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# PNN and Lloyd's Clustering approach for detection and segmentation of nuclei in brain tumor

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**ABSTRACT**

**Analysis of preferential localization of certain genes within the cell nuclei is emerging as a new technique for the diagnosis of brain tumour. Computer-aided methods, which can significantly improve the objectivity and reproducibility, have attracted a great deal of interest in recent literatures. Computer aided system is to analysis of nucleus or cell detection and segmentation plays a very significant role to describe the molecular morphological information. Thresholding is generally used technique for segmentation. In this paper, we provide Lloyd's clustering algorithm for nucleus/cell segmentation on different types of microscopy images of brain tumor. The proposed method differs from others in, the simplicity of the developed approach and use of these algorithms to segment and detect nucleated cells.**

**Keywords: Brain Tumor, Magnetic Resonance Imaging, Pre-processing, Segmentation, Lloyds Clustering, Discrete wavelet transform (DWT), Probabilistic neural network (PNN), Radial basis function network (RBFN).**

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## I. INTRODUCTION

The tumor is an abnormal growth of cancer cells in any part of the body. Tumors are of different types and have different characteristics and different treatments. The brain tumors are mainly classified into two categories primary brain tumors and secondary brain tumors. The Primary tumors are classified into Benign and Malignant tumor. The emerging new imaging modalities, such as X-ray, Ultrasonography, Computed Tomography (CT), and Magnetic Resonance Imaging (MRI), show the detailed and complete aspects of brain tumors. Once a brain tumor is clinically suspected, radiologic evaluation is required to determine the location, the level of the tumor, and its relationship to the surrounding structures. The MRI scan is more comfortable as it doesn't use any radiation. A magnetic resonance imaging (MRI) scanner uses powerful magnets to polarize and excite hydrogen nucleus (single proton) in human tissue, produces a signal which can be detected results in images of the body. This information is very important and critical to decide the different forms of therapy such as surgery, radiation, and chemotherapy.

In preprocessing stage structure of the brain can be viewed by the MRI scan or CT scan. The MRI scanned image is taken for the entire process of brain tumor detection. The MRI scan is more comfortable than CT scan for diagnosis. It is not affecting the human body. Because it doesn't use any radiation. MR image is low contrast image. Diagnosing with these low contrast images is a difficult task for doctors. The contrast enhancement of MR brain image can be done by using the powerful method in image processing called mathematical morphology.

The computer-aid image analysis can significantly improve the objectivity and reproducibility. It is difficult to separate nuclei from each other as well as background due to nucleus occlusion or touching, shape variation, intra-nucleolus in homogeneity, background clutter and poor contrast. In order to tackle these challenges, many state-of-the-art approaches have been applied so far to medical image segmentation. Different approaches and techniques have been developed and used for the brain tumor segmentation. Some are based on cellular automata approach, some utilize clustering phenomena, some are based on graph theory, and some uses edge detection

mechanisms. Segmentation using Lloyd's clustering classifies the depth and extension region of the identified area.
Automatic categorization and detection of tumors in different medical images is important to obtain high accuracy results when dealing with a human life. Probabilistic Neural Network is fast and accurate classifier than other neural networks and it is a promising tool for classification of the tumor.

The input MR images acquired for brain tumor detection is pre-processed to improve the accuracy of tumor detection. The proposed system uses Lloyd's clustering for segmentation, discrete wavelet transform for hybrid feature extraction & Probabilistic neural network for classification of tumor. The system is divided into four main parts such as pre-processing, Segmentation, Feature Extraction and classification.

## II. LITERATURE REVIEW

Analysis of MRI images and extraction of brain tumor from MRI images are challenging tasks in medical image processing. Researchers have contributed in segmenting and analyzing brain tumor by applying varieties of the techniques and different hybrid approaches. These methods mainly include segmentation, feature extraction and classification stages to detect tumor from different brain MR images. By studying many literatures in this area we have proposed simple method to segment & detect brain tumor using PNN and Lloyd's clustering from different brain MR images.

