COMPRESSION OF FINGERPRINT USING K-SVD-SR METHOD

V.M Joshi[1], Rounak Mangroliya[2]

[1]*Assistant Professor, VLSI & Embedded System, PVPIT, Maharashtra, India*
[2]*Student, VLSI & Embedded System, PVPIT, Maharashtra, India*

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Abstract - *In this paper, we have introduced a new fingerprint compression algorithm which is dependent on sparse representation. By acquiring an over-complete dictionary from a set of fingerprint patches, it lets us to exhibit them as sparse linear combination of the dictionary atoms. First of all, we represented a dictionary in the algorithm for predefined fingerprint image patches. Then exhibit the patches for a current given fingerprint images on the basis of the dictionary by reckoning l0-minimization and later quantize and encode the representation. Thus in this experiment, we observed the effect of different factors on the results of compression. The experiments show that our algorithm is efficient as compared with other competing compression techniques (WSQ, JPEG and JPEG 2000), especially at high compression ratios.*

Keywords: Fingerprint, compression, sparse representation, JPEG 2000, JPEG, WSQ, PSNR.

1. INTRODUCTION

Images are considered most important medium of conveying information. To work with images in some applications they need to compressed, more or less depending on purpose of the application. There are some algorithms that perform such kind of compression in different ways; some are lossless and keep the same information as original image, others losses information when compressing the image. Some algorithms even let you change the parameters they use to adjust compression better to the image.

A new fingerprint compression technique based on sparse representation is introduced. Obtaining an over complete dictionary from a set of fingerprint patches allows to represent them as a sparse linear combination of dictionary atoms. In this experiment, we first construct a dictionary for predefined fingerprint image patches. For a new given fingerprint images, represent its patches according to dictionary by computing minimization and then quantize and encode the representation [1].

In this experiment work, we considered the effect of various factors on compression results. Three groups of the fingerprint images are tested. The experiments demonstrate that our algorithm is efficient compared with several competing compression techniques (WSQ, JPEG and JPEG 2000). The experiment also shows that proposed algorithm is robust to extract minutiae.

1.1 LOSSLESS COMPRESSION

In lossless compression scheme, the reconstructed image is numerically identical to the original image. It is used in applications like ZIP file format & in UNIX tool gzip. It is important when original and decompressed data be identical. Some of the image file formats like PNG or GIF use only lossless compression. The lossless compression programs do two things in sequence: the first step generates a statistical model for the input data, and the second step uses this model to map input data to bit sequences in such a way that "probable" (e.g. frequently encountered) data will produce shorter output than "improbable" data.

1.2 LOSSY COMPRESSION

Lossy compression technique provides higher compression ratio as compared with lossless compression. In this technique, the compression ratio is high; the decompressed image is not exactly similar to the original image. Different types of lossy compression methods are widely used, characterized by the quality of the reconstructed images and its adequacy for an application. A lossy compression technique, may examine the color data for a range of pixels, & identify subtle variations in pixel color values that are so minute that the human eye/brain is unable to compare the difference between them.

2. METHODOLOGIES BY PREVIOUS RESEARCHERS

Image compression exploits redundancy to attain the reduction within the actual quantity of the information with or without the quality info loss in keeping with sure rules through the remodel and combination. Many compression algorithms are in follow like JPEG, WSQ and JPEG2000, etc. despite the fact that there are a unit several applications for compression very small work has been exhausted the progressive retrieval of pictures.

Table -1: Different Image format with its characteristics

FORMAT	NAME	CHRACTERISTICS	Compression Ratio(True Colour Image) of 24 bit
BMP	Window bitmap	Uncompressed format	1:1
TIFF	Tagged Image File Format	Lossless: Document scanning and imaging format. Flexible: LZW, RLE,	2:1
PNG	Portable Network Graphics	Lossless: improve and replace GIF. Based on the DEFLATE algorithm.	2.7:1
JPEG	Joint Photographic Experts Group	Lossy: big compression ratio, good for photographic images	16:1
JPEG 2000	Joint Photographic Experts Group 2000	Lossy: eventual replacement for JPEG	20:1

The formula ought to offer efficient and progressive compression and decompression for gray-scale and color icon (.bmp) images applying provides economical & versatile compression for (.bmp) images with variable compression ratios, applying finds use in transmission of pictures, storage of pictures moreover as image mining. Sparse representation has already applications in image compression. Table 3.1 shows different Image format with its characteristics.

3. METHODOLOGIES USED IN THIS SYSTEM

A replacement method the K-SVD algorithm generalizing the K- means cluster method. The K-SVD formula is versatile and might work with any pursuit methodology. The K-SVD is a rule for training of dictionaries. This rule is versatile and works in conjunction with any pursuit rule. The K-SVD is very economical, as a result of an efficient sparse writing and a Gauss–Seidel-like accelerated wordbook update algorithm. The algorithm's steps square measure coherent with every there, each operating towards the step-down of a transparent overall objective perform.

Following are the steps of fingerprint compression using K-SVD-SR Method:

- For a given fingerprint, slice it into small patches
- For each patch, its mean value is calculated and subtracted from the patch
- For every patch, solve the l^0-minimization problem by matching pursuit method.
- Those coefficients whose value is less than a given threshold are treated as zero. Record the remaining coefficient and their location
- Encode the atom number of every patch, the mean value of every patch, and the indexes; quantize and encode the coefficients.
- Output the compressed stream.

