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DETECTION OF HYDROCEPHALUS USING SEGMENTATION AND NEURO FUZZY TECHNIQUE IN BIO-MEDICAL IMAGES- A REVIEW

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ABSTRACT
This work proposes a new Medical Image Processing technique for detecting Hydrocephalus in early stage. Medical Image Processing is the fast growing and challenging field now days. Medical Image techniques are used for medical diagnosis. Detecting hydrocephalus using image processing technique involves four stages namely image pre-processing, image segmentation, features detection and classification. Using segmentation and earlier detection technique we can predict tumor in early stage.

Key Words: Image pre-processing, image segmentation, feature detection, classification ,tomography, image dialation ,gabor feature extraction, Image classification ,neural network, spasm, arteriography, radioisotopes, histogram, neuro-fuzzy etc.

I. INTRODUCTION

Hydrocephalus is a buildup of fluid inside the skull that leads to brain swelling. Hydrocephalus means "water on the brain."Hydrocephalus is a condition characterized by an abnormal accumulation of cerebrospinal fluid (CSF) or “spinal fluid” within cavities called ventricles that are inside the brain. CSF surrounds the brain and spinal cord. The functions of CSF include physical support or cushioning of the brain, excretion of some waste products and distribution of important substances within the central nervous system. The average adult produces about one pint (500 cc) of clear spinal fluid daily. When the circulatory path of the CSF is blocked, fluid begins to accumulate, causing the ventricles to enlarge and the pressure inside the head to increase, resulting in hydrocephalus.

Our bodies produce approximately a pint (500 ml) of CSF daily, con- tinuously replacing CSF as it is absorbed. Under normal conditions there is a delicate balance between the rate at which CSF is produced and the rate at which it is absorbed. Hydrocephalus occurs when this balance is disrupted and the rate of absorption is less than the rate of production. Although there are many factors that can disrupt this bal- ance, the most common is a blockage, or obstruction, somewhere along the circulatory pathway of CSF. The obstruction may develop from a variety of causes, such as brain tumors, cysts, scarring and infection. Specific causes will be discussed more fully below.

Because CSF is produced continuously, when its flow is blocked it will begin to accumulate upstream from the site of the obstruction, much like a river swells behind a dam. Eventually, as the amount of fluid accumulates, it causes the ventricles to enlarge and pressure to increase inside the head. This condition is known as hydrocephalus.

Causes: CSF normally moves through the brain and the spinal cord, and is soaked into the bloodstream. CSF levels in the brain can rise if the flow of CSF is blocked. The fluid does not get absorbed into the blood properly. The brain makes too much of the fluid.

In young children, hydrocephalus may be due to:

Infections that affect the central nervous system (such as meningitis or encephalitis), especially in infants. Bleeding in the brain during or soon after delivery (especially in premature babies).Injury before, during, or after childbirth, including subarachnoid hemorrhage. Tumors of the central nervous system, including the brain or spinal cord. Hydrocephalus most often occurs in children. Another type, called normal pressure hydrocephalus, may occur in adults and the elderly.

Magnetic resonance imaging [1] is a powerful tool for investing the body’s internal structure.MRI provides better quality images for the brain, the muscles, the heart and cancerous tissues compared with other medical imaging techniques such as computed tomography (CT) or X-rays. In tumorous brain. MR images intensity level of tumorous tissues exhibit different intensity level on T1-w and T2-w images based on the type of tumor. On T1-w most tumors have low or intermediate signal intensity. On T2-w most tumors have bright intensity. The anatomy of the Brain can normally be viewed by the MRI scan. So this technique is a special one for the brain tumor detection and cancer imaging.