In Harsimranjot Kaur et al. [1] Studied techniques for Brain Tumor Segmentation of MRI images proposed various existing techniques for detection and segmentation of brain tumor from MRI images i.e. threshold-based, edge-based, region-based and clustering-based segmentation have been studied.

Fuyong Xing et al. [2] An Automatic Learning-Based Framework for Robust Nucleus Segmentation proposed a framework for robust and automatic nucleus segmentation with shape preservation. Given a nucleus image, it begins with a deep convolution neural network (CNN) model to generate a probability map, on which an iterative region merging approach is performed for shape initialization. One of the important benefits of the proposed framework is that it is applicable to different staining histopathology images.

Jin Liu et al. [3] proposed a Survey of MRI-Based Brain Tumor Segmentation Methods provided a comprehensive overview of the state of the art MRI-based brain tumor segmentation methods.

Mr. Vishal Shinde et al. [4] In brain Tumor Identification using MRI Images a review of the methods and techniques used during brain tumor detection through MRI image segmentation of brain MRI image using K-means clustering algorithm followed by morphological filtering.

Benson C.C. et al. [5] Morphology Based Enhancement and Skull Stripping of MRI Brain Images proposed two simple algorithms which are easy to implement for MR brain image enhancement and skull stripping based on mathematical morphology. In the contrast enhancement procedure, input image is low contrast MR Image of brain and produced output is high contrasted image.

Natarajan P et al. [6] Tumor Detection using threshold operation in MRI Brain Images proposed threshold operation and Morphological processing technique to detect brain tumor. The morphological operators can change the structuring elements of the image according to their use. Some operators like open, spur, dilate and close have proved helpful in extracting the brain tumor from the MRI brain images.

P.Kishore Kumar et. al. [7] Effective Segmentation of Image Using Thersholding of Lloyds Clustering proposed two methods for gray scale image segmentation Otsu thresholding & Lloyd's clustering. Otsu method can able to identify the target region even in the presence of background noise. Lloyd's method produces very good results. This method can achieve better performance in challenging cases.

J.selvakumar et al. [8] Brain Tumor Segmentation and Its Area Calculation in Brain MR Images using K-Mean Clustering and Fuzzy C-Mean Algorithm proposed K-means algorithm is to extract tumor from the brain cells. The noise present in the brain MR image removed before the K-means process. The noise free image is given as a input to the k-means and tumor is extracted from the MRI image.

M.V SubbaRao et al. [9] Mri Brain Image Classification Using Probabilistic Neural Network and Tumor Detection Using Clustering Technique proposed PNN to classify stage of the brain tumor images and detect the Tumor using clustering technique. Decision making was performed in two stages: feature extraction using GLCM and the classification using Probabilistic Neural Network (PNN).

Shreepad S. Sawant et al. [10] Introduction to Probabilistic Neural Network –Used for Image Classifications proposed basics of PNN classifiers. PNN has more advantages over the other types of neural network classifiers. It gives satisfactory classification accuracy. After removing unnecessary neurons the speed of operation equal to the MLP. PNN has more accuracy over the other types of Neural Network classifiers.

## III. OBJECTIVE

- To study & preprocess MR image for better segmentation.

- To study & segment nuclei by using Lloyd's clustering.
- To study and implement simple algorithm for brain tumor detection.
- To study and implement probabilistic neural network with Radial basis function classifier for classification of brain tumor.

## IV. PROPOSED SYSTEM

For the analysis of spatio-temporal dynamics, different automated processing methods have been developed for nuclei segmentation. These methods tend to be complex for segmentation of images with crowded nuclei. Thus, it is useful to evaluate the ability of simple methods to segment images with various degrees of crowded nuclei.

The system architecture shown in figure: 1 fully describes about overall process of the proposed system. This consists of stages like, initially preprocessing of input MR image then Segmentation, Feature Extraction & Classification by using probabilistic neural network.

