleted during decompression.

4.4 ALGORITHM

1. Fix the parameter M to an integer value.
2. For N, the number to be encoded, find a. quotient = q = int[N/m] b. Remainder = r = N modulo m.
3. Generate Codeword The Code format: ,
   A. WhereQuotient Code (in unary Coding)
      i. Write a q-length string of 1 bits
      ii. Write a 0 bit.
   B. Remainder Code (in truncated binary encoding)
      I. If M is power of 2, code remainder as binary format. So log2(m) bits are needed.
      II. If M is not a power of 2, set b= log2(m).

a. If r < 2b - m code r as plain binary using b-1 bits.
b. If r>= 2b - m code the number r + 2b–m in plain binary representation using b bits.

Golomb coding uses an integer's quotient and remainder (d). Mod [10] in binary. Stop quoting. Using 1 as the stop bit if the unary quotient is 0 Rice coding is power-of-2. 15/4 = 000111.

V. SIMULATION RESULTS

Compressing medical images improves power, frequency, and slices. Golomb code maps, pictures Computers exhibit image-wise compression results. Golomb rice coding enhances the signal-to-noise ratio and lowers video storage memory. Verilog is easier than other HDL languages and allows mathematical definitions of terminals and external parameters. ModelSim 6.2 simulation. Analyzing statistics and waveforms is correct. This part simulates Golomb encoding and decoding methods on the FPGA. Golomb coding improves PSNR and compression over DWT. Both methods were tested on RGB and grayscale pictures. 128x128, 512x512, 8 bits/pixel. Figures indicate experiment results. The new technique and the previous algorithm were simulated in MATLAB on varying-sized colour images.

1. Mean Squared Error (MSE):

It refers to an average or total (or integral) of squares of the error between two photographs, as illustrated in Eq. (4.1).

$$MSE = \frac{1}{MN}\sum_{0}^{m-1}\sum_{j=0}^{n-1}\|I(i,j) - K(i,j)\| \quad (4.1)$$

Where I (i, j) is the original image data and K(i, j) isthe compressed image data.

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2. Peak Signal to Noise Ratio (PSNR):

The ratio between the signal variance and the reconstruction error variance. Peak Signal to Noise Ratio is computed using the following variables Eq. (4.2).

$$PSNR = 10\log((255)^2 2/MSE) \qquad (4.2)$$

3. Compression Ratio (C.R.):

The definition of compression ratio is the ratio between the original image size (n1) and the compressed image size (n2) Eq. (4.3).

$$CR = n1/n2 \qquad (4.3)$$

This section lays out the proposed framework for picture compression. VHDL is generated and tested using Matlab. Xilinx combines VHDL. First, the product is rebuilt and analyzed in Matlab, then the MATLAB HDL coder translates the suggested framework into EDL. Xilinx ISE merges hardware code.

