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MEDICAL IMAGE FEATURE EXTRACTION USING WAVELET TRANSFORM

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Abstract— **There are several approaches and various methods developed by researchers for computer aided diagnosis of brain tumour problems. Depending on the type of brain tumour, each of the brain pathologies requires a particular approach to follow in order to characterise the disease. Since the focus of this paper is on brain tumour diagnosis & classification, one way is by measuring the characteristics of these tumour masses, we can predict their aggressive behaviour (i.e. how high is their metabolic activity). There could be early signs of cancer so one should try to investigate whether they are benign or malignant. Major approaches in brain tumour detection and classification are discussed in this paper. MRI is the most important technique, in detecting the brain tumor. A new algorithm is purposed which is a combination of support vector machine (SVM) and fuzzy c-means, a hybrid technique for prediction of brain tumors, which gives accurate and more effective result for classification of brain MRI images.**

Keywords— **MIP, Image Acquisition, Preprocessing, Segmentation, Feature Extraction, Computer Aided Diagnosis, MRI Image, ROI, Artificial Neural Network (ANN), Malignant, Benign, Grey level run length matrix (GLRLM), Support Vector Machine (SVM) and Fuzzy c-means**

I. INTRODUCTION

Medical image processing is the technique which is used to create images of the human body for clinical purposes. It is often perceived to designate the set of techniques that noninvasively produce images of the internal aspect of the body. This implies that cause is inferred from effect. It is very important in improving the diagnosis, prevention and treatment of the diseases. Medical imaging is nothing but a part of biological imaging and incorporates radiology, nuclear medicine, investigative radiological sciences, endoscopy, thermography, medical photography and microscopy [10]. When an image is processed for visual interpretation, the human eye is the judge for the working of a particular method. For medical diagnosis, Computed Tomography (CT) gives the best information on denser tissue with less distortion. Magnetic Resonance Image (MRI) gives better information on soft tissue with more distortion. With more available multimodality medical images in clinical applications, the idea of combining images from different modalities has become very important and so medical image fusion is emerging as a new promising research field [21].

Medical image processing (MIP) is undergoing a revolution in past decades with the advent of faster, more accurate mass invasive devices [3]. This has given rise to the need for corresponding software development which has provided impetus for new algorithms in signal and image processing [4]. Over the recent years, analysis of images such as segmentation, Edge Detection, Boundary detection, classification, clustering and texture property extraction attracts the attention of many researchers in the image processing and pattern recognition area. As compared to ordinary images the medical images, has so many information, in which the feature extraction is not so easy. CT & MRI type of medical images show the information inside the patient body by non-invasive method, so that it is very helpful for diagnoses by doctors and not much painful for patients. However the raw data can only give the material to doctor, he has to decide by himself which is important & which is not.

The computer-aided diagnoses (CAD) uses computer for processing the medical images to extract the useful information so that the doctor can make a diagnoses decision easily and quickly. But it is not very easy to locate the problems in medical images if it is noisy or if it is not in a proper format because of the irregular structure of human body. Application of image processing technologies plays a important role in processing and analyzing & forming the images. Edges detection in an image will help us to understand the image feature. Since edges often occurs at image locations representing object boundaries. Edge detection is widely used in image segmentation. The CAD system consists of five stages such as acquisition of TRUS image of prostate, preprocessing, segmentation, feature extraction and classification. The overview of the CAD system is depicted in figure 1 [2].

