Final Year Software Project
Brain Inspector

Detection and 3D Visualization of Brain Tumor from MRI Scans

Project Team

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We, Ghazanfar Latif, Irfan Mehmood, Sarfraz Ahmad and Sadia Kanwal do hereby solemnly declare that the work presented in this report is our own, and has not been presented previously to any other institution.

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Ghazanfar Latif: _____

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Sarfraz Ahmad: _____

Sadia Kanwal: _____

(Researchers)

Certified:

_____   _____

Supervisor   Co-Supervisor

_____

Examiner

Abstract

This report documents the initial development on the Brain Inspector Project. We discuss the motivation to select this project, the current work environment, the research that has been carried out and the work in designing of the solution. Development methodology and environment is also discussed in this report. We provide a roadmap for building the prototype of Brain Inspector, the techniques we shall employ for testing and deployment and the future work that can be carried out to take this project further.

Acknowledgment

Summary

In medical field visualization of the organs is very imperative for accurate diagnosis and treatment of any disease. The increased importance of automated computer techniques for anatomical brain mapping from MR images and quantitative brain image analysis leads to an increased need for validation and evaluation of the effect of image acquisition parameters on performance of these procedures. Brain is the core and most complex part of human body which makes its analysis and treatment difficult and risky as compared to other human organs. Brain has three main tissue types Gray matter, White matter, background and cerebrospinal. It is difficult task to distinguish between different tissue boundaries as in image they seem overlapping. Our proposed system facilitates brain tumor detection and analysis more easy and accurate. Brain tumor diagnosis and surgery also required impressive 3D visualization of the brain to the radiologist. Proposed system presents an interactive 3D visualization model of the brain and tumor inside which greatly helps the radiologist to effectively diagnose and analyze the brain tumor. In this system brain MR images are used for 3D visualization purpose. First these images are classified as normal and tumorous by naïve bayes classifier using discrete wavelet transform. After classification segmentation is performed on the images those are determined as tumorous. Error rate of segmentation is very low because proposed system segments only those images that are classified as tumorous. 3D model is built on the results of this segmentation. Proposed system is tested against MRI dataset available from Pakistan Institute of Medical Sciences (PIMS) Islamabad and Abrar MRI&CT center Rawalpindi.

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Introduction

Segmentation of images has become an important and effective tool for many technological applications like brain MRI segmentation, medical imaging and many other post-processing techniques. The increased importance of automated computer techniques for anatomical brain mapping from MR images and quantitative brain image analysis leads to an increased need for validation and evaluation of the effect of image acquisition parameters on performance of these procedures. Validation of analysis techniques of acquired images is complicated due to the lack of reference data. Brain has three main tissue types Gray matter, White matter, background and cerebrospinal. Also it is very difficult to distinguish between different tissue boundaries as in image they seem overlapping. In this project our main focus is on two things first to segment the images and second is make a 3D Model from those MRI to facilitate analysis of tumor easy and more naturally.

For segmentation we are working on many papers but for implementation we have selected recent papers in which modern techniques are used. In our work artificial intelligence, neural networks and digital image processing are used. Our main idea is to develop such a CAD system to help medical specialist to make accurate decisions. In this system there will be minimum human intervention, it will be totally automatic.

We are making 3D model in such a way that user can slice through the structure of brain. This will be really amazing and it will be really helpful to analyze and visualize the brain and locate tumors. User will realize as he is dealing in reality with real human brain and seeing every part of brain. It is like onion and we are moving inward by removing its layers iteratively. Further Semantic Web based Decision Support System will prescribe the treatment and medication based on the previous history that were maintained by the brain inspector.

1.1 Medical Image Modalities

There are four techniques exist for medical image modalities which are most commonly used.

1.1.1 X-Rays

X-rays are primarily used for diagnostic radiography and crystallography. The term X-ray is metonymically used to refer to a radiographic image produced using this method, in addition to the method itself. X-rays are a form of ionizing radiation and as such can be dangerous. X-rays are especially useful in the detection of pathology of the skeletal system, but are also useful for detecting some disease processes in soft tissue. Some notable examples are very common chest X-ray, which can be used to identify lung diseases such as pneumonia and lung cancer etc.

