Analysis of Adaptive Binary Optimization for Lossless Medical Image Compression

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***Abstract*—In modern sciences and technologies, images are the important source of scientific visualization. Image compression is concerned with minimizing the number of bits required to represent an image. Medical imaging techniques such as CT, MRI and PET modalities produce huge amounts of data. As a result, storage and transmission of image data electrically are prohibitive without the use of compression. This paper deals with analyzing the various functionality and features of adaptive binary optimization (ABO) technique based on Repetition and correlation coding for compressing a medical images using GUI in matlab.ABO is a process and a system for compressing image data having high correlation value. This technique is simple in implementation and utilizes less memory as compared to other lossless compression technique. Compressing the image without loss in the quality of the image make it an efficient lossless technique for medical image compression.**

Keywords—Repetition Coded Compression; high correlation; bitplane; lossless image data.

I. INTRODUCTION

Image compression can be bifurcated as lossy and lossless compression. Lossy image compression technique provides higher compression ratio than lossless image compression but it cannot completely recover the original image data. In this method the decompressed image is not exactly identical to the original image. In lossless image compression the original image and compressed image are identical .Therefore it is preferred for archival purposes and best suited for medical imaging. Lossless image compression can completely recover the original image data but this reduces the compression ratio as compared to lossy compression. In all medical application, lossless compression has been used because the loss of any diagnostic information is not permitted.

To choose between lossy and lossless image compression depends primarily on the need of the application. Certain applications require a perfectly lossless image compression so as to achieve zero errors in the automated analysis of image data. In some other applications, the human eye visually inspects the images. Since the human eye is insensitive to certain patterns found in the images, such patterns are discarded from the original images so as to yield good compression of data. These compression scheme are termed as "visually lossless" compression schemes. This is not a perfectly reversible process as the de-compressed image data is different from the original image data. The degree of difference depends on the quality of compression, and the compression ratio.

II. ICAL IMAGING

Medical imaging is the technique and process of creating visual representations of the interior of a body for clinical analysis and medical intervention. Medical imaging seeks to reveal internal structures hidden by the skin and bones, as well as to diagnose and treat disease. Medical imaging also establishes a database of normal anatomy and physiology to make it possible to identify abnormalities. The trend in medical imaging is increasing toward direct digital image acquisition. Currently, many modalities such as CT (computed tomography), MRI (magnetic resonance imaging), PET (positron emission tomography), SPECT (single-photon emission computed tomography), and DSA (digital subtraction angiography) produce images directly in digital form.

It appears that telemedicine and digital image processing will eventually completely replace conventional film (hard copy) imaging in medicine. Important advantages of digital imaging are in support of image transfer and archival, and the possibility for manipulating and enhancing diagnostic information.However, digital image transmission and storage face major challenges due to the size of medical image data sets. For instance each MRI and CT image requires an average of 5 to 12 Mbytes and a single X-ray may require as much as 24 Mbytes. The size has leads to searches for effective image compression methods to reduce the storage requirements and network traffic and improve efficiency.

A.COMPUTED TOMOGRAPHY (CT)

Computed Tomography (CT), also commonly referred to as a CAT scan, is a medical imaging method that combines multiple X-ray projections taken from different angles to produce detailed cross-sectional images of areas inside the body. CT images allow doctors to get very precise, 3-D views of certain parts of the body, such as soft tissues, the pelvis, blood vessels, the lungs, the brain, the heart, abdomen and bones. CT is also often the preferred method of diagnosing many cancers, such as liver, lung and pancreatic cancers.

B. Magnetic Resonance Imaging (MRI)

Magnetic Resonance Imaging (MRI) is a medical imaging technology that uses radio waves and a magnetic field to create detailed images of organs and tissues. MRI has proven to be highly effective in diagnosing a number of conditions by showing the difference between normal and diseased soft tissues of the body.

C. Positron Emission Tomography (Pet)

Positron Emission Tomography (PET) is a nuclear imaging technique that provides physicians with information about how tissues and organs are functioning. PET, often used in combination with CT imaging, uses a scanner and a small amount of radiopharmaceuticals which is injected into a patient's vein to assist in making detailed, computerized pictures of areas inside the body.

D. *Ultrasound*

Diagnostic ultrasound, also known as medical sonography or ultrasonography, uses high frequency sound waves to create images of the inside of the body. The ultrasound machine sends sound waves into the body and is able to convert the returning sound echoes into a picture. Ultrasound technology can also produce audible sounds of blood flow, allowing medical professionals to use both sounds and visuals to assess a patient's health.

E. X-RAY

X-ray technology is the oldest and most commonly used form of medical imaging. X-rays use ionizing radiation to produce images of a person's internal structure by sending X-ray beams through the body, which are absorbed in different amounts depending on the density of the material. In addition, included as "x-ray type" devices are also mammography, interventional radiology, computed radiography, digital radiography and computed tomography (CT). Radiation Therapy is a type of device which also utilizes either x-rays, gamma rays, electron beams or protons to treat cancer.

