

Latent Fingerprint Compression Using Sparse Representation

H.S.Vimala

Associate Professor, Department of CSE, UVCE, Bangalore University, Bangalore, Karnataka, India

ABSTRACT: Latents are usually partial fingerprints with smaller number of minutiae points. Minutiae are the main feature used to match two fingerprint images i.e., ridge endings and bifurcation. Therefore, difference between pre and post compression is considered. Fingerprint compression algorithm based on sparse representation is considered in this paper. Obtaining a complete dictionary from a set of fingerprint patches allows us to represent them as a sparse linear combination of dictionary atoms. First construct dictionary for predefined fingerprint image patches. For a new given fingerprint images represent its patches according to the dictionary by computing L_0 -minimisation and quantize and encode the representation. Three groups of fingerprint images are tested. This method works efficiently when compared to JPEG, JPEG 2000, WSQ at high compression ratios. Due to the block by block processing mechanism, the algorithm has higher complexities.

KEYWORDS: Biometric, invariance, Lossy, Wavelet scalar Quantization, Minutiae

I. INTRODUCTION

Recognition of persons by means of Biometric characteristics is an important Technology in the Society, because it can't be shared and they intrinsically represent the individual's bodily identity. Among the many Biometric recognition technologies, Finger print recognition is very popular for personal identification due to the uniqueness, universality, collectability and invariance. Large volumes of Fingerprint are collected and stores every day in a wide range of applications, including Forensics and access control.

In 1995, the size of the FBI Fingerprint card archive contained over 200 million items and archive was increasing at the rate of 30,000 to 50,000 new cards per day. Large volume of data consume the amount of memory. Fingerprint image compression is a key technique to solve the problems.

Compression techniques can be classified as

1. Lossless 2. Lossy

Lossless technique allows the exact original images to be constructed from compressed data. These are used cases where it is important that the original and decomposed data are identical. Avoiding distortion limits their compression efficiency, when used in image compression where slight distortion is acceptable. Lossless compression techniques are often employed in the output coefficients of Lossy compression.

Lossy compression techniques usually transform an image into another domain, quantize and encode its coefficients. Transform – based image compression technologies have been extensively researched and some standards have appeared.

- Discrete cosine transform (DCT)
- Discrete wavelet transform (DWT)

DCT based encodes can be thought of as compression of a stream of $8*8$ small block of images. This is adopted in JPEG..

Pros,

- Simplicity,
- Universality,
- Availability.

Cons.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 7, July 2015

- Bad performance at low bit rates mainly because of the underlying block- based DCT scheme.

DWT includes three steps.

- ADWT computation of the normalized image.
- Quantization of the DWT coefficients.
- Lossless coding of the quantized coefficients.

DWT based algorithm,

SPIHT (set partitioning in hierarchical Trees) algorithm used for General image compression.

Wavelet scalar Quantization (WSQ) is a special algorithm become FBI standard for the compression of 500 dpi finger print images.

Other Method is the *Contourlet Transform (CT)*,

JPEG :

JPEG established JointPhotographic specialists cluster.

Joint Photographic Group or JPEG standard has been established by ISO and IEC (International Electron technical commission)

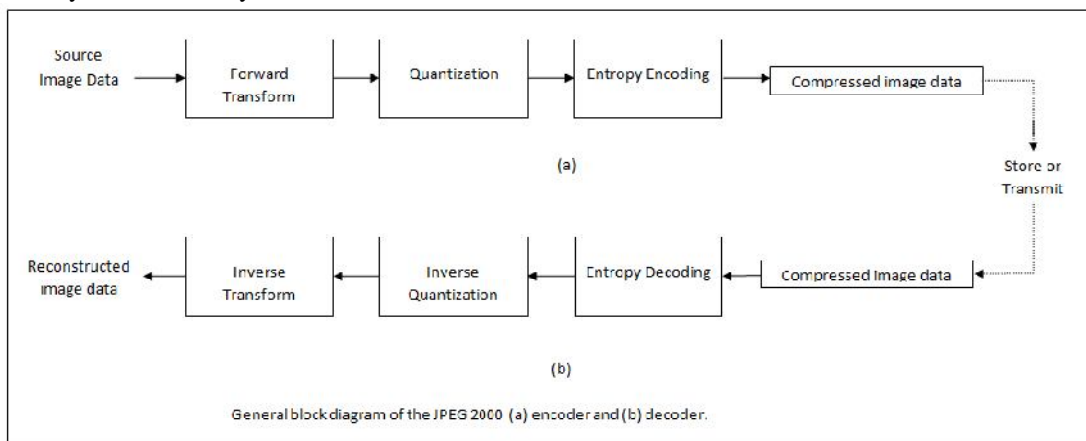
Steps :

