Application of Haar Wavelet Techniques for Chromosome Medical Images

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Abstract

Recently image segmentation has become one of the significant tools to be used in the field of medicine. Now a day the uppermost problems in computer vision system are truncated contrast and low quality of the images in the medical field. Haar Wavelet method is ideally suitable for dealing with the treatment of such insecurity problematic in the segmentation process it takes up much less storage space and transmits faster electronically without reducing the resolution. The main objective of this work the concept of Haar wavelet technique applied for segmentation of darkbands in chromosome image. The output chromosome image after different enhancement weights coefficients of high quality and preserve the original image's edge property efficiently.

Keywords: *Chromosome, Haar Wavelet, Medical images, Enhancement, Darkbands.*

AMS Subject Classification : 33E15

1. Introduction

Mathematical models can take many forms but not limited to medical systems, statistical techniques, differential applications and dynamical theoretic models. The other types of models can overlap with a given model involving a variety of abstract structures. In general, mathematical models may contain logical representations as far as logic is concerned. Mathematical models are applied not only in the ordinary sciences such as community science, microbiology, earth science, weathercasting, arts and engineering disciplines.

The Haar Wavelet was 1910 on initiated and independently developed by Haar. Recently, the Haar theory has been innovated and applied to various fields in sciences, medical and engineering applications. In particular, Haar Wavelets have been applied extensively for image processing, signal processing in communications and proved to be a useful mathematical tool.

Chromosome studies are utilized in the general genetics clinic to identify a reason for formative postponement/mental impediment, cell division, birth defects, dysmorphic features, and/or autism. Chromosome in metaphase can be recognized utilizing special staining techniques called banding. A band is characterized as a piece of chromosome which is unmistakably recognizable from its contiguous sections by seeming darker or more splendid with all the more banding procedures. The chromosomes are pictured as comprising of a ceaseless arrangement of bright and dark bands. In this regard, proposed model is effectively executed utilizing chromosome image to improve the investigation in medical field. The fundamental point of the paper is to decide the darkbands in chromosome pictures, viably utilizing Haar Wavelet calculation and to show the precision by applying it to some picture chromosomes. The paper is organized as follows: Section 2 discusses the literature survey, Section 3 illustrates the Haar Wavelet properties, Section 4 deals with the methodology, Section 5 shows the results and comparison followed by the conclusion.

2. Literature Survey

The focus is given to many papers are published related to the field of Haar wavelet and medical image processing; The experimental analysis and result:

Sivasubramanian et al. [18] proposed Enhanced Adaptive Kernelized FCM algorithm for color image segmentation. This technique is superior to other methods in terms of evaluation metrics with less computational overhead. Nidhi et al.[11] developed computationally efficient algorithm for lossy image compression using wavelet techniques. The result obtained concerning the reconstructed image quality as well as preservation of significant image details is promising. Avinash and Priyanka [2] proposed Modified fast Haar Wavelet transform algorithm to reduces the calculation work and image compression. Sulaiman Khan et al. [17] presented Haar Wavelet transform, discrete cosine transforms, and run length encoding techniques, for advanced manufacturing processes with high image compression rates. In addition, this algorithm helps in achieving high CR along with high PSNR value that promises significant details and high quality during reconstruction of image.

Jagadees et al.[7] investigated medical image fusion process which deals with enhancing multiple image like CT scan, MRI scan fuses them into a single or multiple imaging modalities by reducing randomness in them using wavelet transform technique proved time taken for the entire process is approximately less than one and a half second and input image without reducing the resolution of the final image. Roopali et al.[16] proposed Medical color image enhancement method using wavelet transform and distinction stretching technique displayed medical image is decomposed and enhanced an image which conserves its edge features effectively with high quality. Jaffar Iqbal and Hemachandran[6] had done wavelet transform and its applications in digital image processing. Some of the equations of discrete wavelet transform are described and review was conducted to study the different suitable areas of wavelet transforms.

Pankaj and Rekha [12] done a survey image denoising using various wavelet transforms many researchers have worked over wavelet transform based noise removal techniques for images presents a vast scope for readers to understand the usefulness of these techniques.

Abdulaziz Saleh and Salem Saleh [1] introduced adaptive median filter method for speckle noise in the medical image and showed experimental results and compared mean filter, median filter, adaptive median filter applied in the four types of image and compared the adaptive median filter method results.Yadvendra and Amit [19] applied fusion algorithm based on wavelet transform which is an effective approach in image fusion area image fusion scheme based on a new wavelet coefficients contrast is proposed .

