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AN EFFECTIVE ANALYSIS OF MRI BRAIN IMAGES AND 3D RECONSTRUCTION

M.Fathima Zahira[1] and M.Mohamed Sathik [2]
[1]Assistant Professor, Department of Computer Science, Syed hameedha Arts and Science College, Kilakarai, Tamilnadu, India.
fathimazahira.m@gmail.com
[2]Principal, Sathakathullah Appa Collage, Thirunelveli, Tamilnadu, India.
mmdsadiq@gmail.com

ABSTRACT:

Medical Image Processing is defined as the process of creating visual representations of the interior of a body for medical intervention. Brain tumor is a major dangerous disease in the world. Many treatments are growing for curing the brain tumor disease. Nowadays 3D images are used for identifying brain tumors. Several techniques such as marching cubes and dividing cubes formed a topological relationship for the slices that converts 2D images into 3D images which does not provide accurate results and they depends on number of input sections, positions and the shape of the images. These processes take more time consuming for running and their tasks are very tedious. Our proposed system introduces a 3D reconstruction for analyzing the MRI brain efficiently. This system involves six stages such as preprocessing, region growing segmentation, feature extraction, feature selection, classification and 3D reconstruction. Our approach gets simulated in Matlab simulation and provides effective results on accuracy, specificity and sensitivity.

Index terms: Brain Tumor, Digital Image Processing, 2D images, 3D images, Fuzzy logic

I. INTRODUCTION:

Digital Image Processing is a term used for processing and displaying digital images based on computer algorithms. This process allows wider range of algorithms for input data while processing to avoid problems such as noise and signal distortion. Nowadays, Digital Image processing is used in medicinal field in order to identify diseases in human body. Image processing is used in various applications such as Remote sensing, Medical imaging, Forensic studies, Military, Material science and Biomedical Engineering. Medical Imaging is a part of biological imaging which establishes a database of anatomy and physiology that identifies the abnormalities in human beings. Biomedical Image Processing involves the steps like intelligent image analysis such as feature extraction, segmentation, classification, quantitative measurements and interpretation [1]. The continuous enhancement in applications and techniques such as interpolation, medical diagnosis, compression and image registration are to be improved for the growing technologies that must satisfy the quality of service. These are growing for GPDPU platforms [2]. Heart attack disease causing symptoms such as clot in blood, thrombus can be identified using image processing techniques. These symptoms identification is processed with help of echocardiographic images [3]. Parallel processing is used in image processing in order to give the high performance in computation problem. These are solved through data, task and pipeline mechanism, medical imaging requires more computation power for processing the images so they use parallel processing [5]. Image processing techniques are widely used in identification of document forensic problems that uses printing technology. Here the processing is based on textures, spatial correlation, spatial variation and features [4]. Material science is enhancing the production process with help of image processing while maintaining physical properties. This leads to improve the materials with excellent properties like global structure, microstructure, electric traits and diffusion [6].

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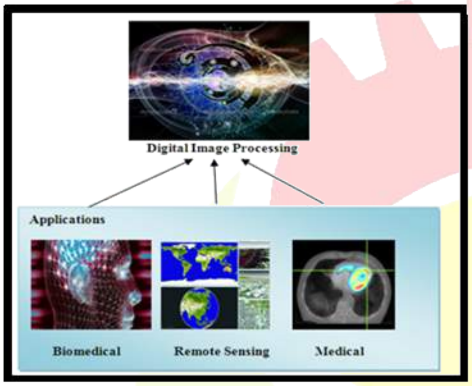

Fig 1: Application of Image Processing

Fig 1 refers the application of image processing. Brain tumor is a dangerous disease in the world, which is a collection of abnormal cells in our brain. The tumors may be cancerous or non-cancerous, when they grow, increases the pressure inside our skull that leads to brain damage and causes an injury or illness. Modalities such as MRI, CT, and PRT are used for diagnosing the brain tumor which results in the 2D images. Nowadays, 3D image gives effective results for identifying brain tumors. For this purpose we need to reconstruct 3D images from 2D images, which is a tedious process.

To overcome this problem, our approach uses the conversion process based on image processing techniques such as filtration, segmentation, feature extraction, classification process. Our contribution of the paper is as follows:

i) Initially, we select 2D images such as MRI images of the brain tumor and allow for filtration process which is based on Modified Spatial Median Filtration process that results in reduction of noise.

ii) Segmentation is defined as the process of dividing the portion of the images. In our approach we use unseeded region growing segmentation process.

iii) After segmentation process, we extract the features on the image based on WV-GLCM mechanism and feature selection process is based on ANFIS algorithm.

iv) We need to classify the features extracted from above mechanism, therefore classification Process is based on Type2 Fuzzy Logic Algorithm for classifying the all texture values in an image.

v) For 3D reconstruction process, we use ImageJ tool for 3D construction of an image.

The remaining sections of this paper can be organized as follows. Section II discussed with review of literatures. The formulated problems in our previous work described in Section III. Section IV presents proposed work that contains brief demonstration of different process such as Filtration, Preprocessing, Segmentation, Feature extraction, Feature selection, 3D Reconstruction. In Section V, experimental results of proposed approach and compare those results with state-of-the-art technique. Finally, we conclude the paper in Section VI.

