AN APPROACH FOR COMPRESSING DIGITAL IMAGES BY USING RUN LENGTH ENCODING

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ABSTRACT

Digital images are having a very significant role in sciences. Digital images (biometric images) are produced by the mechanism of digital imaging which is the process of creating images of the human body or parts of the body using various techniques to detect, diagnose or treat a disease. An digital image is essentially a 2-D signal processed by the human visual system. A digital image is a 2-Dimensional array of pixels. Biometrics means "Life Measurements” but this term is mainly associated with the unique physiological characteristics to identify an individual. Biometrics provides security that is the reason people relates to the biometrics. Biometrics have physiological characteristics means it includes of face recognition, iris recognition and fingerprint verification and behavioural characteristics means it includes voice and signature. Biometrics includes verification and identification. Verification means the process of establishing the validity and validation means making a legal validation. Storage and sharing of digital image data are expensive and excessive without compressing it because various techniques of digital imaging produce large sized data therefore these digital images are compressed before saving them or sharing them. In this we use a new hybrid discrete cosine transform and Run length encoding compression and noise removal in further steps and then image similarity detection by Fourier transform.

Keywords: Discrete Cosine Transform, Run Length Encoding, Fourier transform, Correlation, Results.

1. INTRODUCTION:

Image compression saves a lot of space and resources while sending the data from one place to another place. Image compression addresses the problem of reducing the amount of data required to represent a digital image. It is a process intended to yield a compact representation of an image, thereby reducing the image storage/transmission requirements. Digital image Compression techniques reduce the irrelevance and redundancy of the image data in order to be able to store or transmit data in an efficient form. It is the useful process to save a lot of space and resources while sending images from one place to another. It eliminates the redundant part and functions which can be generated at the time of decompress. Hence, Compression of medical images plays an important role for efficient storage and transmission. The main goal is to achieve higher compression ratios and minimum degradation in quality. The digital image compression techniques uses different medical images like X-Ray angiograms, Magnetic resonance images (MRI), Ultrasound and Computed Tomography (CT) DICOM (Digital imaging and communications in medicine) is used for storing, transmitting and viewing of the digital images.

2. TECHNIQUES USED FOR COMPRESSION:

2.1 Discrete Cosine Transformation:

It is a mathematical transformation which is related to the Fourier transformation which is similar to the discrete Fourier transformation but it uses only real numbers. DCTs are equivalent to DFTs roughly it is twice the length and operating on real data with even symmetry, where in some variants the input and/or output data are shifted by half a sample. Discrete Cosine Transformation technique is often used in signal and image processing, mainly for lossy data compression, because it has a strong “energy compaction” property. DCTs are also widely employed in solving partial differential equations. Transform coding constitutes an integral component of contemporary image/video processing applications. It involves expression of data points in sequence in terms of cosine function’s sum oscillating at different frequencies. The use of cosine rather than sine functions is critical in these applications, for compression it turns out that cosine functions are much more efficient. Transform coding relies on the premise that pixels in an image exhibit a certain level of correlation with their neighbouring pixels. Similarly in a video transmission system, adjacent pixels in consecutive frames show very high correlation. Consequently, these correlations can be exploited to predict the value of a pixel from its respective neighbours. The transform coding comprises an important component of image processing.
Fourier transformation is a mathematical tool used to transform signals from one domain to another. It is widely used in various applications such as image processing, signal analysis, and data compression. The Fourier transform decomposes a signal into its frequency components, allowing for easier analysis and manipulation.

### 2.2 Run Length Encoding:

Run length encoding (RLE) is a data compression technique that is particularly useful for compressing data with an expected distribution of runs of zeros. It encodes runs of zeros and ones using a run length code (RLC), which is a sequence of run lengths. The runs are encoded using a run length code (RLC) that consists of a sequence of run lengths.

There are two types of run length codes: fixed-length and variable-length codes. Fixed-length codes are used for runs of zeros and ones, while variable-length codes are used for runs of zeros that are not in the expected distribution. The fixed-length codes are based on the assumption that the distribution of runs of zeros is known in advance.

### 2.3 Fourier Transformation:

The Fourier transform is a fundamental concept in signal processing and is used to analyze signals in the frequency domain. It transforms a signal from the time domain to the frequency domain, allowing for the separation of the signal into its frequency components. The Fourier transform is a linear operation that decomposes a signal into a series of sinusoidal functions.

The Fourier series is a representation of a periodic function as a sum of sine and cosine functions. The Fourier transform extends this concept to non-periodic functions and is defined as an integral of the function multiplied by a complex exponential function. The Fourier transform is a powerful tool for analyzing signals and is used in a wide range of applications, including image processing, signal analysis, and data compression.
2.4 Huffman Coding

Huffman codes are variable-length codes and are optimum for a source with a given probability model [6]. Here, optimality implies that the average code length of the Huffman codes is closest to the source entropy. In Huffman coding, more probable symbols are assigned shorter code words and less probable symbols are assigned longer code words. The procedure to generate a set of Huffman codes for a discrete source is as follows.

Huffman Coding Procedure

Let a source alphabet consist of M letters with probabilities \( p_i \), \( 1 \leq i \leq M \).

1. Sort the symbol probabilities in a descending order. Each symbol forms a leaf node of a tree.
2. Merge the two least probable branches (last two symbols in the ordered list) to form a new single node whose probability is the sum of the two merged branches. Assign a “0” to the top branch and a “1” to the bottom branch. Note that this assignment is arbitrary, and therefore, the Huffman codes are not unique. However, the same assignment rule must be maintained throughout.
3. Repeat step 2 until left with a single node with probability 1, which forms the root node of the Huffman tree.
4. The Huffman codes for the symbols are obtained by reading the branch digits sequentially from the root node to the respective terminal node or leaf.