III. ABO MECHANISM

Adaptive Binary Optimization (ABO)is the process and a system for compressing highly correlated image data .The back bone of this technology is based on Repetition and Correlation Coding. It comprises of capturing the image and convert them to digital form, means for reshaping and encoding the image data and finally result in storing and retrieving the compressed data. ABO technology can drastically compress the image as a result transformation can be felt strongly at every level of the network. The results of this simple and powerful process just transforms the way in which data is stored, transmitted, retrieved and applied with highest compressibility and without loss of data and integrity.

This lossless image compression algorithm by matrixview uses a patented method to compress the high correlation found in digital content signals and additional compression with standard entropy encoding algorithms like Huffman coding. ABO exploits the repetition and correlation found in data. This results in a revolutionary data transformation and establishes a strong foundation for further modeling and source coding of data.ABO uses sequentially ordered steps for compression of an image described below

A. Image Acquisition

The first step in image processing begins with capturing an image.An image must be captured by a camera and converted into a manageable entity. This process is known as *imageacquisition*. In image acquisition process *energy* reflectedfrom the object of interest,an *optical system* which focuses the energy and finally a *sensor* which measures the amount of energy.

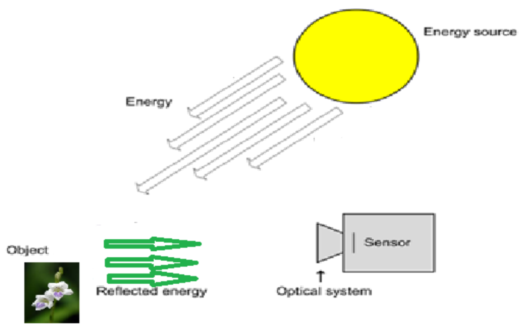
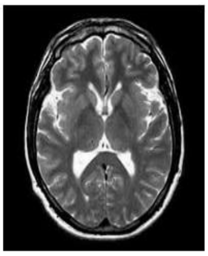


Fig. 2.1Image acquisition steps in digital image processing.

B. Digital Transformation

The next step after image acquisition is converting the image into digital form to provide digital data. A **digital image** is a numeric representation normally binaryof a two-dimensional image.that image data is not only analogue in nature, it has many levels of complexity.Then reshaping the digital data into a digital data matrix of image data values is carried out .An image is digitally represented using the pixel valueshown in the below figure

MRI Image



Pixel Value

20	20	20	100	100	100
20	20	20	100	100	100
250	250	250	20	20	20
250	250	250	20	20	20
150	150	150	250	250	250
150	150	150	250	250	250

Fig. 2.2 MRI image and corresponding pixel value

C. Encoding

In encoding process the repetitions found in the pixel value of an image in the form of digital data matrix are converted in to a bit-plane index and encoding image data values of the digital data matrix are further processed to form compressed data. The rule for encoding an image pixel value is as follows

- if adjacent pixel value are both equal, a bit plane is recorded as 1 and
- if adjacent pixel value are not both equal, a bit plane is recorded as 0.

Bit plane index

0	1	1	0	1	1
0	1	1	0	1	1
0	1	1	0	1	1
0	1	1	0	1	1
0	1	1	0	1	1
0	1	1	0	1	1

Pixel value

20	20	20	100	100	100
20	20	20	100	100	100
250	250	250	20	20	20
250	250	250	20	20	20
150	150	150	250	250	250
150	150	150	250	250	250

Rules for adjacent pixels
If same value ,bit plane='1'
If different value, bit plane='0'

Fig. 2.3 Bit plane index

D. Value Store

In this final processthestorage of compressed data take place wherein each image data value is compared with a previous image data value and

- if they are both equal, a first value is recorded; and
- if they are not both equal, a second value is recorded.

PIXEL VALUE

20	20	20	100	100	100
20	20	20	100	100	100
250	250	250	20	20	20
250	250	250	20	20	20
150	150	150	250	250	250
150	150	150	250	250	250

VALUES STORED

20	100	20	100
250	20	250	20
150	250	150	250

BIT PLANE

0	0	0	0	0	0
1	1	1	1	1	1
0	0	0	0	0	0
1	1	1	1	1	1
0	0	0	0	0	0
1	1	1	1	1	1

Rules for adjacent pixels
If same value ,bit plane='1'
If different value, bit plane='0'