From the previous related works many techniques are applied and experiment by various authors Bhavana and Krishnappa [3], Guihong et al.[5], Milindkumar and Prashant [10],Gayathri and Kuppusamy [4], Kanisetty and Hima [8].

3. Properties of Haar Wavelet

The orthogonal set of Haar wavelets $h_i(t)$ is a collection of square waves with scale of ± 1 in some intermissions and zeros elsewhere. In general,

$$h_n(t) = h_1(2^j t - k), \text{Where } n = 2^j + k,\ j \ge 0,\ 0 \le k < 2^j,\ n,\ j,\ k \in Z \qquad (3.1)$$

The function y *(t),* which is square integrable in the interval [0, 1) can be extended in a Haar series with more number of terms

$$y(t) = \sum_{i=0}^{\infty} c_i h_i(t), \text{with } i = 2^j + k \qquad (3.2)$$

Where $c_i = 2^j \int_0^1 y(t) h_i(t) dt$ the Haar coefficients $j \ge 0,\ 0 \le k < 2^j, t \in [0,1)$

The error ε is minimized $\varepsilon = \int_0^1 \left[y(t) - \sum_{i=0}^{m-1} c_i h_i(t) \right]^2 dt, \text{Where } m = 2^j,\ j \in \{0\} \cup N$

If *y (t)* is a piecewise constant or may be approximated as a piecewise constant, and then the sum in Eq. (3.2) will be terminated after *m* terms. That is,

$$y(t) \approx \sum_{i=0}^{m=1} c_i h_i(t) = C_{(m)}^T h_{(m)}(t), \qquad t \in [0,1)$$

$$c_{(m)}(t) = [c_0 c_1 \ldots c_{m-1}]^T, \quad h_m(t) = [h_0(t), h_0(t), \ldots\ldots\ldots, h_{m-1}(t)]^T \qquad (3.3)$$

Where “T” indicates inversion, the subscript *m* in the parentheses denotes their dimensions, $C_{(m)}^T h_{(m)}(t)$ denotes the truncated sum. Integration of the Haar wavelets can be expressed in the following forms

$$\int_0^t h_m(\tau) d\tau = \sum_{i=0}^{\infty} C_i h_i(t)$$

If truncate to $m = 2^n$ terms in the Eq. (3.3), then integration is done by vector multiplication and this series can be obtained with Haar matrix.

$$\int_0^1 h_{(m)}(\tau)d\tau \approx E_{(m\times m)}h_{(m)}(t), \qquad t \in [0,1)$$

For discrete values of $m,$ we can get the Haar square matrix. If we set $m = 8$, the Haar matrix would be

$$H_{8\times 8} = \begin{bmatrix} 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & -1- & 1 & -1 & -1 \\ 1 & 1 & -1 & -1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 1 & -1 & -1 \\ 1 & -1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & -1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & -1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & -1 \end{bmatrix}$$

Then $H_{(m\times m)}$ and $H^{-1}_{(m\times m)}$ contain so many zeros, let us express $h_{(m)}(t)h^T_{(m)}(t) \approx M_{(m\times m)}(t)$,and $M_{(1\times 1)}(t) = h_0(t)$ sustaining $M_{(m\times m)}(t)C_{(m)} = C_{(m\times m)}h_{(m)}(t)$ and $C_{(1\times 1)} = c_0$.

4. Proposed Methodology

4.1 Haar Wavelet Image Processing

This section the proposed methodology for image compression for measurement and the back ground details of the image compression and how to track compression in images explain. Haar Wavelet transform is a mathematical tool that converts original signal or image into different domains for analysis and processing. The Haar wavelet transform is one of the space domains to a local frequency domain. Recently, Haar wavelet grown the significant attention many fields more attention in real life image processing and the real life medical images. The proposed methodology for JPEG image compression can be implemented in seven steps as show in block diagram of operating systems. The Haar Wavelet decomposes each images into two components first is called average another one called difference. Input images are grayscale and colour medical images.