1. Divide the image into 8x8 sub pictures.
2. Shift the gray-levels within vary [-128, 127].
3. Apply DCT on the divided image (64 constants are going to obtained: one DC coefficient and sixty three AC coefficients.
4. Quantize the coefficients and therefore the lesser coefficients square measure set to zero.
5. Order the coefficients mistreatment zigzag ordering and therefore the coefficients obtained square measure so as of increasing frequency.

JPEG committee developed Wavelet – based compression for still images i.e

JPEG2000 :

A fast summary of the whole system is asfollows:



The supply image is broken into parts.

- 1) The image parts square measure (optionally) rotten into rectangular tiles. The tile component is that the basic unit
- 2) of the initial or reconstructed image.
- 3) A moving ridge remodel is applied on every tile. The tile is decomposed into completely different resolution levels.
- 4) The decomposition levels square measure created from sub bands of coefficients that describe the frequencycharacteristics of local areas of the tile parts, instead of across the entire image element.
- 5) The sub bands of coefficients square measure quantity and picked up into rectangular arrays of “code blocks.”

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 7, July 2015

6) The bit planes of the coefficients in a very code block (i.e., the bits of equal significance across the coefficients in a very code block) square measure entropy coded.

7) The encryption is wiped out such the way those sure regions. Of interest is coded at a better quality than the background.

WSQ

WSQ (special compression algorithm, Wavelet scalar quantization).

It became the FBI standard for the compression of 500 dpi fingerprint images. The WSQ class of encoders involves a decomposition of the fingerprint image into a number of sub bands, each of which represents information in a particular frequency band. The sub band decomposition is achieved by a discrete wavelet transformation of the fingerprint image. Each of the sub bands is then quantized using values from a quantization table. The quantized coefficients are then passed to a Huffman encoding procedure which compresses the data. Huffman table specifications must be provided to the encoder.

K-SVD

K-SVD (Single value decomposition) is an iterative method that alternates between sparse coding of the examples based on the current dictionary, and a process of updating the dictionary atoms to better fit the data. The update of the dictionary columns is combined with an update of the sparse representations, thereby accelerating convergence. The K-SVD algorithm is flexible and can work with any pursuit method (e.g., basis pursuit, FOCUSS, or matching pursuit). We analyze this algorithm and demonstrate its results on both synthetic tests and in applications on real image data.

The k-svd is not effective when the dictionary size is so large. So a new compression standard based on sparse approximation is introduced.

II. PROPOSED SYSTEM

The shortcoming (in all the above methods), without the ability of learning, can't be compressed well. To solve this problem is solved latent fingerprint compression based on sparse representation based is given. Here features are extracted and represent them as dictionary atoms. In most AFIS, the main feature used to match two fingerprint images are Minutiae i.e. Ridge endings and bifurcation. Therefore difference between pre and post – compression is considered.

Based on Sparse representation. To construct a base matrix whose columns represent features of fingerprint images, referring the matrix dictionary whose columns are called atoms. For a given fingerprint, divide it into small blocks called patches whose number of pixels are equal to the dimension of the atoms. To use the sparse matrix to obtain the coefficients, then quantize the coefficients and other related information using lossless coding methods.

Algorithm:

1. For a given fingerprint divide it into patches.
2. For each patch its mean is calculated and subtracted from the patches.
3. Update the fingerprint dictionary by means of MP (Matching Pursuit) method.
4. Those co-efficient whose absolute value less than a threshold is treated as zero.
5. Record the remaining coefficient

We can enhance the algorithm by using OMP (Orthogonal Matching Pursuit) algorithm instead of MP (Matching Pursuit) algorithm. In OMP dictionary atoms taken once never taken again; there by reduces the total algorithm complexity.