II. LITERATURE SURVEY:

Researchers such as Warsha Kandlikar, Toradmal Savita Laxman, Deshmukh Sonali Jagannath proposed a face detection and recognition based attendance system for the students in the class. They overcome the problems such as Lighting variations, Expression variations, variation 3D face recognition based on 2D images and they are converted to 3D based on binocular disparity technique [7]. In paper [8], author investigated the existing algorithms which are developed for the past 30 years in conversion of 2D images to 3D images. These algorithms include binocular disparity, motion, focus, atmosphere scattering, defocus and statistical patterns [8]. Author Thomas M. Deserno summarizes the biomedical image processing with the core steps such as feature extraction, feature selection, segmentation, classification, quantitative measurements and interpretation. And he explains the transmission and exchange of medical images to multimedia applications like electronic patient record monitoring [9]. Researchers such as Bharathi and Vasuki presented an algorithm that converts 2D images into 3D images automatically with the help of edge information of the images. Nowadays three dimensional (3D) displays require depth information which is not available in the conventional 2D contents. Many authors proposed papers that conversion of 2D images to 3D images [10]. Researchers Megha Borse, S.B.Patil, B.S.Patil proposed a literature survey for 3D reconstruction from 2D brain images and they proposed conversion of 2D images to 3D MRI is to visualize the tumors properly. The 3D MRI image is necessary due to the complexity and irregularity of each encephalic tissue boundary [11]. In paper [12], the author proposed a new filtration process is suggested for the image re-noising applications. This approach is observed for the accurate results in the 3D reconstruction process based on a phantom design toolbox that enable complex geometrics generation. Researchers such as C.Saranya and G.Padmavathi

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explains an improved conversion method for creating the 3D representation scene from one or more 2D images. Here they used a weighted motion detection registration method for calculating the difference on current frames and existing frame [13]. In Paper [14], author proposed a automatic conversion of 2D image to 3D process based on determining the depth level of an 2D image. Here they use modulation transfer function squeeze model for the depth level and used a gradient map which is related to each depth level. Authors in paper [15] discuss a new tissue segmentation algorithm for analyzing tissues and diagnose tumor and edema in the quantitative way. This algorithm strips the skull before the segmentation process which is done by self-organizing graphs. Researchers Hadia Bashir, Fawad Hussain and Muhammad Haroon Yousaf proposed an algorithm which is efficient by using limited slices or reconstructing a 3D image for matching criteria that reduces the computational complexity and increases accuracy. Here they use OTSU's segmentation process for the identification of tumor [16]. Authors in [17], presented a comparative study for the region based segmentation some of them are Fuzzy C-mean, Fuzzy C-mean plus K-mean, Genetic algorithm, ANFIS which comparative results in terms of accuracy, sensitivity and specificity. Author Dipankar Hazra developed a texture recognition system that retrieves the image data from browser. He combines GLCM, Daubechies filters and rotated wavelet filters for retrieving a high quality feature set [18]. Researchers such as Nitish Zulpe and Vrushsen Pawar used four different classes of brain tumors and extracted GLCM based features in each class and they applied two layered forward neural network and getting 97.5% of classification rate [19]. Authors Ashwini Vinayak Bhad, M.M. Raghuwanshi, Komal Ramteke proposed an image retrieval technique for finding the image that uses dynamic dominant color, texture and histogram features of an image. Here they use color histogram for achieving better accuracy [20]. In paper [21], author tries to put light on basic principles for segmenting an image and concentrated on basic principles used in this system. Here the author surveyed image segmentation which is broadly classified into semi interactive approach and a fully automated approach. Here the author different types of region growing segmentation process and discussed advantages and disadvantages of different region growing segmentation. Researchers Khin Mya Mya Tun and Aung Soe Khaing discussed feature extraction and classification of lung cancer nodule based on image processing techniques. Here they used GLCM and physical dimension for feature extraction and OTSU's thresholding and artificial neural network for the classification process [22]. Authors D.Chitra and G.M.Nasira presented a study using classification process for CT images using feature extraction based on Gaussian wavelet and GLCM. Here the feature selection is done by wrapper technique using the CFS and Bacterial foraging algorithm which are supervised learning and use inductive algorithms [23]. In paper [24], author presented a review of feature selection methods in medical image processing. In that review, the selection algorithm determines authenticity of medical image process decisions. Here three different methods such as screens, ranks and selects are used, which removes unimportant and problematic predicators. Author Shahar Jamshy presented a searchlight based feature extraction for brain images. Here the classification is based on whole brain classification accuracy and it is performed on a voxel and its neighborhood. The limitation of this process is when number of features grows; performance of this process falls down [25]. In paper [26], author Leela Nangai V. discussed a framework which contains three stages which are segmentation, texture feature medical image classification based on hyperbolic hopfield neural network for the purpose of automatic brain tumor identification. Researchers Brajpal Singh Jadon and Neelesh Gupta presented an algorithm called Fuzzy rule base algorithm for detecting the edges efficiently from the gray scales. This algorithm starts the edges at each pixel of a digital image which is calculated using the linear spatial filters [27]. In Paper [28], the article provides an overview of type-2 fuzzy systems which covers type-2 fuzzy sets, rules, membership functions, type-2 inference, type reduction and defuzzification. Researchers such as Rahil Hosseini, Salah D. Qanadli, Sarah Barman, Mahdi Mazinani, Tim Ellis, and Jamshid Dehmeshki presented an approach for learning and tuning Gaussian interval type-2 membership functions with application. This is done for the classification of multidimensional patterns [29]. Authors Kavita A. Ugale Prof. Dr. S.T. Patil explains a 3D reconstruction model based on support vector machine which solves the non-linearity problem [30].