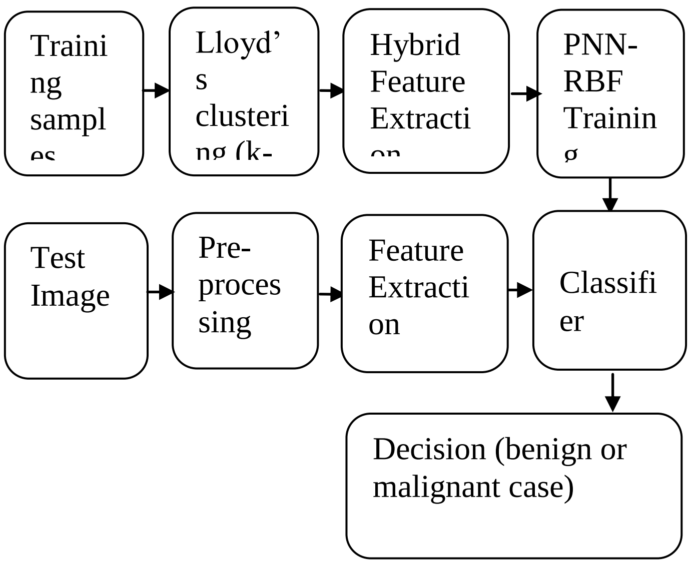



Figure 1: System Block Diagram

**Pre-processing:**

The primary task of preprocessing is to improve the quality of the MR images and make it in a form suited for further processing. In this initially image to be test can be resized to improve quality of image. Then the color MR image converted into Gray scale image is sometimes called "black and white". The brightness levels of the red (R),green (G) and blue (B) components are each represented as a number from decimal 0 to 255, or binary 00000000 to11111111. Black is represented by R = G = B = 0 & white is represented by R = G = B = 255.Filtering can be done to perform some kind of noise reduction. Filtering techniques such as High Pass Filter and low pass Filter are applied to eliminate the high frequency components from MRI image. Binary images may contain numerous imperfections. The simple thresholding produces binary regions which are distorted by noise and texture. So the exact structure of the image can be obtained by using morphological operation which eliminates the imperfection occurred due to simple thresholding. The term morphology refers to the description of the properties of shape and structure of any object. This usually means identifying objects or boundaries within an image.

**Segmentation:**

The k-means clustering provides computational efficiency and low memory consumption, compared to other clustering techniques. K -means clustering reduces the complexity of the data. In K-mean centroid can be find out repeatedly for each set in the partition, and inputs can be repartitioned according to closest centroid. The Lloyd's algorithm (1957, published 1982) is a centroid model. This algorithm is for finding evenly spaced sets of points in subsets of Euclidean spaces, and partitions of these subsets into well-shaped and evenly sized convex cells. Lloyd's algorithm re-partitioning the input uses voronoi diagrams rather than only determining the nearest center to each of a finite set of points.

**Mathematical Equation:**

The Euclidean distance is the "ordinary" (i.e. straight-line) distance between two points in Euclidean space.

$$dE=\sqrt{\sum_{i}^{k}(ci-xi)2}$$

c – Cluster Center, x – is the case it is compared to, i – is the dimension of x (or c) being compared, k -is the total number of dimensions

## V. SOFTWARE ALGORITHM & FLOWCHART

### A. Algorithm:

1. Give the no. of cluster value as k.
2. Randomly choose the k cluster centers.
3. Calculate mean or center for each cluster.
4. Calculate the distance between each pixel to each cluster center.
5. If the distance is near to the center then move to that cluster.
6. Otherwise move to next cluster.
7. Re-estimate the center.
8. Repeat the process until the center doesn't move.

