IJARCCE

ISSN (Online) 2278-1021
ISSN (Print) 2319 5940

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 5, Issue 3, March 2016

Compression of Image by K-SVD Method

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

PVPIT, Pune, Maharashtra, India

Abstract: A new fingerprint compression technique based on sparse representation is introduced. Obtaining an over complete dictionary from a set of different fingerprint patches allows us to represent them as a sparse linear combination of the dictionary atoms. In the algorithm, first step is to construct a dictionary for predefined fingerprint image patches. For a new fingerprint images, represent its patches according to the dictionary by evaluating l0-minimization problem and then quantize and encode the matrix. In this paper, we consider various factors affecting the compression results. The main idea behind the project is to construct a base matrix whose columns represent features of the fingerprint images, referring to the matrix dictionary whose columns are known as an atoms; for a given whole fingerprint image, create a patches whose number of pixels are equal to the dimension of the atoms; use sparse representation method to obtain the coefficients; then, quantize the coefficients; and last, encode the coefficients with the help of lossless coding methods. Especially at high compression ratios the proposed algorithm is efficient compared with several competing compression techniques like (JPEG, JPEG 2000, and WSQ).

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

I. INTRODUCTION

Recognition of persons in the society by means of biometric characteristics is an important technology, because biometric identifiers can't be shared to other and they intrinsically represent the individual's bodily identity. Some of the popular biometric technologies for personal identification are their universality, uniqueness, invariance and collectability. Forensics and access control are collected in large volumes of fingerprints and stored every day in a wide range of applications. There were only 200 million items in FBI fingerprint card archive in 1995 and day by day archive size was increasing at the rate of 30,000 to 50,000 new cards. A fingerprint image compression is the key technique to solve this problem.

Generally, compression technologies can be classified into two types lossless and lossy. Lossless compression allows original images and reconstructed image from the compressed data are same. Avoiding distortion limits their compression efficiency. In image compression where slight distortion is acceptable, lossless compression technologies are often employed in the output coefficients of lossy compression. In lossy compression usually an image is transform into another domain, then quantizes and encodes its coefficients. Two most common technique of transformation are the Discrete Wavelet Transform (DWT) and the Discrete Cosine Transform (DCT).

Compression of a stream of 8x8 blocks of images is a DCT- based encoder and used in JPEG compression technique. The JPEG compression technique has many advantages such as availability, simplicity and universality. Underlying block-based DCT method has bad performance at low bit-rates. Due to this reason, as early as 1995, the JPEG-committee began to develop a new wavelet-based compression standard technique, namely JPEG 2000. In the DWT algorithms consist of following three steps: DWT computation of the normalized image, quantization of DWT coefficients and finally lossless coding of quantized coefficients. In most the cases, the evaluation of compression performance of algorithms is restricted to Peak Signal to Noise Ratio (PSNR). In Automatic Fingerprint identification System, the main feature used to match two fingerprint images are minutiae. Therefore, we have considered the difference of the ridges endings and bifurcations between pre and post compression.

II. THE MODEL AND ALGORITHMS OF SPARSE REPRESENTATION

A. The Model of Sparse representation

For a given matrix $A = [a_1, a_2, ..., a_N] \in R^{M \times N}$, any new sample value which is $y \in R^{M \times 1}$ is assumed to be represented as a linear combination of few columns from the dictionary A, given by below formula

$y = Ax$ Where $y \in R^{M \times 1}, A \in R^{M \times N}$ and $x = [x_1, x_2, ..., x_N]^T \in R^{N \times 1}$

Obviously, the system $y = Ax$ is underdetermined when M < N. Therefore, its solution is not unique. According to the assumption, the representation is sparse. A proper solution can be obtained by solving the following optimization problem:

$$(l^0): \quad \min \|x\|_0 \quad s.t \quad y = Ax$$

B. Sparse solution by greedy algorithm

The researches thought of solving optimization problem L0 directly first. The problem of finding the sparse solution of the system is NP-hard. L0 problem is solving with the help of the MP because of simple and efficient one.

