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Iris Image compression using Mallat based wavelet, Directional Filter Bank and SPIHT

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***Abstract*—One of the common way or method to authenticate identity of person is biometric recognition system.With the growing employment of the iris recognition systems and associated research to support this, the need for large databases of iris images is growing. Iris is considered to be the most unique attribute possessed by an individual and is regarded as the most reliable form of biometric authentication. Iris portion of the eye image is complex annular part it contains many distinctive features such as arching ligaments, furrows and ridges. The compression algorithms developed for iris images have to preserve the details present in the iris part of the image, which are used for subsequent biometric processes. We propose here, a compression scheme of iris images using Mallat based wavelet transform using Directional Filter Bank. Mallat algorithm is based on the multiresolution, and it represents the wavelet transform as a pyramid. Directional Filter Bank provides the flexibility to obtain good resolution, both angularly and radially. DFB has ability to extract the 2D directional information of iris image it and gives the perfect reconstruction. For encoding the SPIHT algorithm is used.**

Keywords— **Biometric Authentication, Iris image Compression, Directional Filter Bank(DFB), Mallat Wavelet Transform, SPIHT.**

I. INTRODUCTION

Personal identification system requires accuracy and reliability for biometric based access control system. Iris recognition system requires iris images databases for training the system. The complex annular iris part of the eye image contains the important features such as arching ligaments, furrows and collaret [1,2].

However, the increasing market saturation of biometric instead of conventional access control methods raises the need for efficient means to store such sensitive data. These motivates to effective image compression on iris biometrics to provide an efficient storage and rapid transmission of biometric records. In a modern world, biometric recognition is a common and reliable way to authenticate the identity of the person. A physiological characteristic is relatively stable physical characteristic such as fingerprints , iris pattern, retina scan etc. This kind of measurement is basically unchanging and unalterable during life time.[1]

Biometric identification or verification of identity is currently a very active field of research. Many applications that require some degree of confidence concerning the personal identification of the people involved such as banking, computer network access or physical access to secure facility are moving away from use of paper or plastic identity cards or alpha-numeric passwords. These systems are too easy to defeat. A higher degree of confidence can be achieved by using unique physical characteristics to identify a person.

Iris recognition is an automated method of biometric identification that uses mathematical pattern recognition techniques on video images of the irides of an individual's eyes, whose complex random patterns are unique and can be seen from some distance.

The iris is a thin circular diaphragm, which lies between the cornea and the lens of the human eye. A front view of the iris is as shown in the fig 1.

Figure1. Iris image

The function of iris is to control the amount of light entering through the pupil and this is done by the sphincter and the dilator muscles, which adjust the size of the pupil The average diameter of the iris is 12 mm and the pupil size can vary from 10% to 80% of the iris diameter.[1] Formation of iris begins during the third month of embryonic life.[2] The unique pattern on the surface of the iris is formed during the first year of life and pigmentation of stroma takes place for first few years. Formation of the unique pattern of the iris is random and not related to any genetic factors. . Due to the epigenetic nature of the iris patterns, the two eyes of an individual contain completely independent iris patterns.

A key advantage of iris recognition, besides its speed of matching and its extreme resistance to False Matches, is the stability of the iris as an internal, protected, yet externally visible organ of the eye.

II. NEED FOR COMPRESSION

In order to use biometrics for identification, the biometric data must be collected by some means. This may be a costly and time consuming process and the data obtained is valuable and must be protected. Furthermore, data collections can create an inordinate amount of data that puts a strain on the available storage. With the growing employment of the iris recognition systems and associated research to support this, the need for large databases of iris images is growing. If the required storage space is not adequate for these images, compression is an alternative. It allows a reduction in the space needed to store these iris images.

There are two types of compression schemes, lossless and lossy compression. Compression deals with techniques for reducing the space required for storage of data. The main motive of image reduction process is to remove the redundant data. In a specific area of still image compression, there are many efficient compression techniques with considerably different features.

In this paper we are introducing a lossless compression method to compress the iris image using Mallat Based pyramidal algorithm and Directional filter bank. First mallat based wavelet is applied on the iris image and Directional filter bank is applied on highpass band to find directionality features. Which gives the better mse,snr and the psnr

III. PROPOSED SYSTEM

In this section we explain the basic idea behind the proposed scheme. The Wavelet Based Mallat Transform and Directional Filter Bank (WBMT_DFB) as shown in Figure2. has two stages ,first stage is wavelet decomposion of iris image based on Mallat pyramidal algorithm[4]for multiresolution analysis.