III. PROBLEM DEFINITION:

Processing of images data for storage, representation for machine perception refers to digital image processing that takes input as digital image. Here the digital image is composed of finite number of elements such as picture

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element, image elements, pels (smallest discrete component) and pixels which has a particular location and value. Brain tumor is a collection of abnormal cells in human brain. Brain tumors are identified by (CT) and (MRI) scans which are commonly used.

These scan reports results in 2D images which do not give effective results of tumors. So conversion of 2D images to 3D images are taken place which has many issues like sharp edges, color ambiguity, large displacement and zoom in-zoom out which results in less accuracy of the image. To overcome the above mentioned problem we propose a 3D reconstruction for analyzing MRI brain images that results efficient accuracy in an image. In the next section we discuss the proposed work of this approach.

IV. PROPOSED WORK:

4.1. OVERVIEW:

Our proposed work is only based on medical image processing. In our work, 3D reconstruction is used for efficiently analyzing MRI brain images. Brain tumor is most dangerous disease in the world. It is diagnosed by the MRI scans which results in 2D images. Our proposed system consists of six stages such as Preprocessing, Segmentation, Feature Extraction, Feature selection, Classification, 3D reconstruction. Initially our approach starts with preprocessing process with the help of modified spatial median filter and it is followed by region growing segmentation process. For extracting the features from segmented image we use WV-GLCM mechanism and the feature selection process is based on ANFIS algorithm. The next process is classification which is done by Type 2 fuzzy logic system. Then the final stage is 3D reconstruction process that is based on ImageJ tool. Fig 2 represents the overall process of proposed approach.

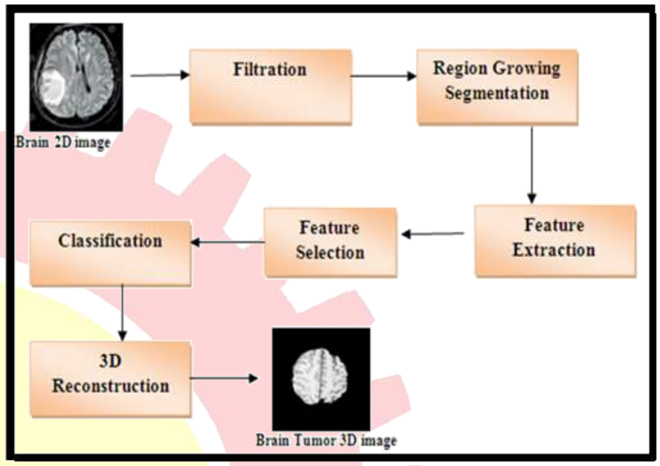

Fig 2: Overall Process of Proposed Work

4.2. FILTRATION:

Filtration is the initial process of our proposed approach which uses 2D images as input. Here we use Modified Spatial Median Filter for the removal of noise from 2D images. This filter uses the window size (mask) and threshold T for removing the noise. The spatial depths between each point are computed within the mask. Here we decide the centered point in the mask are corrupted are not, If it is not corrupted it will not be changed. It identifies spatial depths of each point in the images [12]. The spatial depth is determined by,

$$S(X, x_i) = 1 - \frac{1}{(N-1)} \left\| \sum_{i=1}^{N} \frac{(X - x_i)}{\|X - x_i\|} \right\|$$

Here N is the number of pixels and x_i is the corresponding pixel value.

Here, to fix the point statically, we decide the center point is the uncorrupted point. After the calculation of spatial depths, we sort them in descending order. The point with highest spatial depths represents the spatial median of the set which is used for relocate the center point when there is existence of noise. This descending order of depths represents the creation of spatial level. The higher depth measures are represented as the collected of uncorrupted points which are pushed into front of ordered list. The lower depth measures list represents points with larger spatial difference with others in the mask and corrupted points. These are pushed to end of the list.

A threshold is chosen T represented the estimated number of original points under a mask of points. If centroid point C <= T the current pixel is $(T, x_i) = r_c$ else if centroid point C >= T $(T, x_i) = r_1$ else if C=1, this represents that the pixel cannot be unmodified. Finally the noise is removed from the image. Next our process moves to the next stage.

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4.3. SEGMENTATION:

The process of dividing an image (Digital Image) into multiple segments such as set of pixels (super pixels) is called as image segmentation which is achieved based on similar attributes. The goal of segmentation is to simplify or change the representation of an image that must be meaningful and it is analyzed easily which are further utilized. The brain image segmentation is the challenging task for all researchers. Fig 3: describes the region growing segmentation process. Our proposed process focus on unseeded region growing segmentation which is follows:

- Segmentation process is initialized with the single pixel region called A1 which results in multiple regions such as (A1, A2, A3…..An). Here B is set of all unallocated pixels which borders at least one region,

$$B= \{x \notin \bigcup_{i=1}^{n} A_i \wedge \exists K : N(x) \cap A_k \neq \}$$

Where N(x) are immediate neighboring points of point x.

