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Modified Filtering Scheme for Medical Image

Shashi Kumar[1], Vibhash S. Sisodia[2], Urfa Mustaq[3]

Shri Bhawani Niketan Institute of Technology & Management, Jaipur, India

Abstract: ***Filtering and feature selection methods for characterization and enhancement of liver and chest images are presented in this paper .Our problem focuses on improvement of performance of classification of feature set by various selection algorithms like sequential forward search (SFS), sequential backward search algorithm (SBS) and sequential forward floating search algorithm (SFFS). Here the focus is on statistical texture features obtained from the computed tomography abdominal images taken by the radiologist. Symlet Wavelet is used for filtering and feature extraction. Wavelet transform decomposes the data in such a way that any hidden information in image can be retrieved. We have tried our best to reduce the feature set size as it is very necessary to limit the number of features or to have optimization of feature set, a design of compact classifier is required for improved classification of the selected problem(Liver Tumor, Chest abnormalities), based on the classification. Most and least significant features are identified on the basis of classification performance of the classifier and then unwanted features may be removed from the set of feature to get a feature subset, which is small in size. In this paper we have tried to characterize the hepatic, hepatoma, hemangeoma, hepatic masses using Symlet Wavelet. After comparing the performance of this technique to that of other approaches it is found to be superior and convenient for medical diagnosis.***

Keywords: Feature extraction, Feature selection, tumor classification, Symlet Wavelet

1. Introduction

Medical imaging techniques are being developed of non-invasive nature among which MRI is trending technology and it has got promising future in identification of tumors efficiently. The medical images are most of the time corrupted with the noise. The source of the noise is sometimes a machine problem or it comes into play because of the subject motion under observation. These noises cause the homogeneity in the scan. This eventually leads to the improper identification and detection of malign tissue in scans. The different kinds algorithms were observed like K-mean clustering, C-mean clustering, region based segmentation method and many more which are implemented in different ways to overcome the possible problems occurring in MRI head scans. There is more complexity in most of the scans, which requires to be addressed cautiously so that tumor can be detected at early stage and thus treated on time. Besides these methods were either semi-automatic methods or the methods took too long to jump to the conclusion. The objectives of the research are the noise and blurs to be treated by the de-noising (filtering). Identification of the object which is the diseases by proper segmentation technique, besides the techniques should be fast compared to the earlier methods. Future findings in the segmentation of medical scans will attempt in reducing the amount of manual interaction and thereby, improving the precision, accuracy, and evaluation speed of segmentation methods.

Image enhancement, noise removal and feature extraction at different depth level is essential task for medical image processing. Feature selection is the problem of selecting a subset of "d" feature form a set of "D" feature based on some optimization criterion. The primary purpose of feature selection is to design a more compact classifier with as little performance degradation performance as possible. The features removed should be useless, redundant or of the least possible use. Recently, interest in feature selection has been on the increase for several reasons. Firstly new applications dealing with vast amounts of data have been developed, such as data mining, multimedia information retrieval and medical data processing since the fast processing of a large volume of data is critical in these applications for the purpose of real time processing or to provide a quick response to the users, limiting the number of feature is a very important requirement feature selection is a pre requisite while using multiple set of feature, as this is required for the subsequent processes involving classification or clustering.

A number of approaches to the texture classification problem has been developed over the years a major class of future extractors relies on the assumptions that texture can be defined by local statistical properties of pixel gray levels, from the image histogram, first order statistics can be derived and used as texture feature. Haralick [2] proposed a class of quickly computable texture feature computed for spatial gray level dependence matrix (SGLDM) which seems to have general applicability to many data others textures feature that can be applied to real world texture as the fractal features[3], gray level difference (GLD) statistics[4].

Number of techniques have been put forth for the brain tumor detection till date. The most of current techniques are classified into the categories like edge based, region based, thresholding based and hybrid based segmentation. The boundary detection has been a problem in image processing. X. Mei et al have conducted the study based on the edge detection, where canny algorithm highlighted the weak edges of brain. Region based segmentation methods is based on initial seed, which causes the pixels to group together based on the similarity. The method reduces the weakness of the edges but the initial seed selection needs human intervention which makes it semi-automatic.Paul et al have used multilevel thresholding using the Shannon's entropy and differential evolution. Their study was pivoted around the image compression for the transmission reasons. However, here the case has been used for the segmentation purpose [5-19].