In most instances the evaluation of compression performance of the algorithm is restricted to Peak Signal to Noise Ratio (PSNR) computation.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 7, July 2015

Compared with general natural images, the fingerprint images have simpler structure. They are only composed of ridges and valleys. In the local regions, they look the same. Therefore, to solve these two problems, the whole image is sliced into square and non-overlapping small patches. For these small patches, there are no problems about transformation and rotation. The size of the dictionary is not too large because the small blocks are relatively smaller.

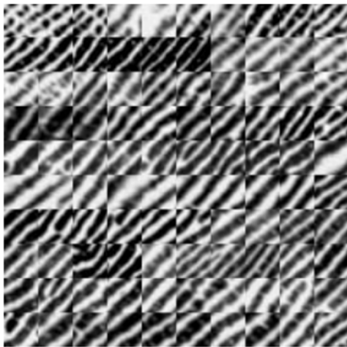


Fig1. 100 patches with size 20*20

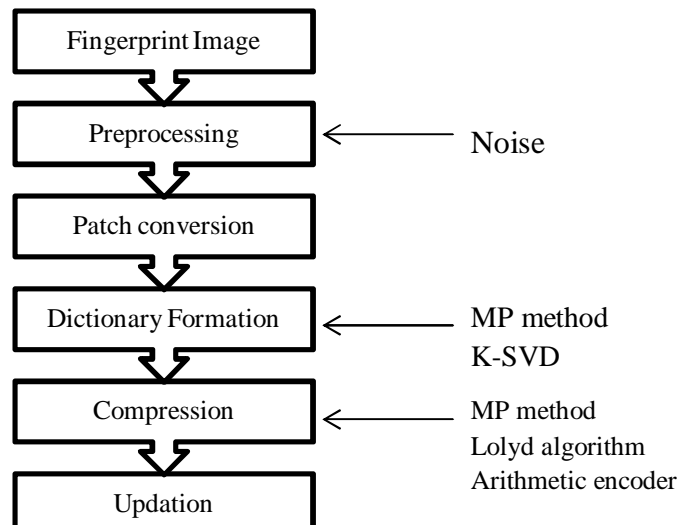


Fig 2. Flow of control

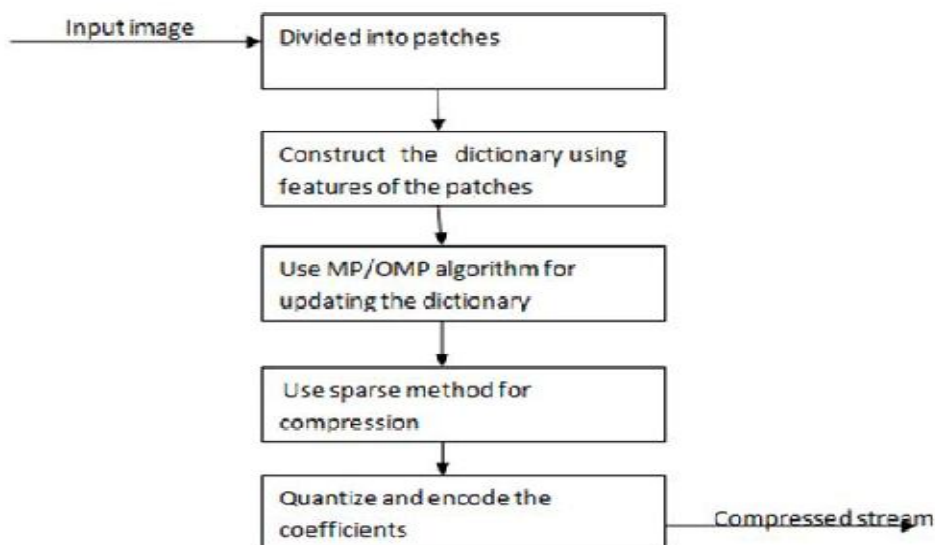


Fig 3. Architectural diagram

Fig.1 shows the sample of 100 patches with size 20*20.