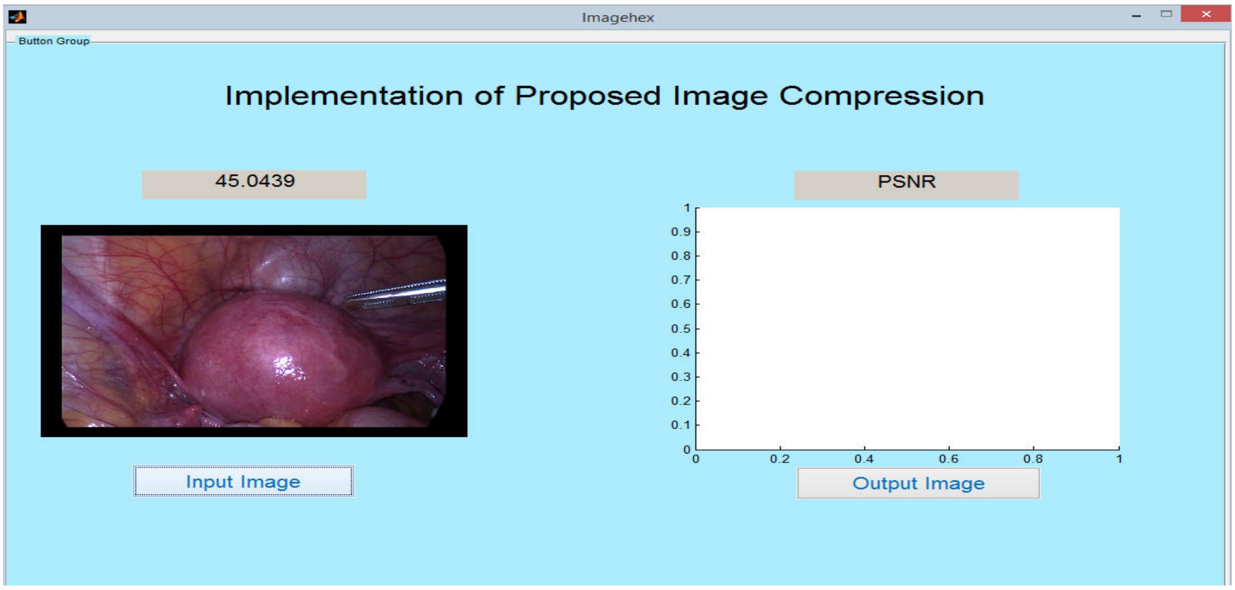

Fig.3.Proposed output GUI

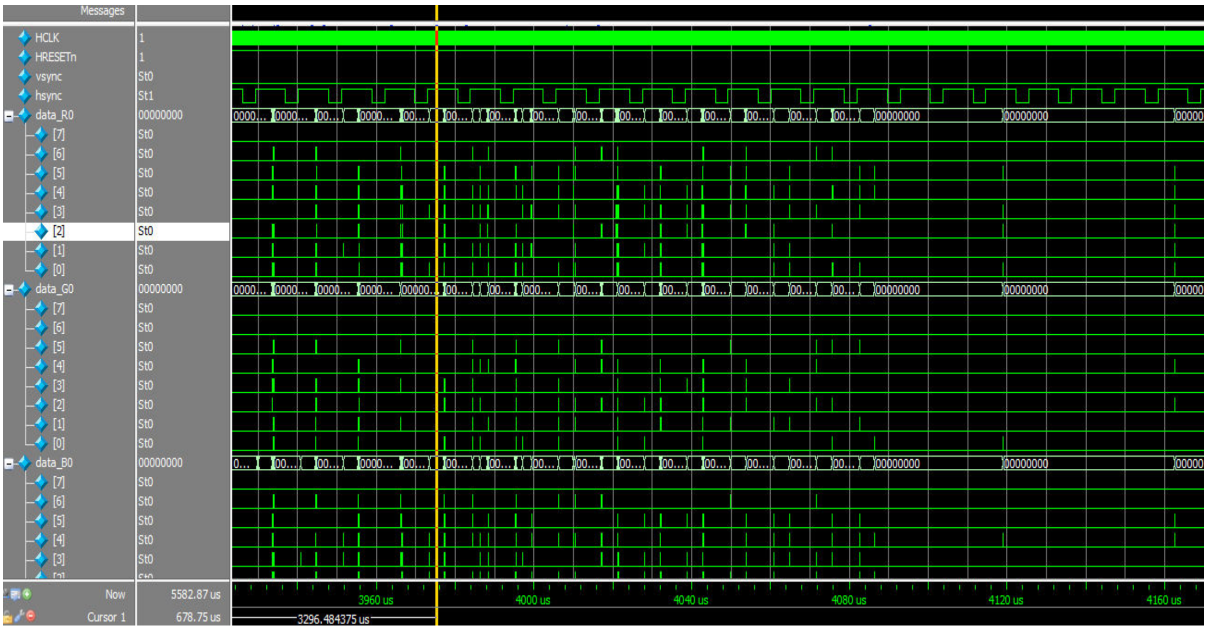

Fig.4. Input and output data for proposed system in modelsim

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PARAMETERS	EXISTING METHOD	PROPOSED METHOD
LUT	3558	3041
Frequency (MHz)	100	100
Slice Register	1482	1209
Occupied Slice	1043	1796
IOB	74	25
Delay (ns)	1.280	1.118
Power (mW)	104	98