Rajeev et al [20] have used modified K means and the morphological operations for the tumor detection. In their methodology the initial center selection makes the method semi-automatic or non automatic methods. This is very difficult tast for radiologists. We have developed image processing system and Wavelet transform (Symlet Wavelet) based processing technique to locate different types of abnormalities tumor in repeat tissue texture without any priori information. Our method is capable of characterizing the textures and able to detect the noise and tumor in the form discontinuity. The proposed approach is able to detect tumor by Meyer wavelet, Multi-level thresholding and Morphological operations. This will help to suppress the noise in medical image and to know the position of any abnormalities

2. Methodology

This data used in this work have been collected from Swati MRI and CT Scan Ghaziabad. The area of interest is captured by SOMATOM Emotion Due CT scanner with 8mm slices at 8mm intervals with 0mm inter slice thickness .70m. As technique has been used with 110 KVP, for field of vision (foV) 280 and image matrix of (256× 256). The image is in DICOM format. They are converted to BMP format which is an acceptable format for medical image processing. The images are enhanced, filtered and inherent features are extracted by Symlet Wavelet transform.

The usefulness of transformations is that they project a function onto a new set of basis functions. If one or more basis functions represent a feature, and all the other basis functions are orthogonal to it, then one can quickly determine if a feature exists in a signal by projecting signal function onto the new basis .

3. Symlet Wavelet and Description of Filtering

Wavelet algorithms process data at different scale or resolution. There are different types of wavelets (Haar, Daubechies, Coiflets and Symlets) . We have used Symlet Wavelet made by I. Daubechies. It is quite effective in boundaries of image in texture. The wavelet decomposition function decomposes the image into different level of intensities, which makes able to compute the wire spacing and wire diameter in both warp and weft directions in the sieve. It detects defective sieve. Daubechies proposes modifications of her wavelet such that their symmetry can be increased while retaining simplicity. The idea consists of reusing the function m_0 introduced in the dbN considering the $|m_0(\omega)|^2$ as function ω of $z = e^{i\omega}$. Then we can factor ω in several different ways in the form of $\omega(z) = U(z)\ \overline{U(\frac{1}{z})}$. The roots of ω with modulus not equal to 1 go in pairs. If one is, z_1, $\frac{1}{z_1}$ is also a root. By selecting U such that the modulus of all its root is strictly less than 1, we build Daubechies wavelets dbN. The U filter is minimum phase filter. By making another choice, we obtain more symmetrical filters; these are Symlets. Symlets are compactly supported wavelets with least asymmetry and highest number of vanishing moments for a given support width. Associated scaling filters are near linear-phase filters having support width 2N-1 and filters length 2N.

Daubechies introduced scaling function $\phi(x) = \sqrt{2}\sum_n h_n \phi(2x-n)$ for wavelet dbN

(h_n are the coefficients associated to a 'standard' multire solution analysis and the corresponding orthonormal basis). However, more symmetric wavelet filters make easier to deal with the boundaries of the image[11,12,13]. Symmetric filters are linear phase filters. More precisely, a filter with filter coefficients a_n is called linear phase if the phase of the function $a(\xi) = \sum_n a_n e^{-in\xi}$ is a linear function of ξ, i.e., if for some $l \in Z$, $a(\xi) = e^{-il\xi}|a(\xi)|$. This means that a_n are symmetric around l, $a_n = a_{2l-n}$.

The phase introduced by I. Daubechies for Symlet wavelet is given below

$$\hat{\Phi}^1(\xi) = m_0(\xi/2)\ \overline{m_0(\xi/4)}\, m_0(\xi/8)\, \overline{m_0(\xi/16)} \ldots\ldots$$
$$= \prod_{j=1}^{\infty} [m_0(2^{-2j-1}\xi)\ \overline{m_0(2^{-2j-2}\xi)}\ ],$$

where $m_0(\xi) = \frac{1}{\sqrt{2}}\sum_n h_n e^{-in\xi}$. The phase $\hat{\Phi}^1$ of the Symlet wavelet is closer to linear phase than that of dbN[11], $\hat{\Phi}(\xi) = \prod_{j=1}^{\infty} m_0(2^{-j}\xi)$.