Fig. 2.4 Storing compressed pixel

IV. EXPERIMENTAL RESULT

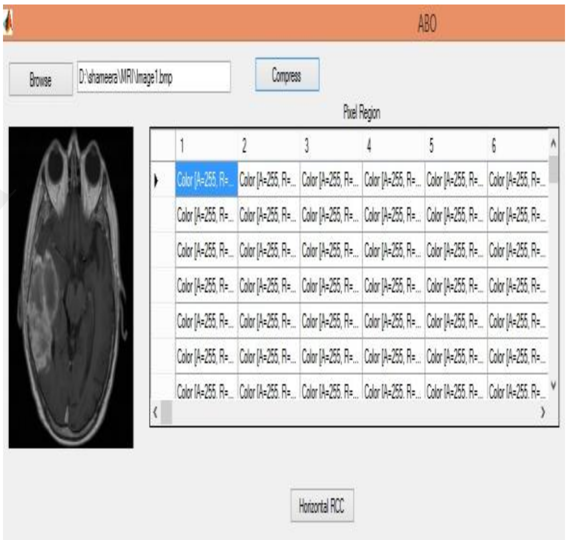


Fig.4.1 Original uncompressed image

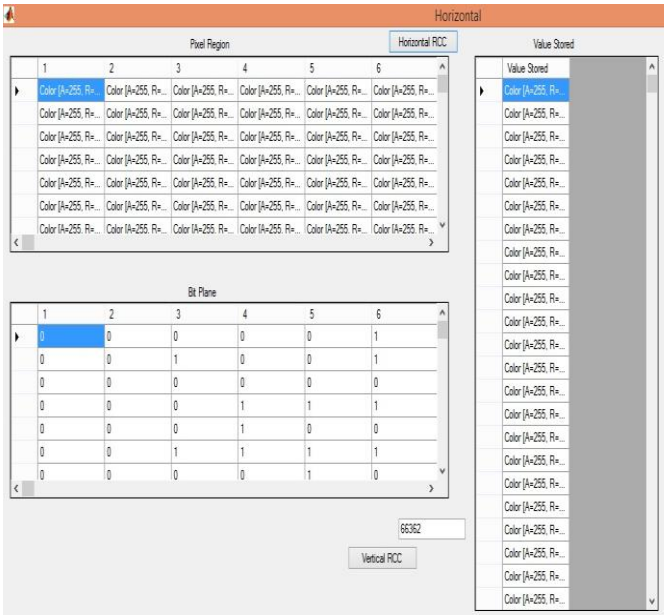


Fig4.2 Bitplane construction

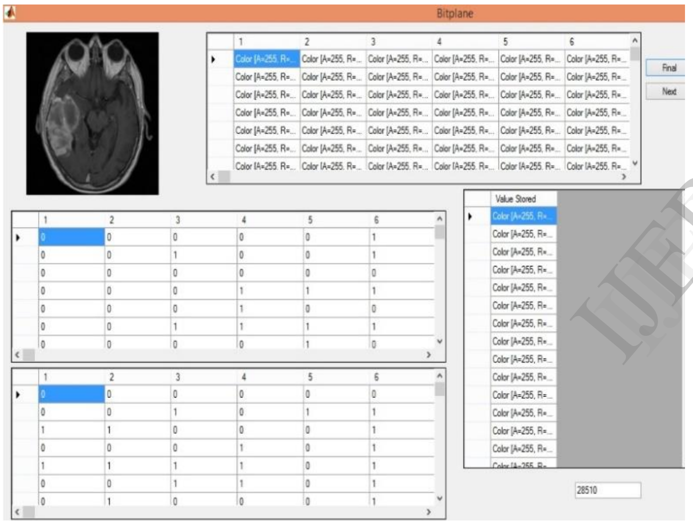


Fig 4.3 Finalvalue store

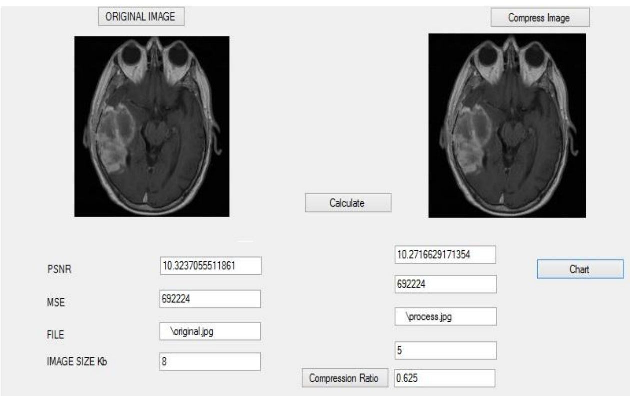


Fig. 4.4 Final compressed image

Figure 4.1 shows original uncompressed Image then it is successfully compressedusing this ABO and the regenerated image is exactly same as original image that is represented by Figure 4.3. For grayscale image this method gives 60% saving in size. Figure 4.2 represents bitplane construction for a MRIimage and its reconstructed image is represented in Figure 4. 4For this image we get 63% compression.

V. CONCLUSION AND FUTURE WORK

ABO achieves a good compression ratio for only those image with high redundancy in pixel value without a considerable loss in the image quality. These techniques propose a unique characteristic which is used to compress medical image. The compression ration attain by this ABO mechanism proves to be better than the Jpeg technology which suffer from visual lossless of discern information during compression.This image compression method is well suited for gray scale (black and white) bit map images and for medical imaging.Future work aims at extending this frame work for color images, video compressions, and denoising applications.

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