Tab1. Comparison of existing and proposed algorithms

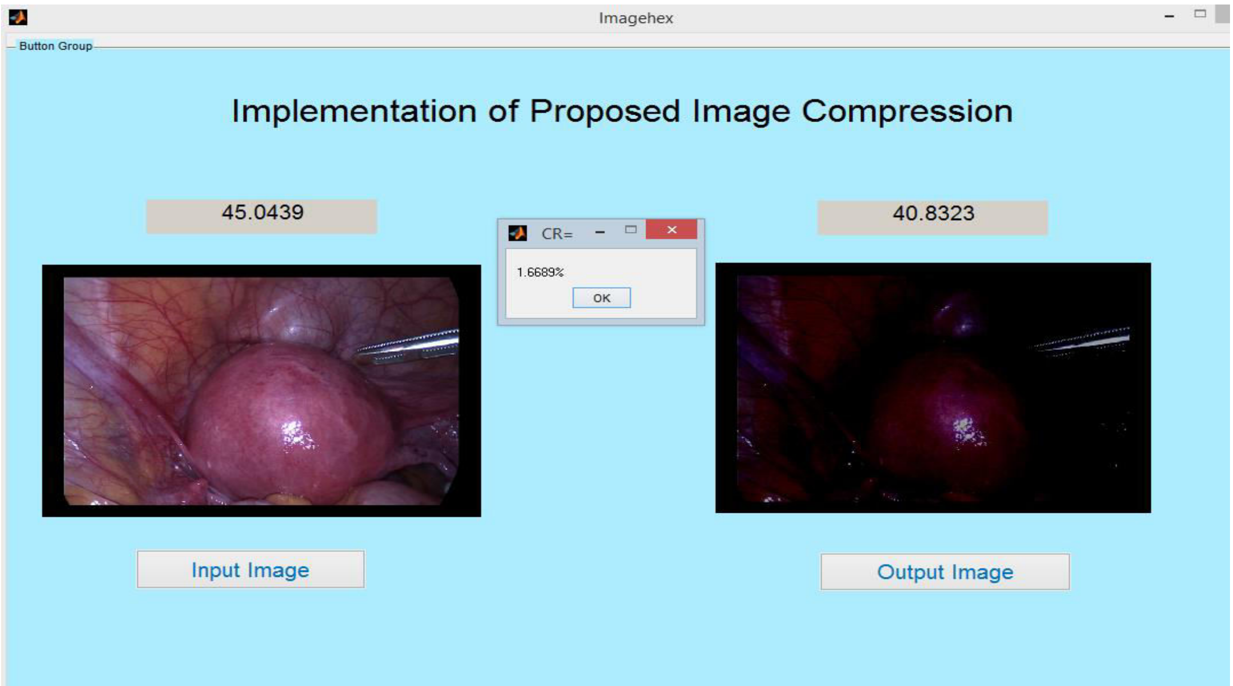

Fig.5. Final image compression output and compressed ratio details of proposed system in GUI