### B. Flowchart:

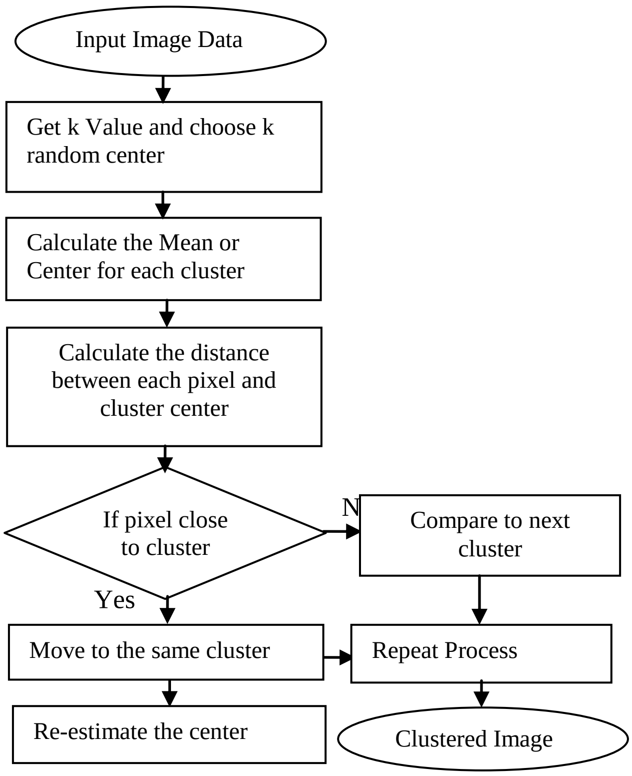



Figure 2: K-Mean Flowchart

According to some uniqueness grouping of pixels can be done that means clustering the image. In Lloyd's algorithm initially we have to define the number of clusters k. Then centers of k clusters are chosen randomly. The distance between each cluster center is calculated with each pixel. The distance may be simple Euclidean function. Using distance formula we can compare each single pixel to all cluster centers. The pixel will move to cluster which is having shortest distance among all. Then centroids are re-estimated. Again each pixel compared to all centroids. The process continuous till center converges.

**Hybrid Feature Extraction using DWT:**
In proposed system feature vectors can be extracted using Discrete Wavelet Transform (DWT) coefficients. The wavelet is a powerful mathematical tool for feature extraction, and has been used to extract the wavelet coefficient from MR images. The wavelets provide localized frequency information about a function of a signal, which is particularly beneficial for classification. Gray-level co-occurrence matrix (GLCM) is the statistical method of finding the textures that considers the spatial relationship of the pixels. The functions of GLCM describes the texture of an image by evaluating how repeatedly pairs of pixel with specific values and in a specified spatial relationship that present in an image forms Gray-level co-occurrence matrix. It is the most widely used and more generally applied method because of its high accuracy and less computation time. The information about the positions of pixels having similar gray level values can be obtained by using gray level co-occurrence matrix (GLCM). The features like Contrast, Correlation, Energy, Homogeneity, Mean, Standard Deviation, Smoothness and Skewness are extracted from brain MR image.

Table 1: Feature Extracted by DWT

| Feature Extraction | image1 | image2 | image3 | image4 |
|---|---|---|---|---|
| Contrast | 4.6787 | 5.7071 | 5.7766 | 5.689 |
| Correlation | 0.5147 | 0.4412 | 0.4137 | 0.5182 |
| Energy | 0.4659 | 0.3824 | 0.4057 | 0.4515 |
| Homogeneity | 0.8131 | 0.7649 | 0.7787 | 0.8104 |
| Mean | 0.3217 | 0.221 | 0.2198 | 0.3942 |
| Standard Deviation | 1.457 | 1.0978 | 1.1574 | 1.5936 |
| Smoothness | 0.9992 | 0.9988 | 0.9988 | 0.9993 |
| Skewness | 4.191 | 3.8066 | 3.4089 | 3.2002 |

**Classification:**
The operation of classification is organized into a multilayered feed forward network with four layers. The proposed system uses Probabilistic neural network with RBFN for classification tumor.

**Probabilistic Neural Network:**
The probabilistic neural network consists of four layers.

- Input layer
- Hidden layer
- Pattern layer/Summation layer
- Output layer

Probabilistic neural network is often used in classification problems. The first layer of PNN computes the distance from the input vector to the training input vectors. The vector produced from it indicates how close the input is to the training input. The second layer produces its net output as a vector of probabilities by summing the contribution for each class of inputs. Finally, a complete transfer function on the output of the second layer picks the maximum of these probabilities, and produces a 1 (positive identification) for that class and a 0 (negative identification) for non-targeted classes.