- Then calculate the difference on those test pixels with mean value of region statistics which decide the allocated and unallocated pixels.

$$\delta(x, A_i) = \left| g(x) - mean_{y \in A_i}[g(y)] \right|$$

g(x) denotes the image value at the point x, I is an index region where N(x) intersects A_i.

- If difference is less, then the pixel is allocated at specific region A_j.

$$\delta(z, A_j) = \min_{x \in T, K \in [1,n]} \{\delta(x, A_k)\}$$

- If condition not satisfied, then the pixel moved to new region A.

$$A = \underset{A_k}{\operatorname{argmin}} \{\delta(x, A_k)\}$$

- If both the above conditions fails then the pixel are moved t a new region A_{n+1}.

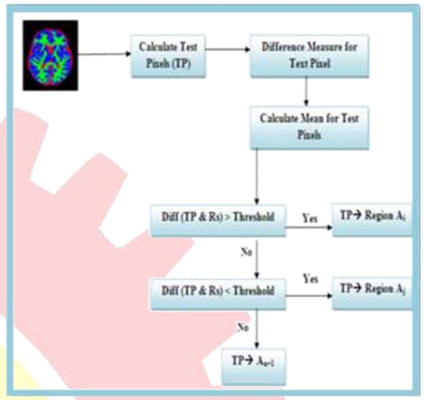


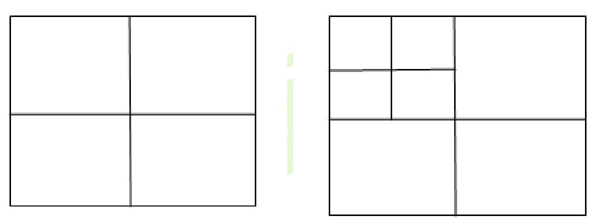
Fig 3: Region Growing Segmentation

4.4. FEATURE EXTRACTION:

The third stage of our process is feature extraction process. Here we use WV_GLCM mechanism for the feature extraction process. This includes combined process of both GLCM and Wavelet process which results in effective results. Here we extract many features based on gray level co-occurrence matrices which can be computed for several distance and orientation. Here we use two components such as:

i) Texture database
ii) Texture recognition function.

Texture database contains mainly two types of tables, which are texture name, texture type and glcm feature vector for the GLCM Texture database and Wavelet Texture database contains texture name, texture type and 2D wavelet feature vector. This process first performs the wavelet process and it is followed by GLCM Process. In wavelet process, The DWT decomposition [18] of image is performed to 5^{th} level which is the end. Energy of each level, for each sub band (High-High, High-Low, Low-High, Low-Low) is calculated.



1^{st} Level Decomposition 2^{nd} Level Decomposition

Fig 4: Image Decomposition

Fig 4 describes 1^{st} and 2^{nd} level decomposition of images. After that, GLCM is a matrix process where number of rows and columns are equal to number of grey levels (G) in the Image. Here the matrix element A (i, j | $\Delta x, \Delta y$) is the

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relative frequency which is separated by a distance between the pixel is represented as ($\Delta x, \Delta y$). The matrix element which is represented as P (i, j | d,θ) contains second order probability values such as distance d and angle θ for changes in gray level i and j. After getting the texture features from GLCM, we need to calculate the features with help of gray levels (G), mean (μ) of A. By summing up the rows and columns we obtain $P_x(i)$ and $P_y(j)$. Here μ_x, μ_y, σ_x *and* σ_y are mean and standard deviations of obtain P_x and P_y.

$$\mu_x = \sum_{i=0}^{G-1} i\mathrm{Px}(i)$$

$$\mu_y = \sum_{j=0}^{G-1} j\mathrm{Py}(j)$$

$$\sigma_x^2 = \sum_{i=0}^{G-1}(\mathrm{Px}(i) - \mu_x(i))^2$$

$$\sigma_y^2 = \sum_{j=0}^{G-1}(\mathrm{Py}(j) - \mu_y(j))^2$$

Fig 5 describes the feature extraction process. We calculate different texture features are as follows:

- Angular Second Momentum(Homogeneity):

$$\mathrm{ASM} = \sum_{i=0}^{G-1}\sum_{j=0}^{G-1}\{P(i,j)\}^2$$

- Contrast:

$$\mathrm{Contrast} = \sum_{n=0}^{G-1} n^2 \left\{\sum_{i=1}^{G}\sum_{j=1}^{G} P(i,j)\right\}, |i-j| = n$$

- Inverse Difference Moment:

$$\mathrm{IDM} = \sum_{i=0}^{G-1}\sum_{j=0}^{G-1}\frac{1}{1+(i-j)^2} P(i,j)$$

- Entropy:

$$\mathrm{Entropy} = -\sum_{i=0}^{G-1}\sum_{j=0}^{G-1} P(i,j) * \log(p(i,j))$$

- Correlation:

$$\mathrm{Correlation} = \sum_{i=0}^{G-1}\sum_{j=0}^{G-1}\frac{\{i*j\}*p(i,j) - \{\mu_x * \mu_y\}}{\sigma_x * \sigma_y}$$