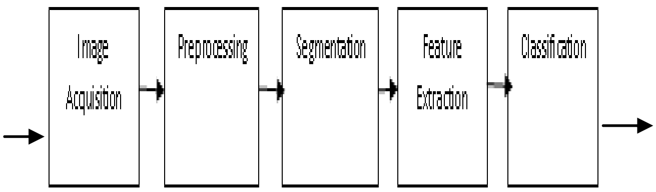

Figure 1: CAD System

All the standard computer vision actually aims to duplicate the effect of human vision by perceiving electronically and understanding the image. It is not an easy task by giving computers the ability to see. The specific implementation of a computer vision system also depends on its functionality if it is pre-specified or if some part of it can be learned or modified during operation. There are, however, many typical functions which are found in many computer vision systems. The five stages of the CAD system are described as below:

A. IMAGE ACQUISITION

A digital image which is produced by one or several image sensors, besides various types of light-sensitive cameras, include range sensors, tomography devices, radar, ultra-sonic cameras, etc. The resulting image data is an ordinary 2D image, a 3D volume, or an image sequence depending on the type of sensor. The pixel values corresponds to light intensity in one or several spectral bands (gray images or color images), but it can also be connected to various physical measures, such as depth, absorption or reflectance of sonic or electromagnetic waves, or nuclear magnetic resonance.

B. PRE-PROCESSING

Before the application of computer vision method to extract some specific piece of information, it is required to process the data to assure that it satisfies certain assumptions which is implied by the method. Examples are:

1. Noise reduction for assuring that sensor noise does not introduce false information.
2. Re-sampling for assuring that the image coordinate system is correct.
3. Contrast enhancement for assuring that relevant information can be detected.
4. Scale-space representation for enhancing image structures at locally appropriate scales.

C. FEATURE EXTRACTION

When the input data available to an algorithm is very large to be processed and it is suspected that it is notoriously redundant (data with not much information) then the input data will be transformed to a reduced representation of set of features (also named features vector). This transformation of the input data into the set of features is called *features extraction*. If the features extracted are chosen carefully then it is expected that the features set will extract the relevant & useful information from the input data to perform the required task using this reduced representation in place of the full size input (example, in medical imaging, extract anatomical boundaries before comparison with normal template and diagnosis). Typical examples of such features are**:** Lines, edges and ridges. Localized interest points such as corners, blobs or points. More complex features may be related to texture, shape or motion. Different methods of feature extraction are being used to detect and classify anomalies in medical images such as wavelets [5,6], statistical methods and most of them used feature extracted using image processing techniques [7].Some other methods are based on fuzzy theory [8] and neural networks [9].

D. DETECTION/SEGMENTATION

Segmentation as the name suggest refers to the process of partitioning a digital image into many segments (which is sets of pixels also known as super pixels). The aim of segmentation is to simplify and/or change the representation of image into something that is more meaningful and easier to analyze. Image segmentation which is typically used to locate objects and boundaries (lines, curves, etc.) in images. More precisely, image segmentation is the process of assigning a label to every pixel in an image such that pixels with the same label share certain visual characteristics. The image segmentation results into a set of segments that collectively cover the whole image, or a set of contours extracted from the image. Each pixel in a region is similar with respect to some characteristic or computed property, such as color, intensity, or texture. Adjacent regions are significantly different with respect to the same characteristic(s).

E. HIGH-LEVEL PROCESSING

At this step we have the input as typically a small set of data which is a set of points or an image region and is assumed to contain a specific object. The remaining processing deals with for example:

1. Estimating the application specific parameters, such as object poses or objects size.
2. Verifying the data whether it satisfy model-based and application specific assumptions.
3. Classifying the detected object into several categories.

II. DIFFERENT METHODS BEING USED & CURRENT TREND

Because features are used as part of a classification procedure so it will increase the cost and running time of a recognition system, there is trend in image processing community to design and implement such systems which have small feature sets. On the other hand there is a strong urge to include a sufficient set of features to achieve high recognition rates under complex conditions. This lead to a variety of techniques within the image processing community to find an "optimal" subset of features from a larger set of possible features. Sérgio *et al.*, in his paper gives the advantage of single-valued functions which evaluate rankings to develop a family of feature selection methods. This is based on the genetic algorithm & it improves the accuracy of content-based image retrieval systems and it also evaluates the quality of ranking which in turn improves retrieval performance [14]. Jaba and Shanthi, reviewed previously on continuous feature discretization and they identified defining characteristics of the methods. On that basis defines a new supervised approach which combines discretization and feature selection for selecting the most relevant features useful for classification purpose. Classification technique which is used is Associative Classifiers [15]. Yong Fan, *et al.*, presented a brain classification framework which is based on multi-parametric medical images, and he described the advantage of the method for multi-parametric imaging which provide a set of discriminative features for classifier construction by using a regional feature extraction method to takes into account joint correlations between different image parameters [16]. Ling-Chen *et al.*,A feature selection algorithm is discussed by him which is based on ant colony optimization (ACO), and said Image feature selection (FS) is an important task & it can affect the performance of image classification and recognition [17]. Ant colony optimization (ACO) is an evolution simulation algorithm which is proposed by M. Dorigo *et al.*, & been successfully used for detecting system fault, job-shop scheduling, network load balancing, graph coloring, robotics and other combinational optimization problems.