In this paper we use a 2D version of this algorithm. The matrix of initial values C_o (k, l) is the image of sieve and the number of levels is N = 4. The scaling function in 2-D case has been chosen as the separable function

$$\Phi(x,y) = \Phi(x)\ \Phi(y), \text{ which is}$$
$$\Phi(x) = \begin{cases} 1-|x| & \text{if } x \in [-1,1] \\ 0 & \text{if } x \notin [-1,1] \end{cases}$$

4. Experimental Results

Image acquired were in digital imaging and communication in medicine (DICOM) format. They were collected from 20 hepatocellular carcinoma patients (malignant), 20cholangio carcinoma patients (malignant), 20 hemangioma (benign) patients and 20 hepato adenoma (benign) patients. Form these patients, 120 hepatocellar carcinoma slices (images), 120 cholangio carcinoma slices (image), 120 hemangioma slices (image) and 120 hepato adenoma slices images) have been considered for this work. The system was implemented using MATLAB and Labview. Figure1 is original chest ct image, figure 2 and figure3 are enhanced image by gradient and Symlet wavelet filter. Figure 4 and 5 is act scan of a patient with a liver tumour. Figure.6 is Lungs tumors detected by Symlet filter.The liver is located along the left upper of the image and is light gray in colour. The

white tubular structures are the normal liver blood vessels. The liver tumour is dark and located. On the edge of the liver and extends toward a blood vessel. The same experiment is repeated with images of different patients in which the probability of tumor is estimated. The input data set is divided into different disjoint groups of training set and testing set to conduct the experiment. To prove the validity while testing, care must be taken so that the slices collected from a patient are not added in the training set.From the tumour region, Identification by radiologist, 42 texture features have been extracted after applying Symlet wavelet filter. The multi-level thresholding stage of this methodology produced the multi-region segmentation. Segmentation following up wavelet treatment has increased the chances of the discoveries of the information that was otherwise hidden due to the low amplitude noise. Segmentation has produced the objectified image in the form of multiple regions. To extract the tumor section from the rest of the compressed image, the largest connected area has been evaluated. This largest area extracted happens to be the tumor region in most of the scans. The binary of largest connected area is treated as mask which helps to obtain the tumor section from original image in grayscale.

Figure 1 (a) Original chest images

Figure 1 (b) Analyzed image

Figure 2 (a): 3D profilometry

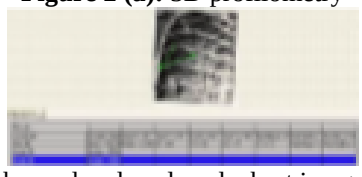

Figure 3: Enhanced and analyzed chest images by gradient and Symlet wavelet filter

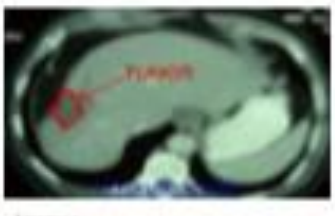

Figure 4: Liver tumor detected

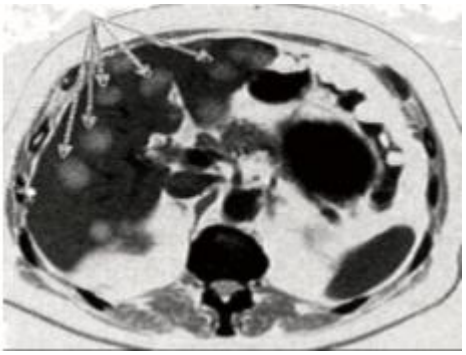

Figure 5: Liver tumors from Symlet filter

Figure 6: Lungs tumors detected by Symlet filter

5. Conclusion

A novel method for filtering and feature extraction for medical image is presented. The results obtained from the methods in literature were seen to be affected by the noises that are inherent in the scans, for instance partial volume effect, pixel homogeneity etc. The preprocessing in these images is inevitable stage. The selection of the type of de-noising and de-convolution methods need study of the noises, mostly affecting MRI and then their remedies. The method adopted has been observed to discover the diseases/abnormalities/ tumor sections from the MRI/ CTs which makes the method applicable and thus helpful to the radiologist for easy detection of the tumor. The method is also automatic, unlike that of the region growing method.

A computer based system for the detection of tumor has been constructed using the minimal feature set, angular second moment, contrast, entropy and homogeneity. Since wavelet transform provides multiresolution, Symlet Wavelet transform is best for texture and other inherent features detection. The results above shows it is best for chest image enhancement, liver tumor, Chest abnormalities, lungs tumor detection for both at the development stage and at developed stage. Of course the tool is helpful for the radiologist and powerful method to detect unidentified diseases.

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