Fig.3 shows the architectural diagram of the proposed standard.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 7, July 2015

III. EXPERIMENTS

There are three methods to construct the dictionary.

1. Randomly select some patches and arrange them as columns of the dictionary called *Random-SR*.
2. Select patches according to orientations called *Orientation-SR*. See Fig.1, they are 100 patches with orientation 45 and size 20×20 .
3. Train the dictionary by K-SVD method (K-SVD-SR in short).

We compare the proposed method with three different image compression algorithms, JPEG, JPEG 2000 and WSQ. The standard JPEG is a part of almost any image processing tool. The wavelet-based JPEG 2000 we use is provided by the Matlab. The WSQ algorithm is provided by a software downloaded on the Internet.

There are 2 groups of fingerprint images (referred to as DATABASE 1 & DATABASE 2) are tested in the experiments. DATABASE 1: Fifty fingerprints that are used to compare various compression technologies. DATABASE 2: the public fingerprint database, including 80 fingerprints with size 300×300 , which are used to compare existing compression technology.

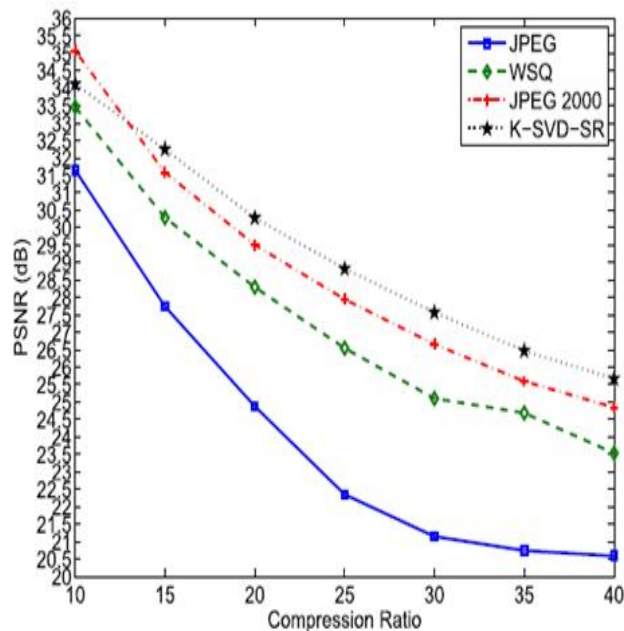


Fig:4 Average performance of proposed algorithms JPEG, JPEG 2000 and WSQ at various compression ratios, on DATABASE 1.

Here KSVD-SR (K-means single value Decomposition using Sparse Representation) has high PSNR value at compression ratio 20:1. The figure shows that the sparse algorithm outperforms the JPEG 2000 algorithm when the compression ratios are high.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 7, July 2015

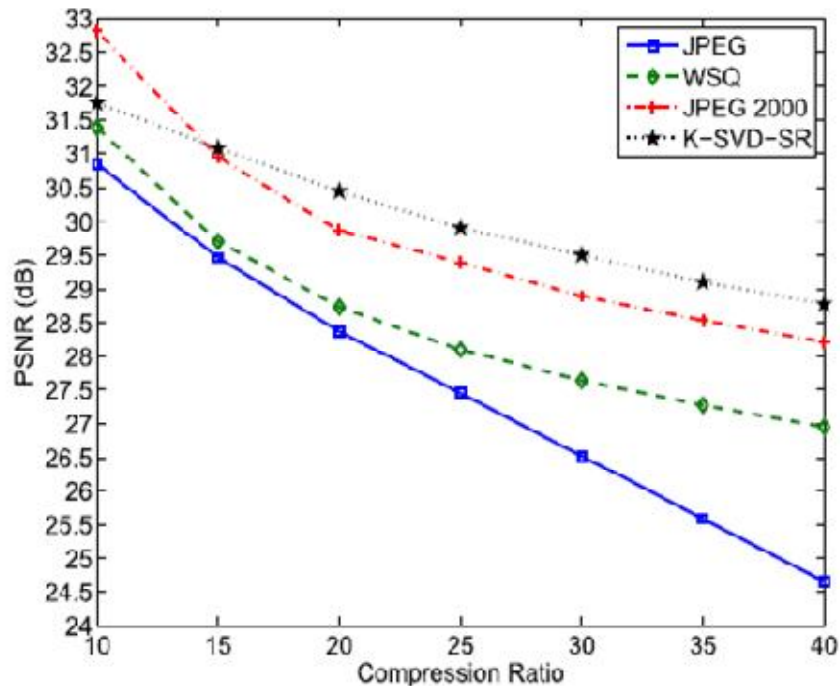


Fig:5 Average performance of proposed algorithm, JPEG, JPEG 2000 and WSQ at various compression ratios, on DATABASE 2.

