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Effective Compression of Pharmaceutical Images Using Butterworth Filter in Python

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Abstract:

In the pharmaceutical industry, image analysis has a major role in detail quality analysis and other analytical purposes. In general, these images consume a lot of space hence it is a challenging task to properly store them. Scientists have used a lot of image compression algorithms for many years. However, a major drawback of them is that, due to the high compression ratio, too much information loss is there. Therefore, it is not suitable for a detailed analysis of pharmaceutical properties. In this communication, we have proposed an effective method for compression of pharmaceutical images using Butterworth low pass filtering (LPF) in the python platform. Here, pharmaceutical images have been transformed into the frequency domain and then they are filtered using suitable cut-off frequency. As the primary criteria of this algorithm are to achieve a reasonably good output, therefore compression ratio should be as minimum as possible. Peak Signal to Noise Ratio (PSNR) and correlation coefficient value is used to measure the quality of output images.

KEYWORDS:

Python, Pharmaceutical Image, Butterworth Filter, Low Pass Filter, PSNR, Correlation Coefficient

I. INTRODUCTION:

For the last few decades, a lot of techniques have been proposed by researchers for the compression of different types of images. All these processes are classified as optical and non-optical processes. In the optical process, recently sinusoidal grating (both sinusoidal and phase) is used for compression of remote sensing and medical images. [1-3] This method provides a better output and storage efficiency. In a non-optical system, researchers Integer form of Wavelet Regression to compress satellite images. Here, a better compression ratio is achieved by modification of the temporal correlation value. [4] Image compression is done by noise bit removal using discrete wavelet transform. [5] Evidence theory along with the k-Nearest Neighbor (KNN) algorithm is also used for image compression. [6] To avoid data loss, some researchers have proposed an image compression algorithm based on Fourier Transform and Huffman Coding. [7] Discrete Wavelet Transform (DWT) is a common tool that is used for image compression. It is used by modifying in various ways. A performance study in each case is analyzed by a T Memane et.

al. [8] All the above-mentioned methods are mainly software-based systems whereas few researchers have proposed a hardware-based system X Sat image compression. [9] Discrete Cosine Transform (DCT) is also used to compress different types of images. [10-12] Recently, an open-source platform, Python is widely used for image processing. The use of SCIKIT- image in image processing offers high-quality and easy-to-use implementations of image processing algorithms. [13] The image processing in Python led to building up an improvised image processing and recognition framework by the utilization of scientific conditions and equations. It encourages image preparation by the use of both verbal and motion techniques of human beings. [14] Lossless image compression algorithms are based on dictionaries, run-length, and entropy. The performance of the state-of-the-art techniques is measured by using standard metrics such as average code length, compression ratio, pick signal-to-noise ratio, efficiency, encoding time, and decoding time. [15] Noises often degrade the quality of an image. So, noise removal is one of the very important aspects of image processing. Among the linear and nonlinear filters, nonlinear filters are best suited for impulse noise removal. De-noising though is easy to implement but leads to the loss of lots of image details. [16]

In this paper, Butterworth Low Pass Filter is used in the python domain for the compression of pharmaceutical images. Here, initially, the selected images are converted into three color planes – Red, Green, and Blue respectively. In the next process, they are converted into the frequency domain for processing. A suitable value of cut-off frequency is selected for filtering. Butterworth Low Pass Filtering is applied to the frequency domain of each plane. In the final process, the filtered output of each plane is added together to reconstruct the color images. Lastly, PSNR and correlation coefficient are used to measure the quality of the output images. A Patra et.al. worked on Butterworth LPF in MATLAB platform for compression of satellite images but all the images are gray-scale images. [17] Here we have worked with color images which is a more practical-oriented application.

II. METHODOLOGY:

Let us assume that $f(x, y)$ is the selected pharmaceutical image that is selected for compression. For an M×N size image, the two-dimensional Discrete Fourier Transform (DFT) is given by:

$$F(u,v) = \sum_{x=0}^{M-1} \sum_{y=0}^{N-1} f(x,y) e^{-i2\pi\left(\frac{ux}{M}+\frac{vy}{N}\right)} \quad (1)$$

where $F(u, v)$ is the Fourier Transform of the image.

The transfer function of the Butterworth LPF may be expressed as

H (u, v) = 1, for $(u, v) \leq D0$ (2)

= 0, for $(u, v) > D0$

Here cut-off frequency is represented by $D0$ and D(u, v) represents the gap of point (u, v) from the center point in the frequency band.

Hence

$$D(u,v) = \left[\left(u-\frac{M}{2}\right)^2 + \left(v-\frac{N}{2}\right)^2\right]^{\frac{1}{2}} \quad (3)$$

$$H(u,v) = \frac{1}{\left[1+\frac{D(u,v)}{D0}\right]^{2n}} \quad (4)$$

Where n is the order of the Butterworth Low Pass Filter.

PSNR value is calculated by

$$MSE = \frac{1}{mn} \sum_{y=1}^{m} \sum_{x=1}^{n} [f(x,y) - g(x,y)]^2 \quad (5)$$

MSE = Mean Square Error; $g(x, y)$ = Extracted image; m, n denotes image size

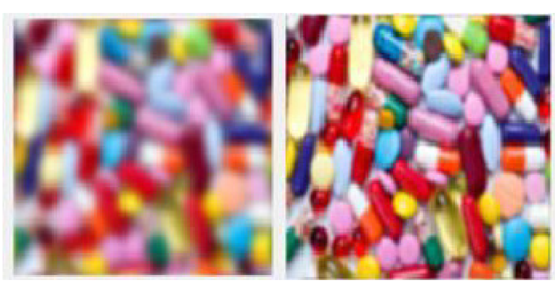
$$PSNR = 20log10 \frac{255}{\sqrt{MSE}}$$

III. RESULT AND DISCUSSION:

For our research work, we have selected a pharmaceutical image of a pixel resolution of 900 x 900. This image is displayed in figure (1). We have performed the entire work using an i5 processor, 32 GB RAM, and Python 3.9 version.

