Lossless Image Compression and Transmission

FUNDAMENTALS OF IMAGE AND VIDEO PROCESSING

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What is Lossless Image Compression and Transmission?

- To store large sized images and make available on internet Compression is required.
- The goal is to represent an image signal with the smallest possible number of bits.
- Without loss of any information.
- Speeding up transmission and minimizing storage requirements.
- Original data to be perfectly reconstructed from the compressed data.

Huffman Coding

- Huffman coding is a lossless data compression algorithm.
- The idea is to assign variable length codes to input characters, lengths of the assigned codes are based on the frequencies of corresponding characters.
- Huffman's code procedure is based on the two observations.
    - More frequently occurred symbols will have shorter code words than symbols that occur less frequently.
    - The two symbols that occur least frequently will have the same length.

Table 1: Huffman source reduction.

Original source Source reduction

S	P	1	2	3	4
a2	0.4	0.4	0.4	0.4	0.6
a6	0.3	0.3	0.3	0.3	0.4
a1	0.1	0.1	0.2	0.3	
a4	0.1	0.1	0.1		
a3	0.06	0.1			
a5	0.04				

Table 2 : Huffman Code Assignment Procedure

Original source Source reduction

S	P	1	2	3	4
a2	0.4[1]	0.4[1]	0.4[1]	0.4[1]	0.6[0]
a6	0.3[00]	0.3[00]	0.3[00]	0.3[00]	0.4[1]
a1	0.1[011]	0.1[011]	0.2[010]	0.3[01]	
a4	0.1[0100]	0.1[0100]	0.1[011]		
a3	0.06[01010]	0.1[0101]			
a5	0.04[01011]				

S-source, P-probability

Lavg = (0.4)(1) +(0.3)(2) + (0.1)(3) + (0.1)(4) + (0.06)(5) + (0.04)(5) = 2.2 bits/ symbol

and the **entropy of the source is 2.14bits/symbol**,

the resulting **Huffman code efficiency is2.14/2.2 = 0.973.**

Entropy, $H=-\Sigma P(aj)\log P(aj)$

Huffman Decoding

- Decoding is accomplished in a simple look-up table manner.
- The code itself is an instantaneous uniquely decodable block code.
- It is called a block code.
- Each source symbol is mapped into a fixed sequence of code symbols.
- It is instantaneous because each codeword in a string of code symbols can be decoded without referencing succeeding symbols.
- It is uniquely decodable because any string of code symbols can be decoded in only one way.

Huffman Decoding

- Any string of Huffman encoded symbols can be decoded by examining the individual symbols of the string in a left to right manner.
- The decompressor keeps the whole Huffman binary tree, and of course a pointer to the root to do the recursion process.
- Make the tree as usual and then you'll store a pointer to the last node in the list, which is the root.
- Navigate the tree by using the pointers to the children that each node has.
- This process is done by a recursive function that accepts as a parameter a pointer to the current node and returns the symbol.

Methodology

Methodology

1. Reading image.
2. Converting RGB to Gray-Scale.
3. Call function to find symbols.
4. Call function for calculating probability.
5. Arrange in Descending order.
6. Code words are achieved related to the corresponding symbols.
7. Code words and final encoded values are concatenated.
8. Huffman codewords are achieved by using final encoding values.
9. Original image is reconstructed in the spatial domain.