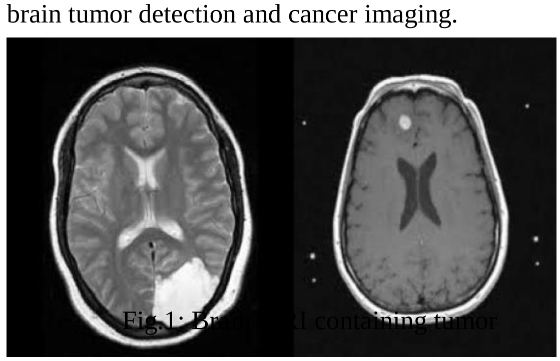

Fig.1: Brain MRI containing tumor

Image pre- processing: Pre-processing of MRI images is the primary step in image Analysis which perform image enhancement and noise reduction techniques which are used to enhance the image quality. Image is enhanced in the way that finer details are improved and noise is removed from the image. Enhancement and noise reduction techniques are implemented in brain tumor detection that can give best possible results. Enhancement will result in more prominent edges and a sharpened image like tumor is obtained noise will be reduced thus reducing the blurring effect from the image.

Image Dilation: Dilation is one of the basic operations in mathematical morphology. Originally developed for binary images, it has been expanded first to grayscale images, and then to complete lattices. The dilation operation usually uses a structuring element for probing and expanding the shapes contained in the input image.

Properties of image dilation:

- It is translation invariant.
- It is increasing
- It is commutative.
- If the origin of E belongs to the structuring element B, then it is extensive.
- It is associative.
- It is distributive over set union.

Image segmentation: The purpose of image segmentation[21-22,17-20] is to partition an image into regions (spatially connected groups of pixels called classes. or subsets) and objects with respect to one or more characteristics or features. The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze. Image segmentation 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 characteristics

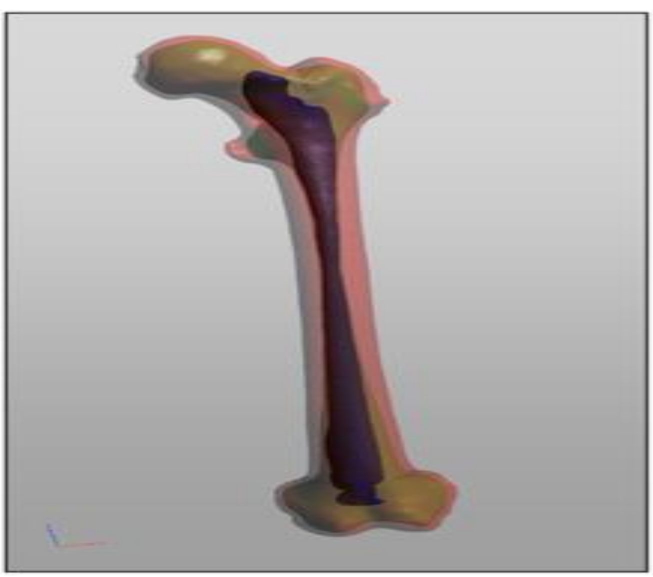

Figure 2.Model of a segmented femur. It shows the outer surface (red), the surface between compact bone and spongy bone (green) and the surface of the bone marrow (blue).

The result of image segmentation is a set of segments that collectively cover the entire image, or a set of contours extracted from the image . Each of the pixels in a region are 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 characteristics. When applied to a stack of images, typical in medical imaging, the resulting contours after image segmentation can be used to create 3D reconstructions with the help of interpolation algorithms like Marching cubes.

Image segmentation plays a significant role in image processing as it helps in the extraction of suspicious regions from the medical images. The idea behind segmentation is to segment an image into several clusters. The results will be such that, it is possible to identify regions of interest and objects in the original image.

II. METHODS

Clustering methods:

The K-means algorithm is an iterative technique that is used to partition an image into *K* clusters.[11] The basic algorithm is

1. Pick *K* cluster centers, either randomly or based on some heuristic method, for example K-means++
2. Assign each pixel in the image to the cluster that minimizes the distance between the pixel and the cluster center
3. Re-compute the cluster centers by averaging all of the pixels in the cluster
4. Repeat steps 2 and 3 until convergence is attained (i.e. no pixels change clusters)

In this case, distance is the squared or absolute difference between a pixel and a cluster center. The difference is typically based on pixel color, intensity, texture, and location, or a weighted combination of these factors. *K* can be selected manually, randomly, or by a heuristic. This algorithm is guaranteed to converge, but it may not return the optimal solution. The quality of the solution depends on the initial set of clusters and the value of *K*.