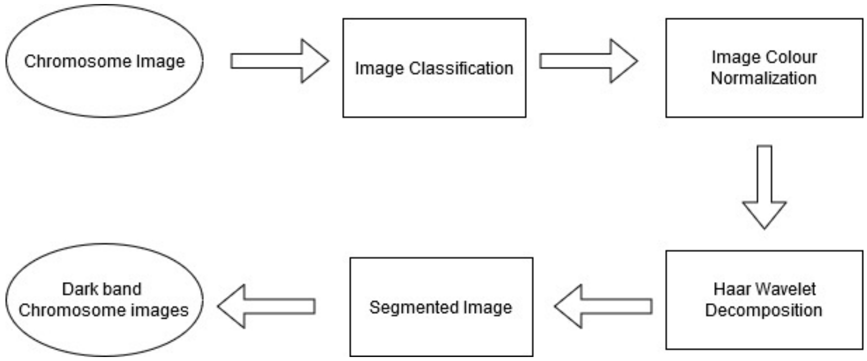


Figure 1. Block Diagram of Haar Wavelet systems

The images array is split into two different classes containing the transformed data and the detail coefficients. The input images are Low pass level filter $L(x,y)$ and High pass level filter $H(x,y)$ in the coefficient of binary element matrices. Transform the given input image in the rows and columns. The binary matrices $L(x,y)$ and $H(x,y)$ to generate sub images as follows LL (x,y),LH (x,y),HL (x,y),HH (x,y). The LL (x,y) the class contains the average image material according to low frequency band with the different decomposition.

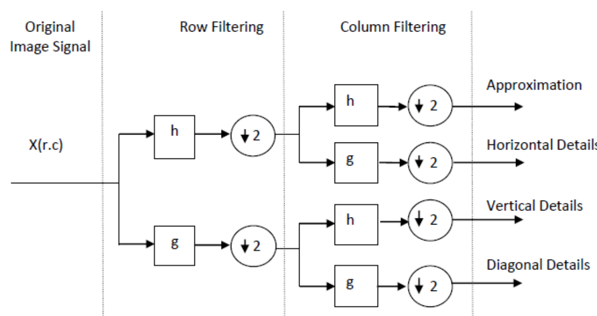


Figure 2. Haar Wavelet Decomposition

The sub images LL (x,y),LH (x,y),HL (x,y),HH (x,y) which contains directional rows ,columns and diagonal (horizontal, vertical and diagonal) information of the input image due to the angle. The inverse Haar wavelet transform is used to reconstruct the low level pass filter images and high level pass filter images. The transformed image data coefficients are the results of the low level pass filter while the detail coefficients are the results of the high level pass filter. This Haar Wavelet mathematical tool can detect the resident feature in a medical image processing.

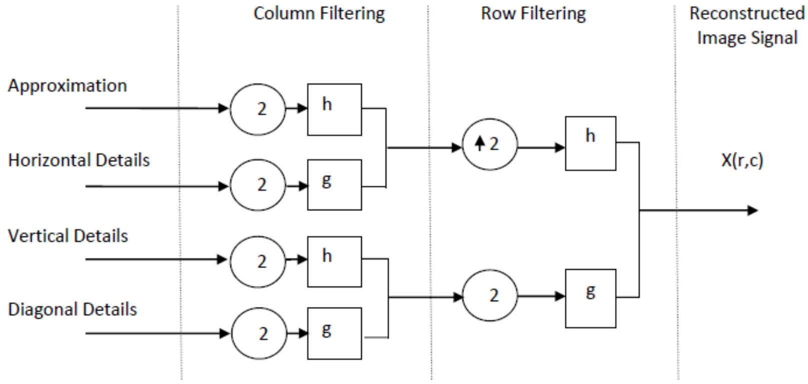


Figure 3. Haar Wavelet Reconstruction.

In order to compute the image efficiency and compression rate of the image compression technique commonly used metric, it is required to define an equation which can calculate the difference between the recovered and the input images. Three equations are given for this process one is called Mean Square Error (MSE), second is called Root Mean square error (RMSE) and third is called Peak signal Noise Ratio (PSNR) respectively the image of size rows (r) × columns (c) :

$$\text{MSE} = \frac{1}{rc}\sum_{X=0}^{r-1}\sum_{Y=0}^{c-1}\left(f(x,y)-f_{enh}(x,y)\right)^2$$

$$\text{RMSE} = \sqrt{\frac{1}{rc}\sum_{X=0}^{r-1}\sum_{Y=0}^{c-1}\left(f(x,y)-f_{enh}(x,y)\right)^2}$$

$$\text{PSNR} = 10\log_{10}\frac{(255)^2}{MSE}$$

4.2 Algorithm

The proposed Haar Wavelet image segmentation algorithm contain following steps:

Step 1: Read an input image:

Step 2: Check the dimension.

Step 3: Separate the colour components of binary matrix and noise remove.

Step 4: Apply Haar Wavelet along row and column wise on entire matrix of the image.

$$C_n = \frac{i_{4n-3}+i_{4n-2}+i_{4n-1}+i_{4n}}{4}, n = 1,2,3....\frac{N}{4}$$

$$H^{-1}{}_n = \begin{cases} \frac{(i_{4n-3}+i_{4n-2})-(i_{4n-1}+i_{4n})}{4}, n = 1,2,3....\frac{N}{4} \\ 0, Otherwise \end{cases}$$

Here N= signal length

Step 5: Output of the Enhanced image

Step 6: Compute MSR, RMSE and PSNR
Step 7: Validate the enhancement image output or go to step 4.