Fig.5 show the average performances of the proposed algorithms, JPEG, JPEG 2000 and WSQ on DATABASE 2. The results on DATABASE 2 are roughly consistent with the results on DATABASE 1. Compared with JPEG and WSQ, proposed method's PSNR and JPEG 2000's PSNR are consistently higher. At compression ratio 15: 1, the performance of sparse method is as good as that of JPEG2000. At higher compression ratio, our algorithm outperforms the JPEG 2000. From the figure, we can see that the curve of our algorithm is the most flat. This means the rate of decay of our algorithm's PSNR is the slowest as the compression ratio increases.

IV. CONCLUSION

The different compression techniques adapted to compress the fingerprint image is reviewed and compared their performance especially at high compression ratios. A new compression algorithm based on sparse approximation is also introduced. Two groups of fingerprint images are tested. The experiments show that sparse algorithm is efficient than competing compression techniques like JPEG, JPEG 2000, WSQ, K-SVD etc, especially at high compression ratio and can hold most of the minutia robustly during the compression and reconstruction. However, the algorithm has higher complexities due to the block-by-block processing mechanism. Optimization of code of the different compression techniques has to be improved to reduce the complexity.

REFERENCES

- [1] Fingerprint Compression Based on Sparse Representation Guangqi Shao, Yanping Wu, Yong A, Xiao Liu, and Tiande Guo
- [2] N. Ahmed, T. Natarajan, and K. R. Rao, "Discrete cosine transform," *IEEE Trans. Comput.*, vol. C-23, no. 1, pp. 90-93, Jan. 1974.
- [3] C. S. Burrus, R. A. Gopinath, and H. Guo, *Introduction to Wavelets and Wavelet Transforms: A Primer*. Upper Saddle River, NJ, USA Prentice-Hall, 1998.
- [4] N. M. I. et al, / (IJCSIT) International Journal of Computer Science and Information Technologies, Vol. 6 (1) , 2015, 228-231 www.ijcsit.com
- [5] W. Pennebaker and J. Mitchell, *JPEG—Still Image Compression Standard*. New York, NY, USA Van Nostrand Reinhold, 1993.
- [6] M. W. Marcellin, M. J. Gormish, A. Bilgin, and M. P. Boliek, "An overview of JPEG-2000," in *Proc. IEEE Data Compres. Conf.*, Mar. 2000, pp.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 7, July 2015

- [6] T. Hopper, C. Brislawn, and J. Bradley, "WSQ gray-scale fingerprint image compression specification, Federal Bureau of Investigation Criminal Justice Information Services, Washington, DC, USA, Tech. Rep. IAFIS-IC-0110-V2, Feb. 1993.
- [7] S. G. Mallat and Z. Zhang, "Matching pursuits with time-frequency dictionaries," *IEEE Trans. Signal Process.*, vol. 41, no. 12, pp. 3397–3415, Dec. 1993.
- [8] J. Wright, A. Y. Yang, A. Ganesh, S. S. Sastry, and Y. Ma, "Robust face recognition via sparse representation," *IEEE Trans. Pattern Anal. Mach. Intell.*, vol. 31, no. 2, pp. 210–227, Feb. 2009.
- [9] O. Bryt and M. Elad, "Compression of facial images using the KSVD algorithm," *J. Vis. Commun. Image Represent.*, vol. 19, no. 4, pp. 270–282, 2008.
- [10] D. Maltoni, D. Miao, A. K. Jain, and S. Prabhakar, *Handbook of Fingerprint Recognition*, 2nd ed. London, U.K.: Springer-Verlag, 2009.