- Inertia:

$$\mathrm{Inertia} = \sum_{i=0}^{G-1}\sum_{j=0}^{G-1} (i-j)^2 * P(i,j)$$

- Variance:

$$\mathrm{Variance} = \sum_{i=0}^{G-1}\sum_{j=0}^{G-1} (i-\mu)^2 P(i,j)$$

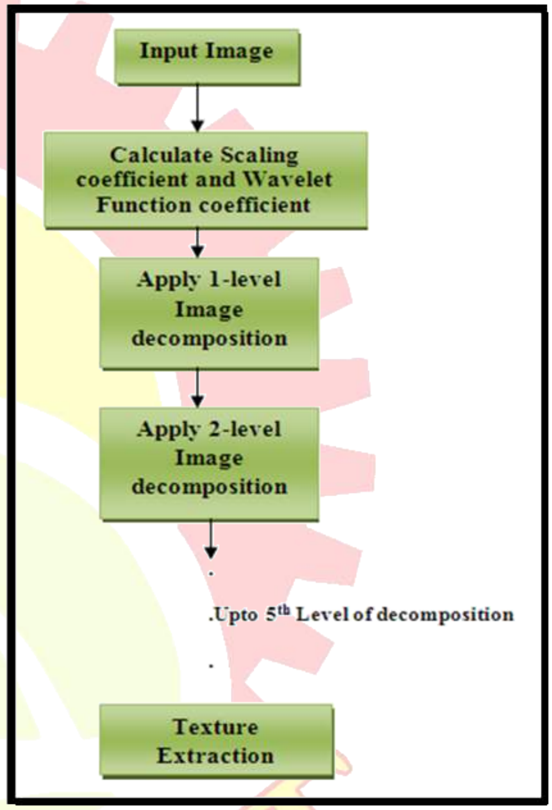

Fig 5: Feature Extraction

4.5. Feature Selection:

Feature selection is also called as attribute seletion or variable selection in machine learning and statistics which is used for selecting the relevant features that used in model construction. This process is used for three reasons:

- Enhancement in generalization
- Reduced timing in training
- To simplify the models for researchers.

This process helps to reduce features by improving the prediction accuracy and reduce computation time. Our proposed process uses genetic algorithm to solve feature subset selection problem. Genetic Algorithm is excellent technique and it is combined with ANFIS (Adaptive neural network fuzzy inference system) which works as a filter for reducing the computation time. Here we develop a pseudo code for this feature selection process which is displayed in Fig 5.

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In this algorithm, we initialize the features that extracted from above section. For selection process, we number the features and we choose (n) any of 7 features randomly for all possible solution subspace because of MCL i.e., maximum chromosome length. P is the maximum population. Calculate the fitness function that decides the genetic algorithm success.

$$\sum_{i=1}^{20} \frac{TP}{TP+FN} + \frac{TN}{TN+FP} + \frac{TN+TP}{TP+TN+FP+FN}$$

Here,

- True Positive (TP)→ Both training algorithm and testing algorithm results are positive
- True Negative (TN) → Both training algorithm and testing algorithm results are negative,
- False Positive (FP) → training algorithm result is positive and testing algorithm are negative
- False Negative (FN) → Training algorithm result is negative and Testing algorithm results are positive.

We differentiate the Fitness (f) and $Fitness_{max}$ in order to find Best Feature Subset (BFS). If the value of BFS is from 0 to 15 then it is considered as the best feature subset otherwise generate the new population based on cross over and mutation process and it is continued. Fig 6 describes the feature selection process.

Pseudo code: Adaptive neural network fuzzy inference system (ANFIS)

Inputs:

F = {f1, f2, f3, f4, f5…}
P, SF=7

Begin:

Step 1: Initialize the parameters
Step 2: set p=10, MCL=7
Step 3: select n from F
Step 4: calculate fitness function:
Fitness (f) =
$$\sum_{i=1}^{20} \frac{TP}{TP+FN} + \frac{TN}{TN+FP} + \frac{TN+TP}{TP+TN+FP+FN}$$
Step 5: Compute BFS
BFS= Fitness (f) – $Fitness_{max}$
Step 6: If (0 >= BFS<=15)
Conclude process
Else
Generate population and Goto step 4

End

Fig 6: Pseudo code for ANFIS algorithm

4.6. CLASSIFICATION:

The Classification is defined as a process in grouping the individual items based on similarity and description of those items. In our proposed work, we use type-2 fuzzy logic system [28], it is an uncertain fuzzy rule based system which has imprecision in the input data and noisy measurement, non stationary feature uncertainty issues, etc.

This system includes fuzzifier, a rule base, fuzzy inference engine, type reducer and a defuzzifier. Here we get the input from feature selection process. The member function can be defined in type 2 fuzzy system as $\mu^{-}_{A}(x, u)$. Fuzzy set can be defined as

$$\tilde{A} = \{((x, u), \mu_{\tilde{A}}(x, u)) \mid \square x \ \square\ X, \square u \ \square\ J_x \ \square\ [0, 1]\}$$

Fig 7 describes the diagrammatic representation of type-2 fuzzy logic system. Fuzzifier maps a numeric vector, $x = (x_1,\dots,x_i)^T \in X_1 * X_2 * \dots * X_i \equiv X$ to the fuzzy set $\tilde{A}_x$ in X. here we use singleton fuzzification. In this process $\tilde{A}_x$ is type-2 fuzzy singleton only if, $\mu_{\tilde{A}_x}(x) = 1/1$ for x = x' and $\mu_{\tilde{A}_x}(x) = 1/0$ for

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all other $x \neq x'$.