Methodology

10. Compressed image applied on Huffman coding to get the better quality image based on block and codebook size.

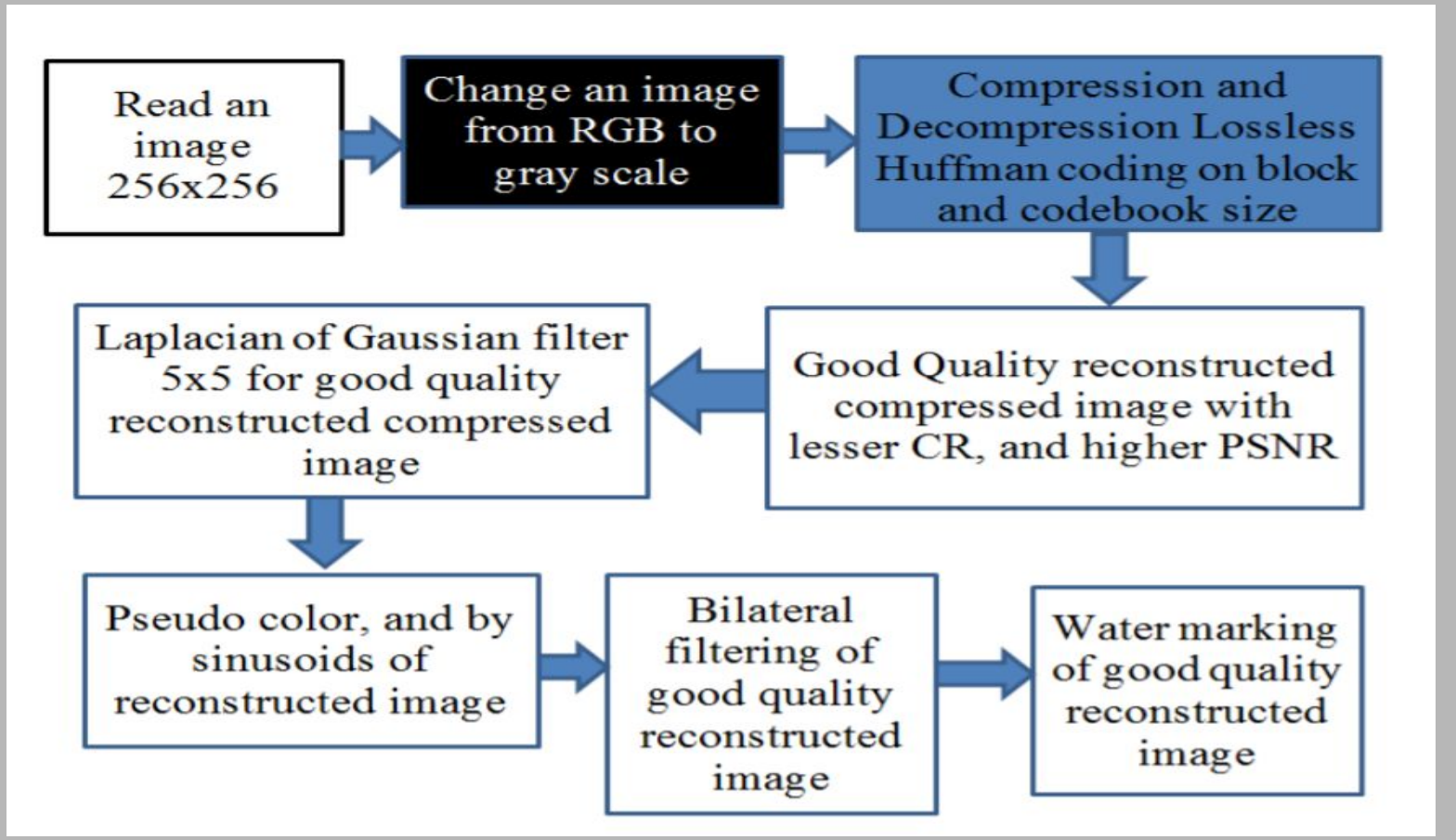
11. Recovered reconstructed looks similar to the original image.