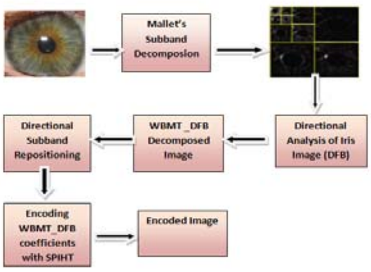

Figure 2.Block Diagram of WBMT_DFB Based Iris Image Compression.

The second stage of the WBMT_DFB is a directional filter bank (DFB)[3] analysis which provides angular decomposition. ForThe second stage i.e. DFB stage, we employ the iterated tree structured filter banks using fan filters. We apply DFB with the equal number of directional decompositions to each high pass band at that level of subband decomposition.

WBMT_DFB coefficient are then given as input to the encoder SPIHT.SPIHT [7] is the well known scheme used for image compression, it partitions sets in the wavelet decomposed image using a special data structure called a spatial orientation tree. A spatial orientation tree is a group of wavelet coefficients organized into a tree rooted in the lowest frequency (coarsest scale) subband with offspring in several generations along the same spatial orientation in the higher frequency subbands. Spatial orientation tree relationship between WBMT_DFB coefficients at different scales is developed.

A. Mallat Based Wavelet Transform

Wavelet theory is vast and provides a unified support for a variety of techniques that have been developed independently for different signal processing applications. For example multiresolution signal processing was developed considering
employing it in computer vision; subband coding was developed for signal and image compression; and wavelet expansion series was developed for applied mathematics. All of them have been recognized as different points of view of a unified theory.

In 1988, Mallat produced a fast wavelet decomposition and reconstruction algorithm [Mal89][4]. The Mallat algorithm for discrete wavelet transform (DWT) is, in fact, a classical scheme in the signal processing community, known as a two-channel subband coder using conjugate quadrature filters or quadrature mirror filters (QMFs).

The wavelet transform can be considered, as an analysis tool able to obtain the location of a variable in the time-frequency space and it is comparable to a fixed location obtained by the short time Fourier transform. _

Next, we will describe the pyramidal scheme for a wavelet representation[13].

Let D^0 be the image f, D^n is decomposed into a set of images $\{A_0^{n+1}, A_1^{n+1}, A_2^{n+1}$ *and* $D^{n+1}\}$, where each image is the result of a convolution operation between D^n and the 2D discrete filters GG,GH,HG and HH respectively. After each convolution, resultant images are subsampled, it means, we remove one column and one row for each two in order to decrease at half size; the result corresponds to a wavelet representation at resolution *n* composed by four images. The decomposition can be carried out repeatedly, preserving the A_x images and decomposing the image *D*. Resolution *n* is limited by image dimension. Figure 3 presents the scheme.

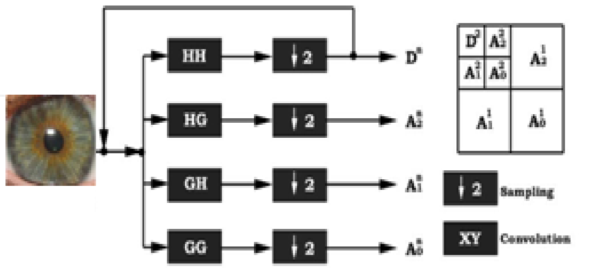

Figure3. The Pyramidal Scheme for Wavelet Representation

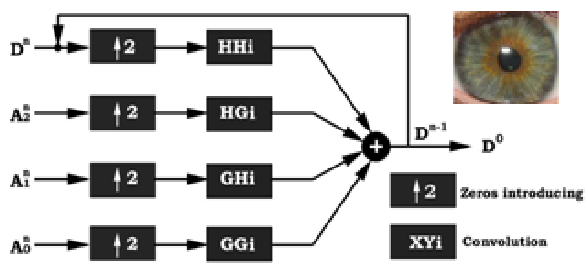

Figure4. The Wavelet Reconstruction Scheme

Reconstruction algorithm is presented in Figure 4. Initially it takes the last obtained images set { A_0^n, A_1^n, A_2^n *and* D^n}. Every element is expanded introducing zero vectors between rows and columns. Next, a convolution operation is performed at each image with their respective reconstruction filters *GGi, GHi, HGi* and HHi. Finally, image addition is carried out in order to obtain the D^{n-1}mage. Once *D* is obtained the algorithm finishes, it corresponds to the reconstructed image.

In order to understand the multiresolution analysis concept based on Mallat's algorithm it is very useful to represent the wavelet transform as a pyramid, as shown in figure 5. The basis of the pyramid is the original image, with C columns and R rows .

The basic algorithm for the DWT is not limited to dyadic length and is based on a simple scheme: convolution and down sampling[11] . As usual, when a convolution is performed on finite-length signals, border distortions arise. To remove these border effects, Fast Wavelet Transform was introduced. This algorithm is a method for the extension of a given finite-length signal.