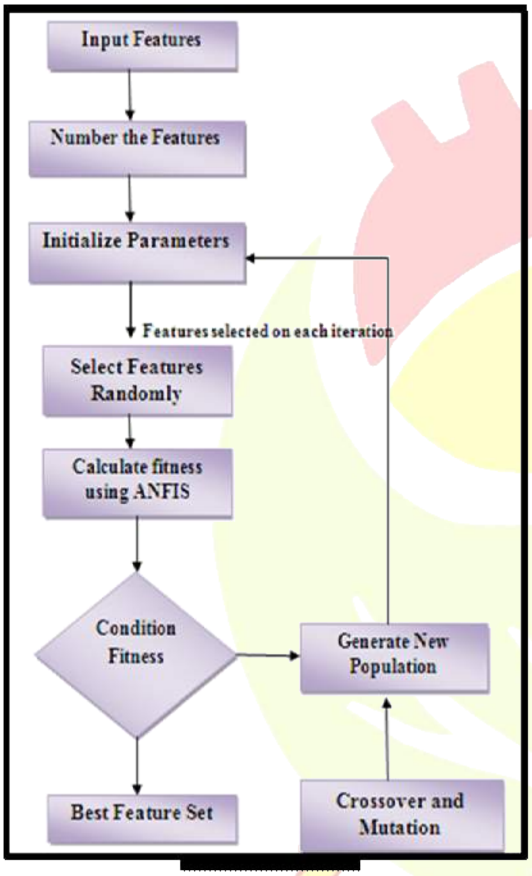

Fig 7: Feature Selection based on ANFIS

The Rules in the type 2 fuzzy logic system, there are n inputs, x1 □ X1… x_n □ X_n and it has one output y □ Y. We assume that there is Multi Input Single Output (MISO), here there are m rules, l^{th} rule in type 2 fuzzy logic system is taken as,

R^l: IF X_1 is $\tilde{F}_1^l$ and… and X_i is $\tilde{F}_i^l$; THEN y is $\tilde{G}^l$ where = 1 . . . M.

The Fuzzy inference engine, the author in [28] derived an equation such as, l

$$F^l(x') = \left[\underline{f}^l(x'), \quad \overline{f}^l(x')\right] \equiv \left[\underline{f}^l, \overline{f}^l\right]$$

The type reducer is generates a type-1 fuzzy set and it is converted in a numeric output through running the defuzzifier. The output or type-2 FLS system we use center of sets i.e. cosine type reduction that is expressed as follows:

$$Y_{cos}(x) = [Y_l, Y_r] = \int y^1 \epsilon [y_l^1, y_r^1] \; . \; . \; . \int y^M \epsilon [y_l^M, y_r^M] \int f^1 \epsilon \left[\underline{f}^1, \overline{f}^1\right] \ldots \int f^M \epsilon \left[\underline{f}^M, \overline{f}^M\right] 1 \Big/ \frac{\sum_{i=1}^{M} f^i y^i}{\sum_{i=1}^{M} f^i}$$

After identifying $Y_{cos}(x)$ we defuzzify the process with the average of y_l and y_r, $Y(x) = \frac{y_l + y_r}{2}$

Where, $y_l = \frac{\sum_{i=1}^{M} f_l^i y_l^i}{\sum_{i=1}^{M} f_l^i}$ and

$$y_r = \frac{\sum_{i=1}^{M} f_r^i y_r^i}{\sum_{i=1}^{M} f_r^i}$$

Finally, after the defuzzification process, we classify the textures and we move to the final stage.

4.7. 3D RECONSTRUCTION:

Our final stage of our approach is that 3D reconstruction or modeling which is based on ImageJ tool. This tool can perform the process on images like display, edit and analyze. This supports image stacks, multiple images sharing single window and it is multithreaded, so it can perform parallel processing on multi-CPU hardware this leads to higher time consuming. This tool is integrated with public domain software, and also used for java based program. It was designed with an open architecture which provides for extensibility through recordable macros and java plugins. This tool is particularly flexible image-processing package and it is capable of handling both grayscale and color images. This tool intended purpose is medical image processing. Fig 8 shows the pictorial representation of 3D reconstruction.

V. PERFORMANCE EVALUATION:

In this section, our proposed process is evaluated. The Unseeded Region growing segmentation and type-2 fuzzy logic system is implemented using MATLAB and real dataset can be used which is for improving the segmentation accuracy and classification accuracy. Brain tumor disease has two types they are Benign, Malignant. Our proposed process involves unseeded region growing segmentation and type-2 fuzzy classification systems are most important work for analyzing MRI Brain efficiently. Here we make a comparison with other classification methods such as SVM, Statistical Classifier, and Hyperbolic Hopfield Neural Network (HHNN). This will provide efficient results of brain tumor

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classification.