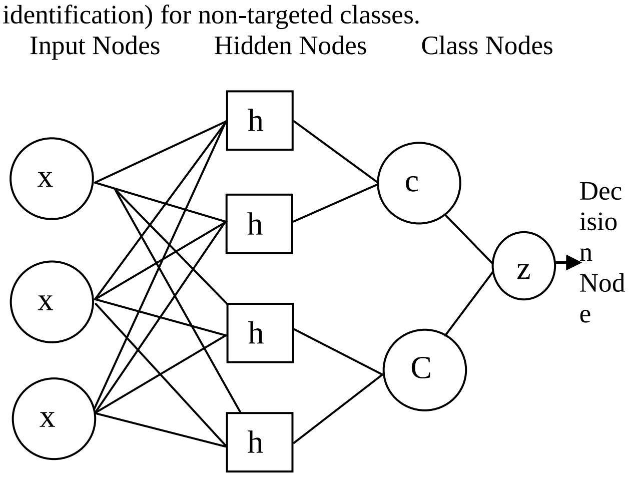



Figure 3: Architecture of Probabilistic Neural Network

The probabilistic neural network (PNN) classifier has been accepted as belonging to the class of radial basis function. The distance between point being evaluated to each of the other points is computed, and a radial basis function (RBF) (also called a kernel function) is applied to the distance to compute the weight (influence). The radius distance is the argument to the function hence it is named as radial basis function.
Weight = RBF (distance)

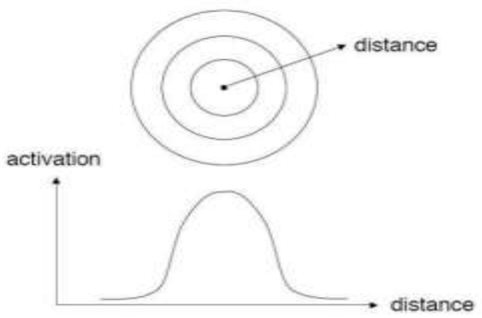



Figure 4: Radial Basis Function

**Radial Basis Function Network Architecture:**
Radial Basis Function Network (RBFN) approach is more intuitive than the Multi layer perceptron. An RBFN performs classification by measuring the input's similarity to examples from the training set. These training set examples are stored in each RBFN neuron as a "prototype". Each neuron computes the Euclidean distance between the input and its prototype to classify a new input. If the input more closely resembles the Category 1 prototypes than the Category 2 prototypes, it is classified as Category 1.

Following figure 5 shows the typical architecture of an RBF Network. It consists of an input vector, RBF neurons layer and an output layer with one node per category or class of data.

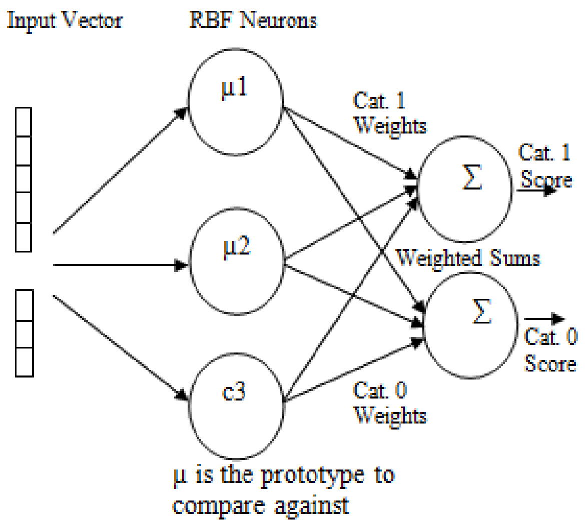



Figure 5: RBF Network Architecture

**Input Vector:** The input vector is the n-dimensional vector for classification. The entire input vector is shown to each of the RBF neurons.

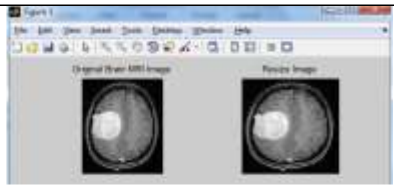
**RBF Neurons:** All training set vectors stored in RBF neuron as a "prototype" vector. The output value 0 and 1 can be obtained by comparing the input vector to its prototype in each RBF neuron which is a measure of similarity. If input is equal to the prototype then output of RBF neuron is 1.As the distance between the input and prototype grows, the response falls off exponentially towards 0. The shape of the RBF neuron's response is a bell curve. The neurons response in the form of bell curve is called as "activation" value. The prototype vector is also called the neuron's "center", since it's the value at the center of the bell curve.