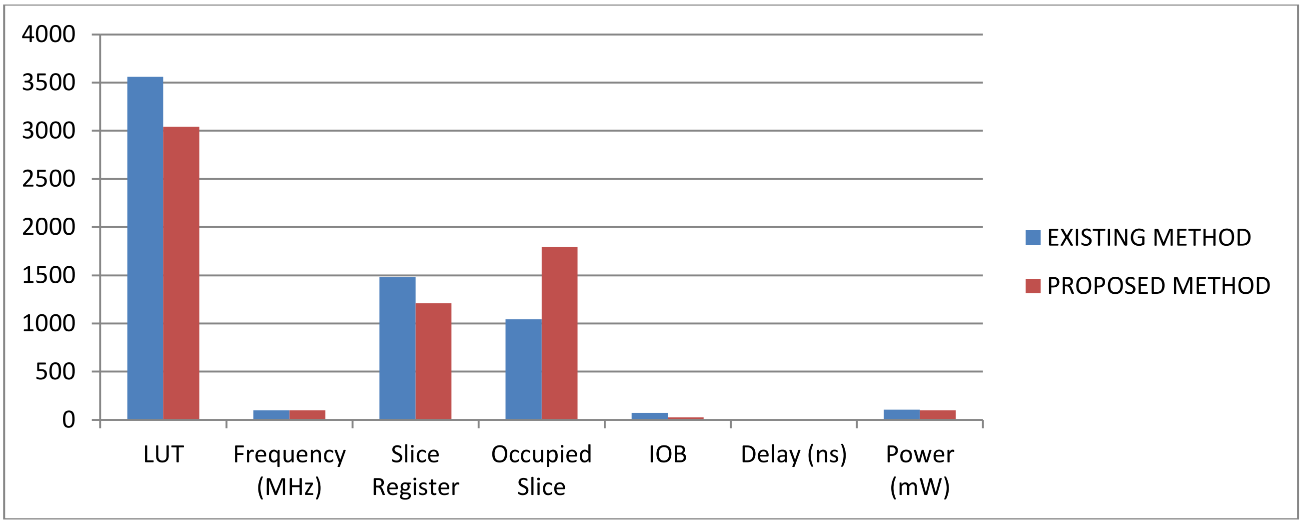

Fig.6. Performance metrics of Existing and Proposed

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VI. CONCLUSION AND FUTURE WORK

The unique lossless picture compression technique analyzed algorithm bottlenecks. The visual quality of compressed and rebuilt images is enhanced when compression efficiency is kept high. The new method outperforms the previous ones. The compression parameter PSNR is highlighted to produce high-quality images. Medical, satellite, and nature images can all be captured using the algorithm proposed here. It's also possible to use raw image validation. For example, the proposed compression method automatically selects parameters based on the compression percentage. Bitmask compression and Golomb encoding both benefit from one other when used together.