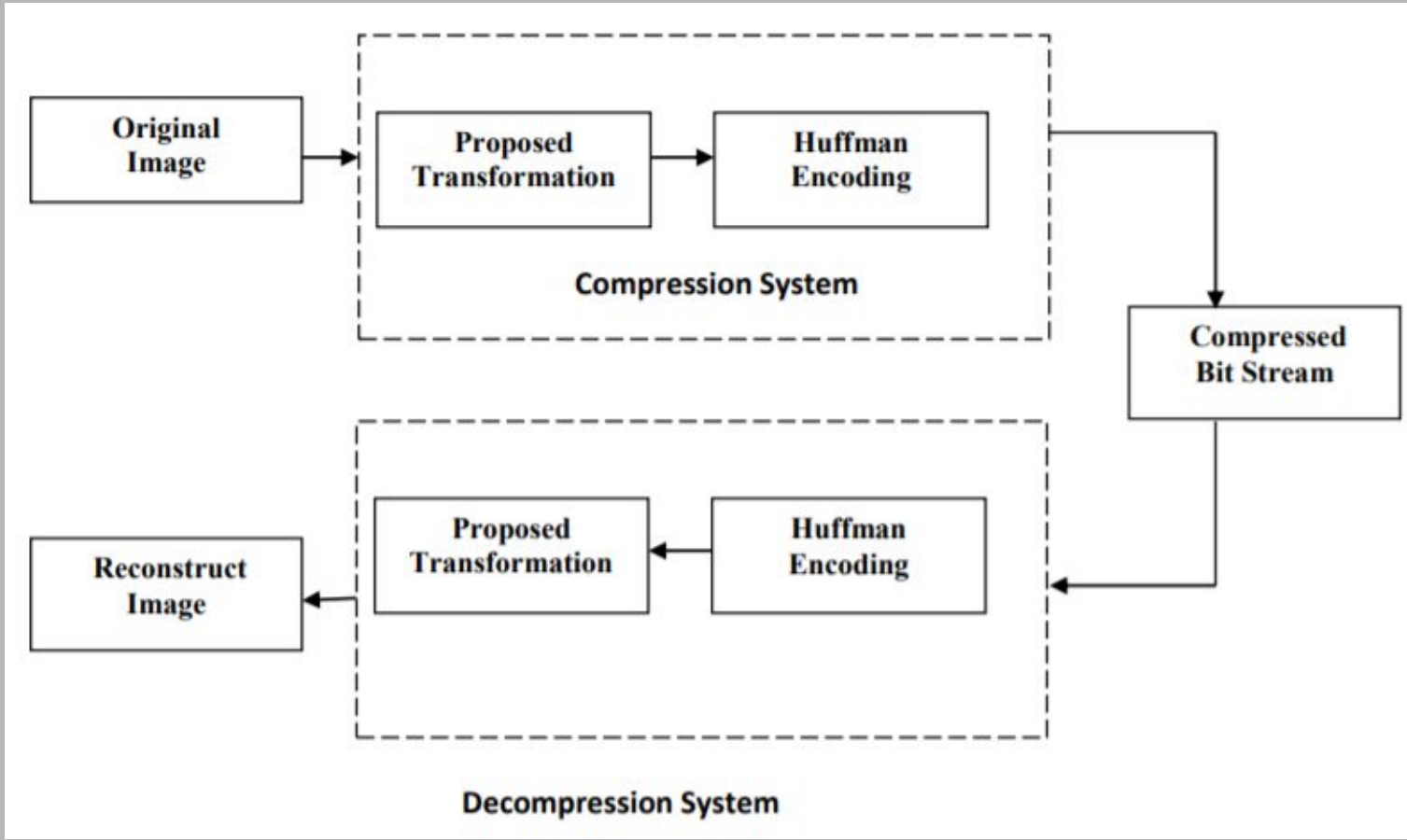
12. Implement Laplacian of Gaussian filtering.

13. Implement Pseudo coloring.

14. Implement Bilateral filtering.

15. Implement Watermarking.


Read an image 256x256
Change an image from RGB to gray scale
Compression and Decompression Lossless Huffman coding on block and codebook size
Good Quality reconstructed compressed image with lesser CR, and higher PSNR
Laplacian of Gaussian filter 5x5 for good quality reconstructed compressed image
Pseudo color, and by sinusoids of reconstructed image
Bilateral filtering of good quality reconstructed image
Water marking of good quality reconstructed image


Original Image
Proposed Transformation
Huffman Encoding
Compression System
Compressed Bit Stream
Reconstruct Image
Proposed Transformation
Huffman Encoding
Decompression System

Output

Variance : 13

Average Length :7.865064e+00

Time Elapsed : 4.3565

Entropy is :7.840854 bits

Efficiency is :0.996922

Image before Transmission

Image after Transmission

Applications

- Medical imaging is been used for diagnosis of diseases and surgical planning, and they need long-term storage for profiling patient's data as well as efficient transmission for long diagnosis
- In the field of online diagnosis or real time applications such as telemedicine, demands for hardware to handle lossless compression that can accelerate the computation process.
- Works well for text and fax transmissions.

Conclusion

Efficient and Effective communication of superior quality digital images needs a reduction of memory space and less bandwidth requirement.
(a) Good quality image with Lower compression ratio.
(b) Lower entropy and more the Average Length.

Thank You !