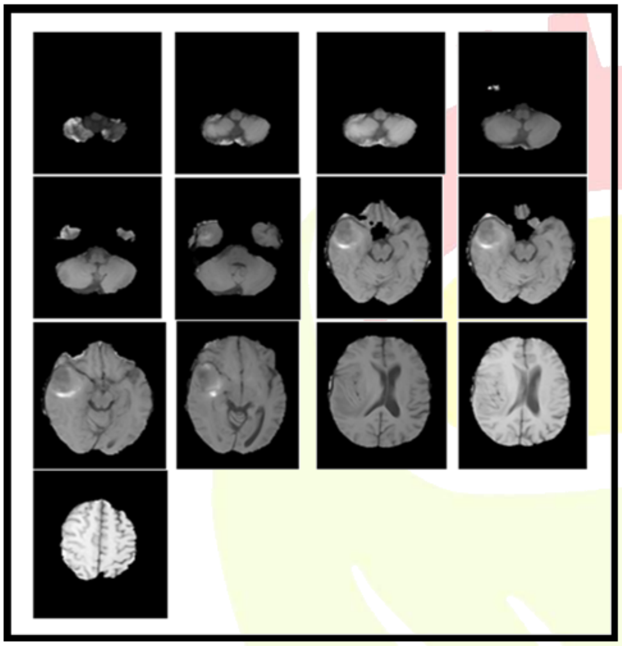

Fig 8: 3D Reconstruction

Dataset:

The MRI images of brain are used to evaluate the accuracy of our proposed system. Brain MRI 2D images are useful for screening and learning the patient disease in an efficient manner. The results of MRI Scan clearly display the mass of cell growth in human brain which are called as tumor. There are two types of brain tumors; they are benign tumors and malignant tumors. Our process use MRI 2D images which are a real brain images used for the 3D Reconstruction. This MRI brain images are directly collected from Medical Diagnostic Imaging Center. Our dataset contains more than 250 real images which are used to improve the segmentation accuracy and classification accuracy.

Result and Discussion:

In our proposed approach we have to compare segmentation process of OTSU's threshold segmentation and unseeded region growing segmentation. In OTSU's threshold segmentation, threshold value which results in gradient problem and their process results in over segmentation or under segmentation of a feature. This segmentation neglects spatial information of the image. In this unseeded segmentation process, correctly and incorrectly segmented images are taken for calculation process. Correctly segmented images are taken as positive values (TP, FP) and the negative values are taken as (TN, FN). Formulae for computing the segmentation accuracy can be taken as $\text{Accuracy} = \frac{TP + TN}{P+N}$

$$\text{Sensitivity} = \frac{TP}{TP+FN}$$

$$\text{Specificity} = \frac{TN}{FP+TN}$$

where P → TP + TN and N→ FP + TN.

Fig 9 describes the segmentation process. (1) describes the original image of brain tumor (2) describes the OTSU's threshold segmentation (3) describes the Unseeded region growing segmentation.

(1)

(2)

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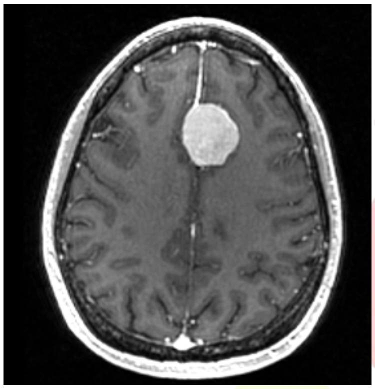

(3)

Fig 9: (1) Original image of brain tumor (2) OTSU's threshold segmentation (3) Unseeded region growing segmentation.

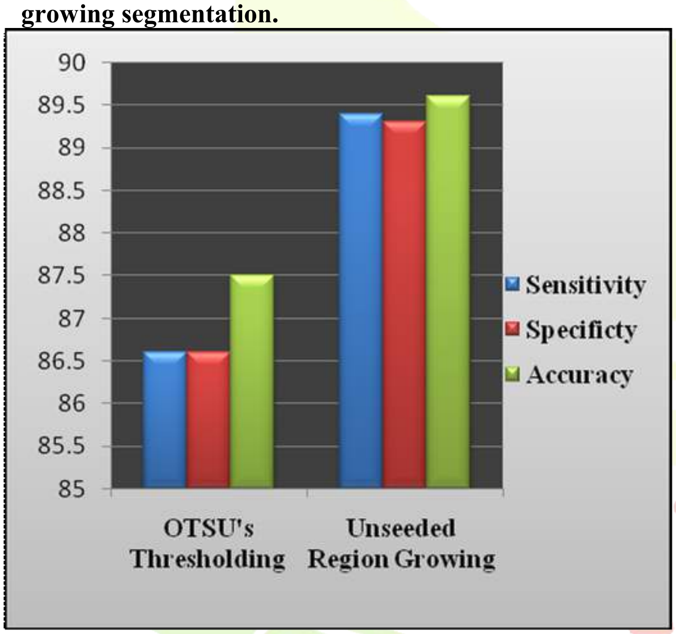

Fig 10: Comparison of Segmentation Methods

For comparison, four segmentation techniques are shown in table. Here k-mean clustering and Watershed algorithm are taken form [32]. For comparison the segmentation accuracy, specificity, sensitivity is taken as parameter. Table 1 describes the comparison of segmentation results. Fig 10 describes the comparison graph for OTSU's threshold method and unseeded region growing segmentation.