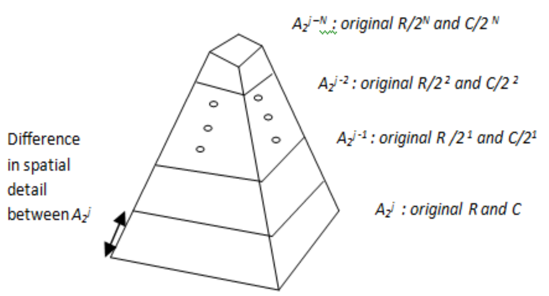

Figure5. Mallat's Pyramidal Representation

B. Directional Filter Banks (DFB)

Bamberger and smith [10] introduced the concept of the directional filter bank. A major property 2-D directional filter bank is its ability to extract directionality features which are very much important in image analysis and other application.

The DFB is maximally decimated and obeys the perfect reconstruction, The term perfect reconstruction indicates that the total number of subband coefficients is the same as that of the original image and they can be used to reconstruct the original image without error.

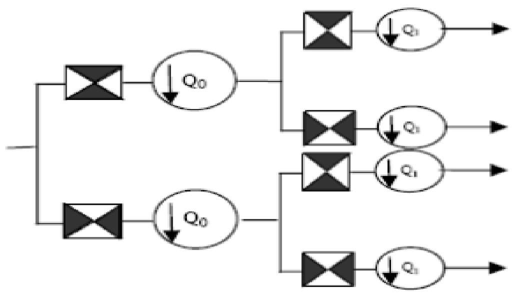

Figure 6. The first two levels of the DFB. At each level, QFB's with fan filters are used. The black regions represent the ideal frequency supports of the filters

Do and Vetterli [6] proposed a new construction for the DFB to avoid modulating input image, which we can obtain the desired 2-D spectrum division as shown in Figure 6. The simplified DFB is intuitively constructed from two building blocks. The first is a two-D spectrum into two directions: horizontal and vertical. The second is a shearing operator, which used to reordering the image samples. We used the DFB which constructed by first method.

The general construct of the DFB[12] involves a tree structure of 2-band splits, where each split increases the angular resolution by a factor of 2.

A typical, uniform angular decomposition may be represented by a balanced tree of 2-band splits, and is presented in· Figure 7. Conversely, applications that require higher angular frequency resolution only in particular directional bands may use an unbalanced tree.

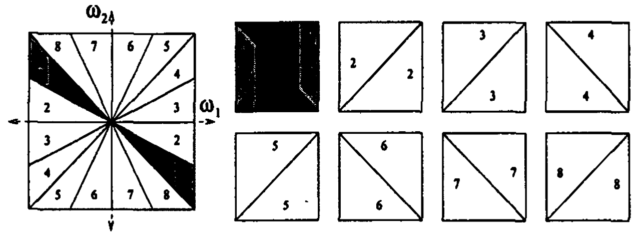

Figure7. A depiction of the passbands associated with an 8-band DFB, showing how directional bands from the input (left) map to their corresponding subbands (right).

It is possible to generate 2-D passband regions along radial frequency lines in addition to angular partitions using this new family of filter banks. Most of the information necessary to derive the octave-band DFB lies in the derivation of the conventional DFB.

The successive application of DFB splits within DFB sub-bands leads to a large family of octave-band decompositions, where each member can be defined unambiguously by the number of angular bands and the number of octave bands.

C . Image Codec (SPIHT)

SPIHT[10] is sophisticated encoding for next generation .Wavelet wavelet transform following bit plane sequence ,encoding exploiting the properties of wavelet transformed images to increase its efficiency. SPIHT[8] codes the individual bits of image wavelet transform following bit plane sequence, SPIHT[9] is capable of recovering the image perfectly by coding all bits of transform.

IV. EXPERIMENTAL RESULT

The proposed compression method based on WBMT-DFB with the SPIHT Encoder scheme is tested on iris images having a size of 128x128 pixels with 8 bit pixel brightness.

The images used in this research has iris database ,which composed of images of 16 different person eyes(left, right), with 3 images of each eye (totaling 96 iris images). Different samples are taken from the database and various parameters are obtained like SNR, PSNR, MSE. Results obtained are as follows.

TABLE I
MSE, PSNR VALUES OF WBMT_DFB COMPRESSION TECHNIQUE

Image Name	MSE	SNR	PSNR
001L_1	2.3846e+004	1.4284	4.3567
002L_1	1.4213e+004	2.5543	6.6040
003L_1	1.3127e+004	2.7257	6.9492
001R_1	2.2784e+004	1.5277	4.5546
002R_1	1.3521e+004	2.6628	6.8208
003R_1	2.4189e+004	1.3964	4.1573

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