III. FINGERPRINT COMPRESSION

In this section we give the idea how to use the sparse representation technique to compress fingerprint images. It includes construction of the dictionary, compress a given

IJARCCE

ISSN (Online) 2278-1021
ISSN (Print) 2319 5940

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 5, Issue 3, March 2016

fingerprint image, quantize and coding and analysis of the algorithm are included here. As more information is contains in a dictionary, its size is huge. So, the pre-processing is essential to obtain a modest size dictionary. Transformation, noise and rotation can influence the finger prints image same finger and can make it look different.

A. Construction of the Dictionary
First step is to construct a training set. Then, dictionary is obtained from the training set. Choose the whole fingerprint, cut them into fixed-size square patches. After the initial screening of patches, a greedy algorithm is employed for construction of the training samples.

1. The first patch is added to the dictionary, which is initially empty.
2. Then we have to check all the patches to find out their similarity in the dictionary. If yes, the next patch is tested; otherwise, the patch is added into dictionary
3. Repeat the second step until all patches have been done.

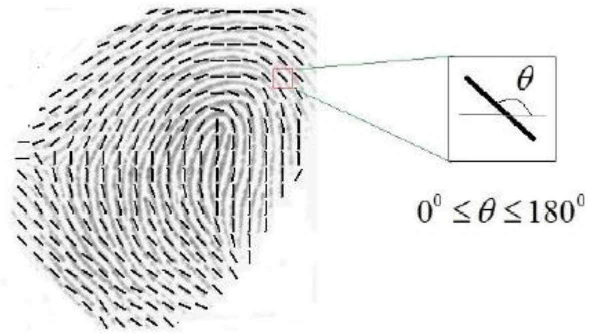

Fig 1: A Fingerprint image with its corresponding orientation image computed over a square-meshed grid.

Before construction of dictionary calculate mean value of each patch and subtract from the corresponding patch. The three methods are given below:

First method: First fingerprint images are chosen at random and average as columns of the dictionary matrix.
Second method: Patches from the foreground of a fingerprint have an orientation but patches from the background don't have orientation. This helps us to construct the dictionary. The intervals are to be divided equally. The intervals have equal orientation. The numbers of patches are same (or) each interval and after that they are arranged into the dictionary.
Third method: Third method is training method. We can obtain the dictionary by iteratively solving an optimization problem.

B. Compression of a given fingerprint
If a new fingerprint is given, that sliced it into square patches of the same size with the training patches. The size of the patches is directly proportional to the compression efficiency. The algorithm becomes more efficient as size of patch increases. We have to choose the proper size. To make the patches fit the dictionary better, the mean of each patch is calculated and subtracted from the patch. After hat, calculate the sparse representation for each patch by solving the l0 optimization problem. The coefficients whose absolute values are less than a given threshold value are considered as zero. For each patch, four kinds of information are recorded like mean value, number of atoms to use, the coefficients and locations for each patches. It is tested that many image patches need few coefficients.

C. Coding and Quantization
Static arithmetic coder carries entropy coding of the atom number of each number, the mean value of each patch, the coefficients and the indexes. We have to code the atom number of each patch and the mean value of each patch separately. Lloyd algorithm is used in the quantization of coefficients from the training set by the MP algorithms over the dictionary we can obtain learnt off-line from the coefficients. A large number of bits are used to quantize the first coefficient of each block. The other coefficients and entropy-coded are quantized by using a separate arithmetic coder

D. Analysis of the Algorithm Complexity
The training process and the compression process are the two parts of algorithm. We analyze only the complexity of compression process as the training process is off-line.

Algorithm: Fingerprint Compression based on Sparse Representation
1) The fingerprint is to be sliced into small patches.
2) We have to calculate the mean of each patch and it is subtracted from the patch.
3) MP method is used to solve the l0- minimization problem for each patch.
4) If the absolute value of a coefficient is less than a given threshold we have to that it was zero. Then the remaining coefficients and their locations are recorded.
5) We have to encode the atom number of each patch, the mean value of each patch, and the indexes, quantize and encode the coefficients.
6) Then the compressed stream is output.