Table 1: Comparison performance of Segmentation Methods

Segmentation Technique	Sensitivity	Specificity	Accuracy
K-mean Clustering Algorithm	84.5	84.5	84.3
OTSU's Thresholding	86.6	86.6	87.5
Watershed Algorithm	79.1	79.1	78.1
Unseeded Region Growing Segmentation	89.4	89.3	89.6

After the Segmentation method, we do the feature extraction process and feature selection process. In the feature selection process gives output to Classification process. Here classification process is an important method in our proposed method. Our proposed technique uses Type-2 Fuzzy logic system. Identification of tumors such as Normal brain, benign tumors and malignant tumors are differentiated with the help of feature values that are generated from Feature selection process based on ANFIS system. In a human brain there is collection or mass of cell growth that may invade to other parts of body which generates the cancer cells. Our classification process differentiates the conditions of normal brain, benign tumor and malignant tumor.

We compare our proposed classification process with SVM, Statistical Classifier and Hyperbolic Hopfield Neural Network (HHNN), for this we refer some previous paper [26]. Fig 11 describes classification of normal images, benign images, and malignant images. Table 2 describes the several classification methods. Fig 12 describes the comparison of various classification methods with accuracy percentage.

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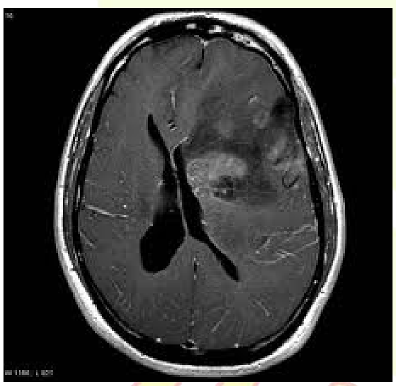
Table 2:
Classification Methods

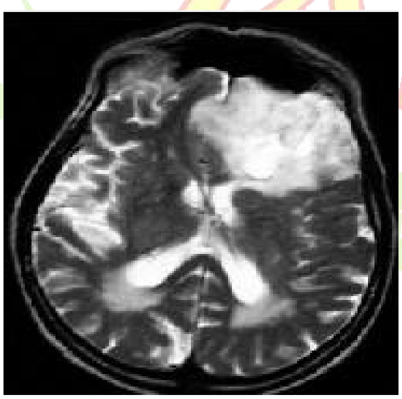
Classification Methods	Accuracy
SVM	97.8
Statistical Classifier	88.2
Hyperbolic Hopfield Neural Network (HHNN)	98
Type-2 Fuzzy Logic System	98.4

(3)

Fig 11: (1) Normal Brain Image (2) Benign tumor (3) Malignant tumor



(1)



(2)

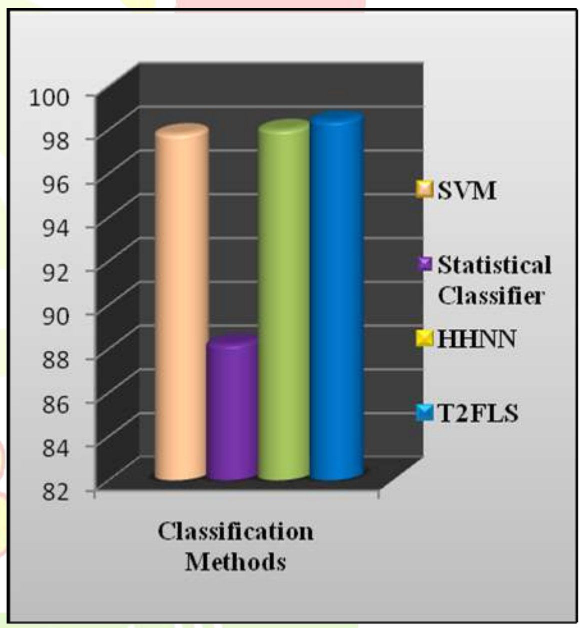


Fig 12: Comparison of Classification Methods

VI. CONCLUSION:

A new system is proposed for 3D Reconstruction and MRI brain analyzing efficiently. This system has many stages for the construction of 3D images. Here we use 2D MRI Brain images as input. Initially we use modified spatial median filter for the noise removal and followed by unseeded region growing segmentation process which provide accuracy result of 89.6%. After

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segmentation Feature extraction process is carried by WV_GLCM mechanism to extract the features. Adaptive Neural Network Fuzzy Inference System (ANFIS) used for selecting the feature values for the proposed process which combines the neural network and fuzzy inference system.

Then, Classification is an important process for the proposed system which is based on Type-2 Fuzzy logic system and classifies the normal brain, benign tumor and malignant tumor that results 98.4% accuracy. At the end of classification process, it is allowed to 3D reconstruction model. In our proposed system 3D Reconstruction is done by an ImageJ tool. Our proposed approach helps us to overcome the issues to conversion of 2D images to 3D images. In our future work, we plan to use several methods and algorithms for constructing the 3D images using 3D Reconstruction model.

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