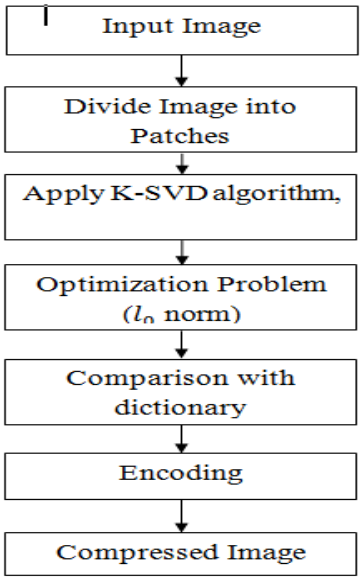

Fig -1: Flow Chart of K-SVD Method

3.1 K-SVD ALGORITHM

In applied mathematics, K-SVD is a dictionary learning algorithm for creating a dictionary for sparse representations, via singular value decomposition technique. K-SVD is a generalization of the k-means clustering method, and it works by iteratively alternating between the sparse coding the input data based on the current dictionary and updating the atoms in the dictionary to better fit the data.

Any real m x n matrix A can be decomposed uniquely

$$A = USV^T$$

Where U is m x n and column orthonormal ($U^T U = I$), S is n x n and diagonal matrix

$$S = diag(\sigma_1, \sigma_2, .., \sigma_n) \text{ Where}$$

σ_1 *is singular value of A*

V is n*n and orthonormal ($V^T V = VV^T$=I)

4. PERFORMANCE PARAMETERS AND RESULTS

For Evaluation of Compression algorithm like WSQ, JPEG, JPEG2000 and K-SVD methods, Quality of image is analyzed on the basis of factors such as MSE and PSNR which needs to be calculated. The Mean Square Error (MSE) and the Peak Signal to Noise Ratio are the two error metrics used to compare image compression quality. The MSE represents cumulative squared error between compressed and original image, whereas PSNR represents a measure of peak error. The lower the value of MSE, the lower will be the error. To compute the PSNR, the block first calculates the mean-squared error using the following equation:

$$MSE = \frac{1}{m*n}\sum_{i=0}^{m-1}\sum_{n=0}^{n-1}[I(i,j) - K(i,j)]^2$$

In the above equation, M and N are the number of rows and columns in the input images, respectively. Then block computes the PSNR using following equation:

$$PSNR = 10 * log_{10}\left(\frac{R^2}{MSE}\right)$$

In the previous equation, R is the maximum fluctuation in input image data type. For example, if the input image has double-precision floating-point data type, then R is 1. If it is an 8-bit unsigned integer data type, R is 255, etc. The PSNR block computes the peak signal-to-noise ratio, in decibels, between the two images. Peak signal-to-noise ratio is often used as quality measurement between original and the compressed image.

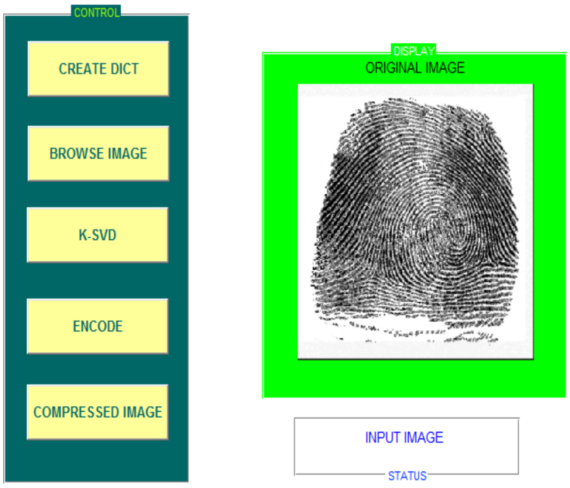

Fig -2: Original Image

Fig -3: Compressed Image

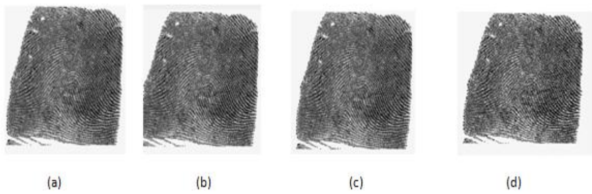

Fig-4: Comparisons with other methods (a) Original Image (b) WSQ ,(c) JPEG (d) K-SVD-SR method at compression ratio 40:1

Table-2: Resulting Average and Variance of PSNR (DB) From Different Algorithms. For Each Grid, the Left is the Mean Value and Right is the Variance

Compression Ratio	10	20	30	40
JPEG	30.85, 1.18	28.37, 1.57	26.52, 1.93	26.66, 2.45
JPEG 2000	32.81, 1.24	29.87, 1.48	28.90, 1.37	28.22, 1.43
WSQ	31.38, 1.30	28.74, 1.41	27.64, 1.31	26.96, 1.27
K-SVD-SR	31.96, 0.84	30.34, 1.12	29.90, 1.21	27.90, 1.20

4. CONCLUSIONS

We found that a new compression algorithm is adapted to fingerprint images. Even though our proposed algorithm is simple, they never fail to compare the existing more sophisticated algorithms at high compression ratios. Because of the block-by-block processing mechanism, we can find that the algorithm has higher complexities. The dictionary that is found out by the K-SVD algorithms works the best. To make the compression result a better one we should have the larger number of a training set. Also we showed that K-SVD algorithm is efficient as compared with other competing compression techniques likes (JPEG, JPEG 2000), especially at high compression ratio.

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