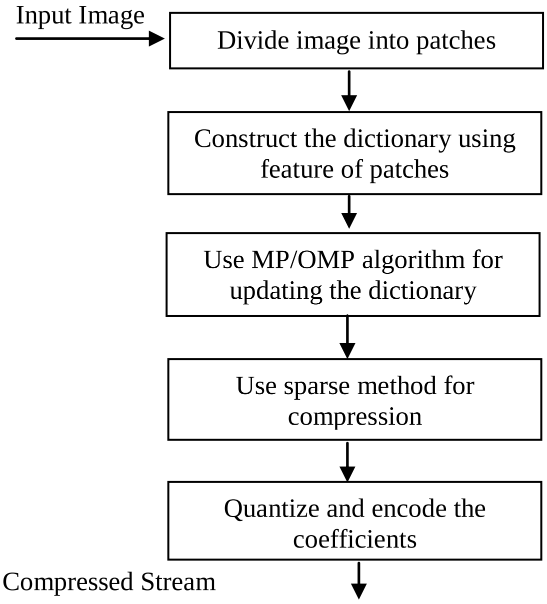

Fig 2: Architectural diagram

IJARCCE

ISSN (Online) 2278-1021
ISSN (Print) 2319 5940

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 5, Issue 3, March 2016

IV. EXPERIMENT

Aiming both to demonstrate the feasibility of the proposed compression algorithm and to validate the claims of the previous sections experiments on fingerprint database for fingerprint compression is presented by us. Initially, we describe the database used in the study. Later, it is proved that the proposed method is feasible and we give the experimental results on three various dictionaries. Then, the method of choosing the proper parameter is studied. Then we make a comparison of our method with the relevant fingerprint compression algorithm namely WSQ, JPEG, JPEG 2000. Then a study is making about the designing of the training set of sparse representation. Experiment is done to show that the proposed compression algorithm is robust to extract minutiae.

A. Databases

A set of training fingerprints including a major pattern types is used to construct a dictionary of fingerprint patches. The distribution of different pattern in this set and the distribution in the other database need not be similar they can be dissimilar also.

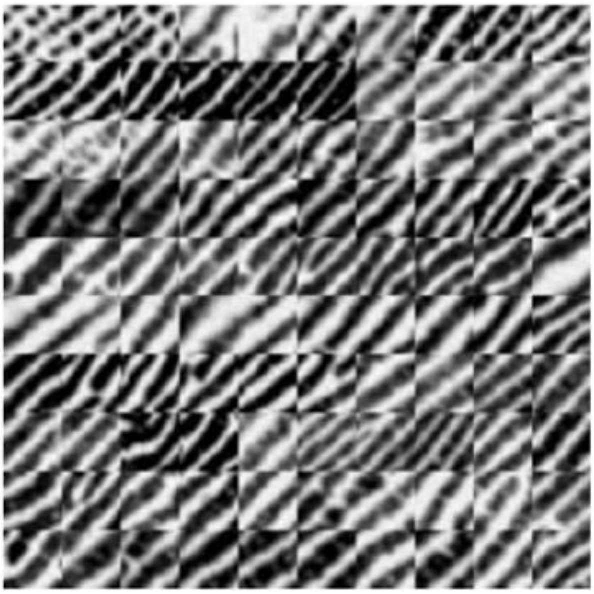

Fig 3: sample of 100 patches with size 20*20

B. Feasibility of Fingerprint Compression on Sparse Representation

There are both a few large coefficients and other coefficients which are approximately equal to zero in the patches of fingerprints. For some patches we don't have coefficients at all. The mean values of the patches of database can be represented effectively from the background of the fingerprint images.

C. Experimental Results in Different Dictionaries

We study, the effects of different dictionaries on fingerprint compression is here. Selecting 4096 patches at random and arranging them as columns of the dictionary, selecting patches as per orientations and training the dictionary by K-SVD method are the three different ways to construct the dictionary.

D. Choose the Algorithmic Parameters

The size of the patches and the size of the dictionary are the parameters in the compression based on sparse representation. The size of patches and compression efficiency are directly related.ie) if the size is larger than the efficiency will be higher. If the dictionary is quite large the arbitrary patch can be represented well which causes more computational complexity. Only with experiments the size of the patch is chosen.