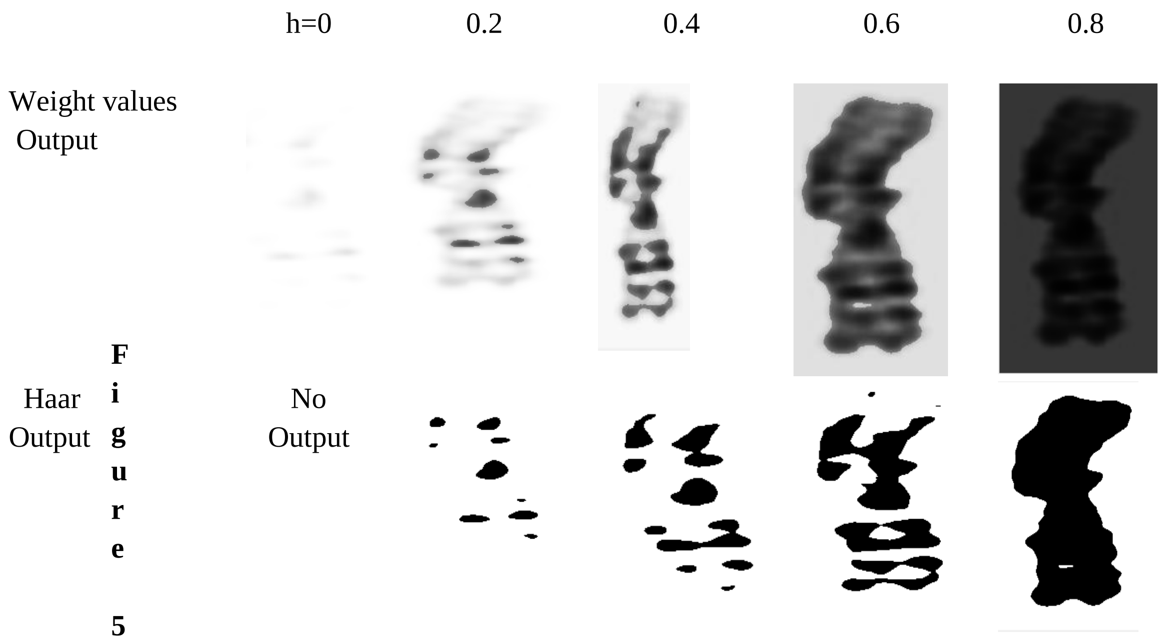
5. Experimental and Discussions

In this section verified application has been investigated with different inputs chromosome images and the results analyzed for its performance and exactness. Here showed two discrete chromosome images are taken as input image for the proposed method. Haar Wavelet technique applied in the chromosome images by using Matlab software. To estimate the efficiency of the recommended method, Haar Wavelet algorithm is established with the support of a numeral of images. The investigational results are shown for chromosome images given in the Figure 4(i).

(i) (ii) (iii)

Figure 4: (a) Chromosome image (b) Weight output (c) Final output

The weight function in Haar Wavelet transforms logic supports in grouping the parallel pixel strength values organized for the image. The final output generally depends on the weigh values used in the segmentation image of darkbands in chromosomes. This weight value function improves the performance of proposed method and benefits in solving the problem related with concentration inhomogeneity. It enhances the concentration of dark region in chromosomes. Then Haar Wavelet is applied to the output of membership function for removing the darkbands in chromosomes. The output of weight function for chromosome image is shown in figure 4(ii). The final output of Haar wavelet process for chromosome is shown in figure 4(iii) respectively. When give the different weight value of h lies between the interval 0.1 and 0.9, the segmentation of darkbands is attained successfully. When the weight values above one and less than zero the segmentation output distorted. The output for weighted function and Haar process on varying h for chromosome is shown in figure 5.



F i g u r e 5 :

Figure 5: Output for chromosome image

6. Conclusion

This proposed Haar Wavelet algorithm devoted to the study of the multi resolution approach to this problems and computationally efficient algorithm for various chromosome image compression techniques, simpler and easy to implement in the medical field. The Haar wavelet technique applied for segmentation of dark bands in chromosome image provides new potential for effectually segmenting chromosome and calculation time. This method output chromosome image after different enhancement weights coefficients of high quality and preserve the original image’s edge property efficiently.

Ethical approval

This article does not contain any studies with human participants performed by any of the authors.

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