Figure 1

We have varied the cut-off frequency from 10, 30, 50, 70, 80, and 90 respectively. At each particular cut-off frequency, output has beenobserved. Simultaneously PSNR and correlation coefficient values are also measured in each case. The filtered images are shown in Figure 2(a-f). Table 1 displays the value of PSNR and correlation coefficient whereas Table 2 shows the value of compression ratio in each cut-off frequency.



a **b**

c **d**

e **f**

Figure 2 - Cut-off value 10 a) 10 b) 30c) 50 d) 70 e) 80 and f) 90 respectively

Original Image Size- 346 kB

Table 1

Cut off Value	Size (kB)	PSNR	Corr. Coeff
10	222	22.5	0.643
30	240	23.8	0.682
50	267	26.3	0.724
70	289	28.4	0.781
80	295	29.7	0.885
90	302	31.2	0.997

Image with Cut-off Value	Size (kB)	Compression Ratio (Compressed Image/ Original Image)
10	222	0.64
30	240	0.69
50	267	0.77
70	289	0.83
80	295	0.85
90	302	0.87

IV. COMPARED WITH THE PREVIOUS METHOD:

Compared to a few other methods, the quality of our proposed method is better. [Ref 1-4] We have worked with a color image which is generally used but in ref. 17, authors have worked on grayscale images only.

V. CONCLUSION :

In this communication, compression of the pharmaceutical image using Butterworth LPF in Python has been discussed. In this type of image, a huge loss of information is not allowed as a very small part of the image is required for detailed analysis using the image. Due to this reason in our proposed technique, we have maintained a low compression ratio. Compared with earlier methods, the visual quality of the selected pharmaceutical images is very good. Moreover, in this method, no post-processing of the image is required to improve the quality of the image. This method can be equally effectively used for multiple color pharmaceutical images also which will be discussed in future communication.

REFERENCE :

1. A Patra, A Saha, D Chakraborty, K Bhattacharya; “Compression of Satellite Images using Sinusoidal Amplitude Grating”; IJEE 11 (1), 664-667; 2019

2. A Patra, A Saha, D Chakraborty, K Bhattacharya; “Compression of High-Resolution Satellite Images Using Optical Image Processing”; Satellite Systems-Design, Modeling, Simulation and Analysis; 2021

3. A Patra, A Saha, K Bhattacharya; “Compression and multiplexing of medical images using optical image processing”; Computational Intelligence and Its Applications in Healthcare; 63-71; 2020

4. Md. Al Mamun and Md. Ali Hossain; “Pharmaceutical Image Compression Using Integer Wavelet Regression”; International Conference on Electrical, Computer and Communication Engineering (ECCE); 2017

5. K Sahnoun, N Benabadji ; “Pharmaceutical Image Compression Technique Using Noise Bit Removal and Discrete Wavelet Transform”; International Journal of Imaging and Robotics; Volume 15, Issue Number 3 , 2015

6. K Sahnoun, N Benabadji ; “Pharmaceutical Image Compression Technique Based On The Evidence Theory”; Advanced Computing: An International Journal (ACIJ), Vol.5, No.1, 2014

7. K Sahnoun, N Benabadji ; “Pharmaceutical Image Compression Algorithm Based On The FFT” ; The International Journal of Multimedia & Its Applications (IJMA) Vol.6, No.1, 2014

8. T Memane and S D Ruikar ; “Selection Of Wavelet For Pharmaceutical Image Compression Using Picture Quality Measures”; International Conference on Communication and Signal Processing ; 2014

9. R.M. Susilo , T.R. Bretschneider; “On the real time pharmaceutical image compression of X-Sat” ; Fourth International Conference on Information, Communications and Signal Processing, 2003

10. I. Hacihalilogluand , M. Kartal ; “DCT and Wavelet Based Image Compression in Pharmaceutical Images”; Recent Advances in Space Technologies, RAST '03, 2003.

11 Nikolay Ponomarenko , Vladimir Lukin, Karen Egiazarian,JaakkoAstola ; “DCT Based High Quality Image Compression; Scandinavian Conference on Image Analysis”; SCIA: Image Analysis pp 1177-1185; 2005

12. Andrew B. Watson ; “Image Compression Using the Discrete Cosine Transform; Mathematica Journal, 4(1), p. 81-88, 1994

13. Stefan van der Walt, Johannes L. Schonberger, Juan Nunez-Iglesias, Francois Boulogne, Joshua D. Warner, Neil Yager, Emmanuelle Gouillart, Tony Yu,; “scikit-image: Image processing in Python”; Article in PeerJ · ;2014

14. Muhammad ArifRidoy; “Image processing in Python”; International Journal of Scientific & Engineering Research Volume 9, Issue 3, 2018

15. Md. Atiqur Rahman and Mohamed Hamada; “Lossless Image Compression Techniques: A State-of-the-Art Survey”; Symmetry; 2019

16. Abdalla Mohamed Hambal, Dr. Zhijun Pei, Faustini LibentIshabailu; "Image Noise Reduction and Filtering Techniques"; International Journal of Science and Research (IJSR) ; 2015

17. A Patra, S Bandyopadhyay, D Chakraborty, A Saha; "A Novel Approach to Compression of Satellite Images Using Butterworth Filtering"; Information, Photonics and Communication, Lecture Notes in Networks and Systems, vol 79. Springer; 2020