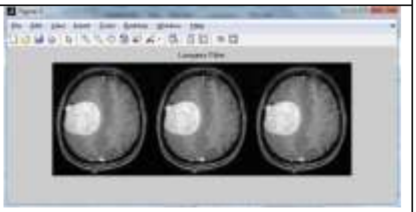
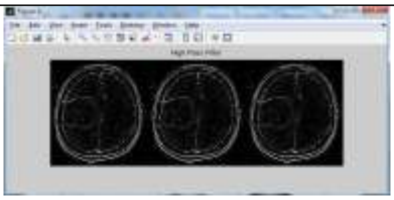
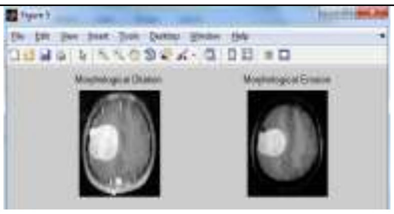
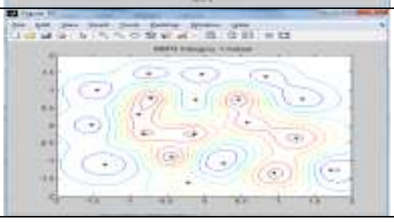
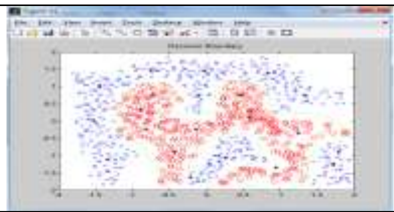
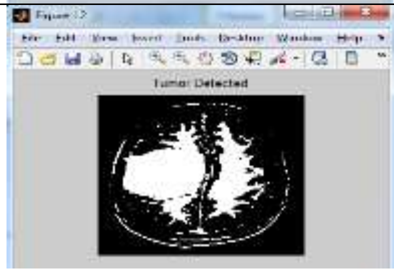
**Output Nodes:** The output of the network consists of a set of nodes, one per category that we are trying to classify. Each output node calculates a sort of score for the associated category. Typically, a classification decision is made by assigning the input to the category with the highest score. The Score each category is computed by taking a weighted sum of the activation values from every RBF neuron. Weighted sum we mean that an output node associates a weight value with each of the RBF neurons, and multiplies the neuron's activation by this weight before adding it to the total response. The output of each node is score computed for a different category, every output node has its own set of weights. The output node will typically give a positive weight to the RBF neurons that belong to its category, and a negative weight to the others.

## VI. RESULTS

We have taken different microscopy brain MR images to detect brain tumor. Initially the brain MR image passed through various stages of pre-processing to reduce noise & obtain exact structure of brain MR image for further processing of segmentation. The following table 2: shows the result of pre-processing stage. The noise free image is given as input to k-Mean clustering along with Lloyd's algorithm to segment & extract tumor from brain MR image. Finally Segmented tumor image is classified using Probabilistic neural network with Radial basis function to obtain brain tumor. The proposed method is simple & provides more accurate results.

Table 2: Output of Preprocessing, Segmentation and classification

| Processing Stage | Output |
|---|---|
| Resized Image |  |

| | |
|---|---|
| Gray Scale Image |  |
| Low Pass Filtering |  |
| High Pass Filtering |  |
| Morphological Operation |  |
| Otsu Threshold Image |  |
| Lloyds Clustering Image |  |
| Three Vectors & their Classes of PNN training |  |
| RBFN Category 1 Output |  |
| Decision Boundary |  |
| Tumor Detected |  |

## VII. CONCLUSION

Probabilistic neural network with radial basis function has been used for the classification of brain tumor and segmentation of nuclei in brain tumor tissue images has been implemented using Lloyd's clustering. Achieved 95.4 % accuracy.

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