Support vector machines were applied in several researches which & is given in [11-13]. H. B. Nandpuru, Dr. S. S. Salankar and academic. V. R. Bora, worked on MRI image brain cancer classification using support vector machine. Support Vector Machines (SVM) was implemented to brain picture classification. In this paper feature extraction from brain MRI pictures were administrated by grey scale, symmetrical and texture feature. They achieved sensibly good result [11]. A. Padma and R. Sukanesh, studies on SVM depend classification of soft Tissues in Brain CT pictures using Wavelet Based Dominant grey Level Run Length Texture feature. They emphasized on the technique of medical CT imaging as one of the widely applied and reliable technique which is used for the detection and site of pathological changes efficiently by using SVM [12]. S.H.S.A. Ubaidillah, R. Sallehuddin and N.A. Ali, worked on cancer found exploitation artificial neural network and support vector machine: A Comparative study. In this paper, they compared the performance on four completely different cancer datasets exploitation of SVM and ANN classifiers. In this study, the ANN classifier gated sensible classification performance on the datasets that have larger quantity of input options (prostate and Ovarian cancer datasets) SVM conjointly given sensible performance as compared to ANN on datasets with smaller quantity of input feature (breast cancer and liver cancer), and finally SVM classifier gives higher result for growth [33]. Guo-Zheng *et al.*, discussed the feature selection methods by using support vector machines which gives satisfactory results, and propose a prediction risk which is based on feature selection method by using multiple classification support vector machines. The performance of this proposed method is compared with the previous methods of optimal brain damage based feature selection methods by using binary support vector machines [21]. Yong and Ding-gang described that feature extraction and selection in neuro image classification are of much importance for identification of informative features and reducing feature dimensionality. This is generally implemented in two separate steps and presented as an integrated feature extraction and selection algorithm having two iterative steps: constrained subspace learning based feature extraction and support vector machine (SVM) based feature selection [19]. Kanazawa et al has detected lung cancer from helical CT images by delineating lung and blood vessels regions and he uses fuzzy clustering algorithm [1]. Then features are extracted related to shape, grey value and position from each region and diagnostic rules were applied to detect lung cancer nodule candidates. Sasikala et al (2006) gives results for magnetic resonance images (MRI's) for finding malignant tumour by automatic segmentation of brain using optimal texture features. These texture features are extracted from normal and tumor regions (ROI) in the brain images which is under study by using spatial gray level dependence method and wavelet transform [20].