E. Comparison with Existing Fingerprint Compression Algorithms

A comparison is made between the proposed methods with existing fingerprint compression algorithms. The same database is used to test our algorithm and all others. We can find in matlab the implementation of our compression algorithm. WSQ, JPEG, JPEG 2000 are the three images used in compression algorithms.

Normally, the fingerprint images are not the multiple of size of the patches. If not the left part of the fingerprint images is arranged into the columns vector if the same size as the patch in a given order. MP algorithm can be used under the same dictionary can be used to represent the column vector.

Each fingerprint image cannot be exactly compressed at the given compression ratios. The nearest one from those which are not less than the given compression ratios minus 2.5 as the final compression ratio is chosen.

F. Design the Training Set

We have to consider many details to target the problem of fingerprint. The number of training samples, components of the training set and how to modify the dictionary we have to take the consideration.

1) The number of training samples:
As K-SVD method trains the dictionary, the effect of the number of training samples on the PSNR is to be considered.

2) Components of the training set:
General images are not easy to deal with even though the fingerprint images are simple. Some of the main feature of the fingerprints is in the orientation, ridge frequency and minutiae. These are important in the construction of dictionary.

3) Modify the dictionary:
Empirical information is to be used to modify the dictionary as it has the ability of learning. If we apply for longer period many patches cannot be represented well. So, these new patches and original patches can be used to update the dictionary.

G. Robustness

Gabor filtering does not rely on minutiae, but minutiae are mainly used in most Automatic Fingerprint Identification System to match two fingerprint images. So, we compare the difference of minutiae between pre and post compression in the illustration of the robustness of our algorithm. The accuracy rate, the recall rate and their sum are the important standards to measure the robustness.

DOI 10.17148/IJARCCE.2016.53148

ISSN (Online) 2278-1021
ISSN (Print) 2319 5940

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 5, Issue 3, March 2016

V. CONCLUSION

We find 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 effect of the block of our algorithm is less serious than that of JPEG. The effect of three different dictionaries on fingerprint compression is considered by us. 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.

We have to preserve the minutiae to find out the identification which is the main difficulty in developing compression algorithms for fingerprints. At the time of compression and reconstruction our algorithm can old most of the minutiae robustly.

Finally we have to give importance to the following points and we should not be forgotten in future work. They are 1) we should think about the features and the methods for constructing dictionaries.2) Fingerprints of various qualities should be included in the training sample.3) the optimum algorithms which can solve a sparse representation are to be investigated.4) we have to optimize the code so that the complexity of our proposed method is reduced. Lastly, applications based on sparse representation for fingerprint images must be founded after through experiments.

REFERENCES

[1] W. Pennebaker and J. Mitchell, JPEG—Still Image Compression Standard. New York, NY, USA: Van Nostrand Reinhold, 1993.
[2] O. Bryt and M. Elad, "Compression of facial images using the K-SVD algorithm," J. Vis. Commun. Image Represent., vol. 19, no. 4,pp. 270–282, 2008
[3] M. Aharon, M. Elad, and A. M. Bruckstein, "The K-SVD: An algorithm for designing of overcomplete dictionaries for sparse representation,"IEEE Trans. Signal Process., vol. 54, pp. 4311–4322, 2006.
[4] S. S. Chen, D. Donoho, and M. Saunders, "Atomic decomposition by basis pursuit," SIAM Rev., vol. 43, no. 1, pp. 129–159, 2001.
[5] M. Elad and M. Aharon, "Image denoising via sparse and redundant representation over learned dictionaries," IEEE Trans. Image Process., vol. 15, no. 12, pp. 3736–3745, Dec. 2006.

BIOGRAPHIES

Rounak Mangroliya received the B.E degree in E&TC from SGBA University, India. He is working with TCS, India. His area of interest are Digital Image processing, Embedded systems, Digital System

Prof. V.M Joshi pursuing her P.HD from Bharati Vidyapeeth pune. She has 16 years of experience in teaching. Her area of interest is Embedded system,VLSI.

DOI 10.17148/IJARCCE.2016.53148