Compression-based methods:

Compression based methods postulate that the optimal segmentation is the one that minimizes, over all possible segmentations, the coding length of the data. The connection between these two concepts is that segmentation tries to find patterns in an image and any regularity in the image can be used to compress it. The method describes each segment by its texture and boundary shape. Each of these components is modeled by a probability distribution function and its coding length is computed as follows:

1. The boundary encoding leverages the fact that regions in natural images tend to have a smooth contour. This prior is used by Huffman coding to encode the difference chain code of the contours in

an image. Thus, the smoother a boundary is, the shorter coding length it attains.

2. Texture is encoded by lossy compression in a way similar to minimum description length (MDL) principle, but here the length of the data given the model is approximated by the number of samples times the entropy of the model. The texture in each region is modeled by a multivariate normal distribution whose entropy has a closed form expression. An interesting property of this model is that the estimated entropy bounds the true entropy of the data from above. This is because among all distributions with a given mean and covariance, normal distribution has the largest entropy. Thus, the true coding length cannot be more than what the algorithm tries to minimize.

For any given segmentation of an image, this scheme yields the number of bits required to encode that image based on the given segmentation. Thus, among all possible segmentations of an image, the goal is to find the segmentation which produces the shortest coding length. This can be achieved by a simple agglomerative clustering method. The distortion in the lossy compression determines the coarseness of the segmentation and its optimal value may differ for each image. This parameter can be estimated heuristically from the contrast of textures in an image. For example, when the textures in an image are similar, such as in camouflage images, stronger sensitivity and thus lower quantization is required.

Histogram-based Methods:

Histogram-based methods are very efficient compared to other image segmentation methods because they typically require only one pass through the pixels. In this technique, a histogram is computed from all of the pixels in the image, and the peaks and valleys in the histogram are used to locate the clusters in the image. Color or intensity can be used as the measure.

A refinement of this technique is to recursively apply the histogram-seeking method to clusters in the image in order to divide them into smaller clusters. This operation is repeated with smaller and smaller clusters until no more clusters are formed[14].

One disadvantage of the histogram-seeking method is that it may be difficult to identify significant peaks and valleys in the image.

Histogram-based approaches can also be quickly adapted to apply to multiple frames, while maintaining their single pass efficiency. The histogram can be done in multiple fashions when multiple frames are considered. The same approach that is taken with one frame can be applied to multiple, and after the results are merged, peaks and valleys that were previously difficult to identify are more likely to be distinguishable. The histogram can also be applied on a per-pixel basis where the resulting information is used to determine the most frequent color for the pixel location. This approach segments based on active objects and a static environment, resulting in a different type of segmentation useful in Video tracking.

Color based segmentation using k-means clustering identifies the tumor region significantly form the pre-processed MR image as a clustering feature. Here the pre-processed gray-level brain MR image is converted into RGB color image. Histogram equalization technique is performed and it takes advantages of the neglected pixel values. The RGB color image is then been coarsely represented using 25 bins. Coarse representation uses the spatial information from a histogram based windowing process. K-means is been used to cluster the coarse image data. This shows better result when compared with other edge detection algorithm and enhance the tumor detection accuracy in less time. This was developed by Sarbani Datta. Dr. Monisha Chakraborty [3,20].

Seeded Region Growing method is an approach to segmentation where it examines neighboring pixels of initial 'seed points' and determines pixel neighbors should be added to the region. It is a technique for determining the regions directly. Formulation of the region –based segmentation is, it must be complete and every pixel in the region must be disjoint so that clear separation from each other can be identified. It satisfies the condition that the gray level of pixel is in the range of region. This segmentation is used to find the abnormality is present in the image or not. Fast and fully automatic algorithm, both the homogenous texture features and spatial features of the MRI are used to find the seed points and segmentation results obtained are accurate. This was developed by Mukesh Kumar, Kamal Mehta in 2011[4].