Huffman coding is an entropy encoding algorithm used for lossless data compression. The term refers to the use of a variable-length code table for encoding a source symbol (such as a character in a file) where the variable-length code table has been derived in a particular way based on the estimated probability of occurrence for each possible value of the source symbol. This technique is proposed by the Dr. David A. Huffman in 1952. This is a method for the construction of minimum redundancy codes. This technique is applicable to many forms of the data transmission. Huffman encoding is a form of statistical coding. In the Huffman encoding not all the characters occur with the same frequency. Yet all characters are allocated the same amount of space. Huffman encoding is a general technique for coding symbols based on their statistical occurrence frequencies (probabilities). The pixels in the image are treated as symbols. The symbols that occur more frequently are assigned a smaller number of bits, while the symbols that occur less frequently are assigned a
relatively larger number of bits. Huffman code is a prefix code. This means that the (binary) code of any symbol is not the prefix of the code of any other symbol. Most image coding standards use lossy techniques in the earlier stages of compression and use Huffman coding as the final step. Huffman coding uses a specific method for choosing the representation for each symbol, resulting in a prefix code (sometimes called "prefix-free codes", that is, the bit string representing some particular symbol is never a prefix of the bit string representing any other symbol) that expresses the most common source symbols using shorter strings of bits than are used for less common source symbols. Huffman was able to design the most efficient compression method of this type: no other mapping of individual source symbols to unique strings of bits will produce a smaller average output size when the actual symbol frequencies agree with those used to create the code. The running time of Huffman's method is fairly efficient, it takes $O(n \log n)$ operations to construct it. A method was later found to design a Huffman code in linear time if input probabilities (also known as weights) are sorted.

### 3. METHODOLOGY:

The compression algorithm for digital images is based on the discrete cosine transform and it comprises of the following steps:

1. First of all we take the digital image of fingerprint.
2. The digital image is of gray level image.
3. Then these digital images are preprocessed using the cosine based image compression and are used to skeletoning the elements of the image which have greater importance.
4. Cosine based image compression is used to eliminate the undesired symbols and signals which arise during the acquisition process.
5. Further we use the run length encoding to eliminate unwanted noise and the pending redundancy of sequence and symbols.
6. Digital Images will be processed through Fourier transform to find the amplitude difference with correlation method and will identify the similarity between two images.
7. Finally, the comparison of the images will be done to find the best similarity result with compression.
4. RESULTS AND DISCUSSION

Figure 1: Flow chart methodology

Figure 2: Showing the fingerprint image taken as input

Figure 3: Compressed image after implementation of DCT algorithm over original image.
Figure 4: Final compressed image after Run length compression.

Figure 5: Histogram of input original image
Figure 6: Histogram of compressed image after process of DCT.

Figure 7: Histogram of final compressed image after Run length process.
Figure 8: Showing the fingerprint image taken as input

Figure 9: Compressed image after implementation of DCT algorithm over original image.
Figure 10: Final compressed image after Run length compression.

Figure 11: Histogram of input original image
Figure 12: Histogram of compressed image after process of DCT.

Figure 13: Histogram of final compressed image after Run length process.
Figure 14: Showing the fingerprint image taken as input

Figure 15: Compressed image after implementation of DCT algorithm over original image.
Figure 16: Final compressed image after Run length compression.

Figure 17: Histogram of input original image
Figure 18: Histogram of compressed image after process of DCT.

Figure 19: Histogram of final compressed image after Run length process

<table>
<thead>
<tr>
<th>Image</th>
<th>Compression ratio according to Run length encoding</th>
<th>Compression ratio according to Huffman</th>
</tr>
</thead>
<tbody>
<tr>
<td>Image 1</td>
<td>62.1118</td>
<td>0.3849</td>
</tr>
<tr>
<td>Image 2</td>
<td>1.263206816421379e+03</td>
<td>0.6010</td>
</tr>
<tr>
<td>Image 3</td>
<td>58.5523</td>
<td>0.0220</td>
</tr>
<tr>
<td>Image 1</td>
<td>0.4641</td>
<td></td>
</tr>
<tr>
<td>---------</td>
<td>--------</td>
<td></td>
</tr>
<tr>
<td>Image 2</td>
<td>0.7300</td>
<td></td>
</tr>
<tr>
<td>Image 3</td>
<td>0.3983</td>
<td></td>
</tr>
</tbody>
</table>

In the figure2, figure8 and figure14 we take the fingerprint image as a input. Then apply the discrete cosine transformation (DCT) encoding technique for the compression in the figure3, figure9 and figure15. Due to DCT the undesired symbols, signals get removed and fingerprint image compressed then we apply run length encoding technique to remove pending noise and pending redundancy in figure4, figure10 and figure16. It shows the Histogram of input original image in figure5, figure11 and figure17. Histogram of compressed image after process of DCT in figure6, figure12 and figure18. The Histogram of final compressed image after Run length process in figure7, figure13 and figure19. The histogram of input of original fingerprint image in figure5,11,17 shows the approximately all the bars are of same size. The histogram of compressed image after process of DCT in figure6, figure12, figure18 shows that the bars having the variation because of the compression applied on fingerprint image in figure no.3. The histogram of final compressed image after run length encoding in figure7, figure13, figure19 shows the bars having more variation because of the compression applied on fingerprint image in figure no.4, figure10, figure16.

5. CONCLUSION

The paper shows that using Discrete Cosine Transformation and Run Length Encoding, the software is developed under Matlab mathematical platform that allows the efficient compression of the digital images. The quality of the image after compression is the main criteria that all the compression techniques should hold. The compression scheme has generally superior performance in a digital image.

References