REFERENCES

1. W.-J. Yang, K.-L. Chung, W.-N. Yang, and L.-C. Lin, ``Universal chroma subsampling strategy for compressing mosaic video sequences with arbitrary RGB color _lter arrays in H.264/AVC," *IEEE Trans. Circuits Syst. Video Technol.*, vol. 23, no. 4, pp. 591_606, Apr. 2013..
2. B. E. Bayer, ``Color imaging array," U.S. Patent 3 971 065 A, Jul. 20, 1976.
3. R. Lukac and K. N. Plataniotis, ``Color _lter arrays: Design and per formance analysis," *IEEE Trans. Consum. Electron.*, vol. 51, no. 4, pp. 1260_1267, Nov. 2005.
4. S. Yamanaka, ``Solid state color camera," U.S. Patent 4 054 906 A, Oct. 18, 1977.
5. M. Parmar and S. J. Reeves, ``A perceptually based design methodologyfor color _lter arrays [image reconstruction]," in *Proc. IEEE Int. Conf. Acoust., Speech, Signal Process.*, May 2004, p. 473.
6. X. Xie, G. Li, X. Li, Z. Wang, C. Zhang, D. Li, and L. Zhang, ``A new approach for near-lossless and lossless image compression with Bayer color filter arrays," in *Proc. 3rd Int. Conf. Image Graph.*, Dec. 2004, pp. 357_360.
7. M. J. Weinberger, J. Rissanen, and R. B. Arps, ``Applications of universalcontext modeling to lossless compression of grayscale images," *IEEE Trans. Image Process.*, vol. 5, no. 4, pp. 575_586, Apr. 1996.
8. M. J.Weinberger, G. Seroussi, and G. Sapiro, ``The LOCO-I lossless imagecompression algorithm: Principles and standardization into JPEG-LS,' *IEEE Trans. Image Process.*, vol. 9, no. 8, pp. 1309_1324, Aug. 2000.
9. Y. Gera, Z.Wang, S. Simon, and T. Richter, ``Fast and context-free losslessimage compression algorithm based on JPEG-LS," in *Proc. Data Compress. Conf.*, Snowbird, UT, USA, Apr. 2012, p. 396.
10. P. G. Howard and J. S. Vitter, ``Fast and efficient lossless image compression," in *Proc. Data Compress. Conf.*, Snowbird, UT, USA, Mar./Apr. 1993, pp. 351_360.
11. P. Merlino and A. Abramo, ``A fully pipelined architecture for the LOCO-Icompression algorithm," *IEEE Trans. Very Large Scale Integr. (VLSI) Syst.*, vol. 17, no. 7, pp. 967_971, Jul. 2009
12. X. Chen, X. Zhang, L. Zhang, X. Li, N. Qi, H. Jiang, and Z. Wang, ``A wireless capsule endoscope system with low-power controlling and processing ASIC," *IEEE Trans. Biomed. Circuits Syst.*, vol. 3, no. 1, pp. 11_22, Feb. 2009.
13. T. H. Khan and K. A.Wahid, ``Lossless and low-power image compressorfor wireless capsule endoscopy," *VLSI Des.*, vol. 2011, no. 3, Jan. 2011, Art. no. 343787. doi: 10.1155/2011/343787.
14. T. H. Khan and K. A. Wahid, ``Design of a lossless image compressionsystem for video capsule endoscopy and its performance in *in-vivo* trials," *Sensors*, vol. 14, no. 11, pp. 20779_20799, 2014.
15. T. H. Tsai, Y. H. Lee, and Y. Y. Lee, ``Design and analysis of high-throughput lossless image compression engine using VLSI-oriented FELICS algorithm," *IEEE Trans. Very Large Scale Integr. (VLSI) Syst.*, vol. 18, no. 1, pp. 39_52, Jan. 2010.
16. S. L. Chen, Y. R. Chen, T. L. Lin, and Z. Y. Liu, ``A cost-efficient losslesscompression colorfilter array images VLSI design for wireless capsule endoscopy," *J. Med. Imag. Health Inform.*, vol. 5, no. 3, pp. 378_384, May 2015.
17. X. Chen, H. Jiang, X. W. Li, and Z. Wang, ``A novel compression methodfor wireless image sensor node," in *Proc. IEEE Asian Solid-State Circuits Conf.*, Jeju, South Korea, Nov. 2007, pp. 184_187.
18. M. Papadonikolakis, V. Pantazis, and A. P. Kakarountas, ``Efficient high-performance ASIC implementation of JPEG-LS encoder," in *Proc. Design, Automat. Test Eur. Conf. Exhib.*, Apr. 2007, pp. 1_6.
19. B.-S. Kim, S. Baek, D.-S. Kim, and D.-J. Chung, ``A high performance fully pipeline JPEG-LS encoder for lossless compression," *IEICE Electron. Express*, vol. 10, no. 12, Jun. 2013, Art. no. 20130348.
20. S. Kim and N. I. Cho, ``Lossless compression of color filter array images by hierarchical prediction and context modeling," *IEEE Trans. Circuits Syst. Video Technol.*, vol. 24, no. 6, pp. 1040_1046, Jun. 2014.S. L. Chen, Y. R. Chen, T. L. Lin, and Z. Y. Liu, ``A cost-efficient lossless compression color filter array images VLSI design for wireless capsule endoscopy," *J. Med. Imag. Health Inform.*, vol. 5, no. 3, pp. 378_384, May 2015.