Feature extraction: Feature extraction is the technique of extracting specific features from the pre-processed images of different abnormal categories. This technique extracts high-level features needed in order to perform classification of targets. Features are those items which uniquely describe such as size, shape, composition, location etc. Feature Extraction is an important step in the construction of any pattern classification and aims at the extraction of the relevant information that characterizes each class. Gaurav Kumar and Pradeep Kumar Bhatia reviewed various types of features, feature extraction techniques and importance of Using this techniques in image processing systems [2]

SivaSankari.S. Sindhu proposed an image processing technique to extract the optimal features of brain tumor in MRI by utilizing **GLCM** [5] (Gray Level Co-occurrence Matrix) and **Gabor feature extraction** algorithm with the help of k-means clustering segmentation. Some features are extracted using GLCM techniques and the Gabor features extractions are Contrast, Correlation, Homogeneity, Entropy. Energy, Shape, Color, Texture and Intensity. Thus the feature was extracted and compared with other metric and gives efficient result [6].

III. IMAGE CLASSIFICATION

Classification is the labeling of a pixel or a group of pixels. Multiple features are used for a set of pixels i.e. many images of a particular object are needed. Image classification refers to the labeling of images into one of a number of predefined categories. Image classification is more important as it is a critical step for high-level processing such as brain tumor classification. Classification is the last step in the process of brain tumor detection used to classify the image into normal or abnormal and classify the abnormality type whether it is benign or malignant. This study evaluates various techniques which are used in tumor detection from brain MRI.

Kailash D.Kharat & Pradyumna Kulkarni [8] proposed two approaches for Brain Tumor classification based on artificial neural networks. The networks were categorized into feed-forward neural networks and Back propagation neural Network. First classifier based on feed forward artificial neural network **(FF-ANN)** and second classifier based on Back propagation Neural Network **(BP-ANN)**.FF-ANN classifier was created with 500 nodes in the first (input) layer. 1 to 50 nodes in the hidden layer and 1 node as the output layer and varied the nodes in order to determine the optimal number of hidden nodes. This was to avoid the fitting or under fitting the data. The most widely used neural-network learning method is the BP algorithm. Learning in a neural network involves modifying the weights and biases of the network in order to minimize a cost function. The classifiers have been used to classify subjects as normal or abnormal MRI brain images.

The MR images are classified by wrapper approach with **Multi Class Support Vector Machine classifier** (MC-SVM) using color, texture and shape features. To reduce the large numbers of features to a smaller set of features wrapper algorithm with multi-class SVM is used. Performance of the MC-SVM classifier is compared with different kernel functions. From the analysis and performance measures like classification accuracy, it is inferred that the brain MRI classification is best done using MC- SVM with Gaussian RBF kernel function than linear and polynomial kernel Functions, the wrapper approach MC-SVM with Gaussian RBF kernel function enhance the classification of MR brain image with normal and benign or malignant classes This approach is efficient for classification of the human brain normal or abnormal (benign or malignant tumor) with high sensitivity, specificity and accuracy rates. This was developed by N.Rajalakshmi and Lakshmi Prabha. [9].

Neuro-Fuzzy technique: Neuro-fuzzy[29] refers to combinations of artificial neural networks and fuzzy logic. Neuro-fuzzy hybridization results in a hybrid intelligent system that synergizes these two techniques by combining the human-like reasoning style of fuzzy systems with the learning and connectionist structure of neural networks. Neuro-fuzzy hybridization is widely termed as Fuzzy Neural Network (FNN) or Neuro-Fuzzy System (NFS).
Fuzzy logic provides an inference morphology that enables approximate human reasoning capabilities to be applied to knowledge based systems. The theory of fuzzy logic provides a mathematical strength to capture the uncertainties associated with human cognitive processes, such as thinking and reasoning.
The conventional approaches to knowledge representation lack the means for representating the meaning of fuzzy concepts.

Method:

Descent methods for minimization:

The error correction learning procedure is simple enough in conception. The procedure is as follows: During training an input is put into the network and flows through the network generating a set of values on the output units.
Then, the actual output is compared with the desired target, and a match is computed. If the output and target match, no change is made to the net. However, if the output differs from the target a change must be made to some of the connections.

IV. CONCLUSION

It is a MRI data based research examining earlier detection of different types of Hydrocephalus. Using segmentation technique you can detect the Hydrocephalus in early stage and by using neuro fuzzy technique you can test and analyze the real time data. We generate a new test for Hydrocephalus. By using this technique you can save the life of many people.

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