III. WAVELET TRANSFORM

Wavelet transform is nothing but any arbitrary function which is represented as a superposition of wavelets. These wavelets are functions generated from a mother wavelet by dilations and translations. It has been used as an important mathematical tool which decomposes a function in terms of its time and frequency components. It outperforms the classical Fourier transform on the condition of localization which should be in time and the frequency domain both for non-stationary signals.The DWT captures the spatial and frequency information both of a signal. DWT actually analyses the given image by decomposing it into a coarse approximation with low-pass filtering and in detail information with high-pass filtering. Such type of decomposition is done recursively on low-pass approximation coefficients which is obtained at each level, until we reached the necessary iterations. In general, two main types of wavelet bases are there: orthogonal and biorthogonal. The Daubechies (db), Coiflets (coif), Symlets (sym), and discreteMeyer (dmey) comes under common orthogonal bases. The most popular & comrnon-redundant orthogonal wavelet bases are Daubechies wavelets. The Symletsis is a quasi-symmetric extension of theDaubechies wavelets. Another extension with vanishing moment conditionsfor both the wavelets and scaling functions and is more symmetrical than the classical Daubechies is Coiflets. Sometimes the biorthogonal (bior) wavelets are more desirable than orthogonal wavelets because of the thing that they can preserve linear phase, they have finite impulse response, and the mother wavelets have arbitrarily high regularity. These wavelet filters also come with different lengths. The length of the wavelet filter is indicated after the name of the basis. Like "db3" stands for the Daubechies wavelet filter having length 3. In biorthogonal wavelets the low pass and high pass filters for may not have the same length so their lengths are separated by a dot. Like, "bior3.5" stands for the biorthogonal wavelet filter in which the low pass filter has length 3; and the high pass filter has length 5. Wavelet usually provides a very sparse and effective representation for images

IV. PROPOSED METHOD

1. The proposed methodology consists of a group of stages starting from grouping brain MRI images. This is a hybrid technique which involves the steps as follows like enhancement, Skull striping, segmentation through fuzzy c-means clustering, feature extraction and coaching or training the SVM classifier using MRI pictures with wavelet based GLRLM feature using 2D DWT, by storing the information and testing. Obtain the sub-image blocks, starting from the top left corner.
2. Decomposing sub-image blocks using 2 level 2-D discrete wavelet transform (DWT).
3. Deriving the gray level run length matrix (GLRLM) for two level high frequency sub bands of the discrete wavelet decomposed image with 1 for distance and 0,45,90 and 135 degrees for è and averaged.
4. The dominant run length texture features called wavelet dominant run length texture features (WDRLT) are extracted from these gray level run length matrices
5. Then these feature values thus obtained are normalized. This is done by subtracting minimum value and dividing by maximum value minus minimum value. In the data set, if the feature value is less than the minimum value, it is set to minimum value and if the feature value is greater than the maximum value it is set to maximum value

In this method, the image is enhanced using enhancement techniques such as contrast improvement, and mid-range stretch. Skull striping is done through double thresholding and morphological operations. Then to detect the suspicious region in brain MRI image fuzzy c-means (FCM) clustering is used for the segmentation of the image.Wavelet based dominant gray level run length feature extraction method is used for the analysis and characterization of textures present in the medical images. In this we obtain the sub-image blocks, starting from the top left corner and then decomposing sub-image blocks by using 2 level 2-D DWT(Discrete wavelet transform). After which a new hybrid technique which is based on the support vector machine (SVM) and fuzzy c-means for brain tumor classification. This algorithm is a combination of support vector machine (SVM) and fuzzy c-means, a hybrid technique for predicting brain tumors, which gives accurate and more effective result for classification of brain MRI images.

V. CONCLUSIONS

Different available medical image feature extraction techniques had been studied in this paper and the proposed method is also studied. A need for development of medical image processing method is required that will be less time consuming and effective. These results demonstrate that the developed systems could help the radiologists for a true diagnosis and decrease the number of the missing cancerous regions or unnecessary biopsies. Computer Aided Diagnosis System has to be developed, which acts as a secondary tool for the radiologists for diagnosing the cancer. Also, public medical database should be developed where categorized medical images can be made available to test system being developed by researchers.

In the system proposed brain MRI images proved to be an important way for detecting the brain tumor. The hybrid technique of combining support vector machine and fuzzy c-means clustering for classification gives accurate result in identifying the brain tumor. Feature extraction is done using 2 level 2-D Discrete wavelet transform, after segmentation through Fuzzy c-means clustering and it is the most important method in image segmentation,. For future work, to get better result in terms of accuracy rate and less error rate a hybrid SVM algorithm is proposed. In future work, different data mining techniques can be used to train by using different kernel functions for improving the performance of the classifiers and the data sets can also be increased.

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