1.1.2 Computer tomography-Scan (CT-Scan)

Computed tomography (CT) is a medical imaging method employing tomography created by computer processing. Digital geometry processing is used to generate a three-dimensional image of the inside of an object from a large series of two-dimensional X-ray images taken around a single axis of rotation.

1.1.3 Magnetic resonance imaging (MRI)

Magnetic Resonance Imaging (MRI) is primarily a medical imaging technique most commonly used in radiology to visualize the internal structure and function of the body. MRI is used to image every part of the body, and is particularly useful for neurological conditions, for disorders of the muscles and joints, for evaluating tumors, and for showing abnormalities in the heart and blood vessels.

1.1.4 Positron Emission Tomography (PET)

Positron emission tomography (PET) is a nuclear medicine imaging technique which produces a three-dimensional image or picture of functional processes in the body. During the test, the tracer liquid is put into a vein (intravenous, or IV) in your arm. The tracer moves through your body, where much of it collects in the specific organ or tissue. The tracer gives off tiny positively charged particles (positrons). The camera records the positrons and turns the recording into pictures on a computer.

1.2   Brain MRI

Magnetic resonance imaging (MRI) of the brain is a safe and painless test that uses a magnetic field and radio waves to produce detailed images of the brain and the brain stem. An MRI doesn't use radiation, which is one way it differs from a CT scan.

For an MRI of the head, patient lie with his head inside a special machine (scanner) that has a strong magnet. The MRI can show tissue damage or disease, such as infection, inflammation, or a tumor. Information from an MRI can be saved and stored on a computer for more study. Photographs of certain views can be made. MRI provides detailed pictures of the brain and nerve tissues. It also provides clear pictures of parts of the brain that are difficult to see clearly on CT scans.

MRI can also show:

- ✓ Blood flow
- ✓ Blood vessels
- ✓ Fluid that surrounds the brain and spinal cord

1.3 Domain Scope

Images are an important part of medical. X-ray images, Magnetic resonance images (MRI) and Computed tomography (CT) images are routinely used tools in hospitals. The development of medical imaging is rapidly going towards more advance computer help. Today, many radiology departments are switching from traditional film handling to complete digitization of the medical images.

The advantages are many. The computer facilitates and speeds up the whole workflow. The images are produced more quickly, earlier examinations are retrieved instantaneously, and no space consuming archives of films are needed. In addition, the computer provides possibilities to improve the usefulness of the images.

MR and CT images are produced as a series of slices through the examined part of the body. Up till now, physicians have mostly looked at them one at a time, browsing through this image stack. One can, however, create an image of the whole volume at once. A three- dimensional image contains much more information, provided that you can display it in an appropriate way. For example, a surgeon is better prepared for an operation if he has had the chance to look at the concerned region from all possible viewpoints.

Brain Inspector mainly deals with segmentation and 3D visualization. Segmentation is a process that separate objects in an image. In medical images, the aim is to separate different parts of the anatomy. The enhancement of 3D visualization is one of many applications for segmentation.

1.4 Product Scope

Brain Inspector focuses on detecting brain tumor and other head injuries from MRI scan. It also enable doctors to take accurate decision depending upon the results that it provides. It also helps doctors to view similar cases occurred in past and also the treatments that other followed to solve the problem. It also provides doctors the 3-D visualization of brain tumors and other head injuries.

1.5 Objectives

There are five major objectives of brain inspector which are:

- ➢ Analyze MRI scans and make segmentation that data.
- ➢ Brain Tumor Detection from MRI Scans
- ➢ 3D Brain Modeling using Open GL
- ➢ Semantic Decision Support, Based on segmentation and the previous similar cases, it must suggest appropriate treatment or medication.
- ➢ Store treatment and observation in database for further usage

1.6 Motivation and Rational

Existing similar products have high cost and many of them do not keep previous knowledge of treatment and use them in current decision and medication. This will also help doctors a lot and make the decision making process easier and efficient.

The project is motivated by the miserable condition of medical sector in Pakistan especially related to brain diseases. In Pakistan the ratio of brain tumor is much higher than the other countries and there is no proper treatment for brain tumor patients.

1.7 The Process

The process model is shown below:
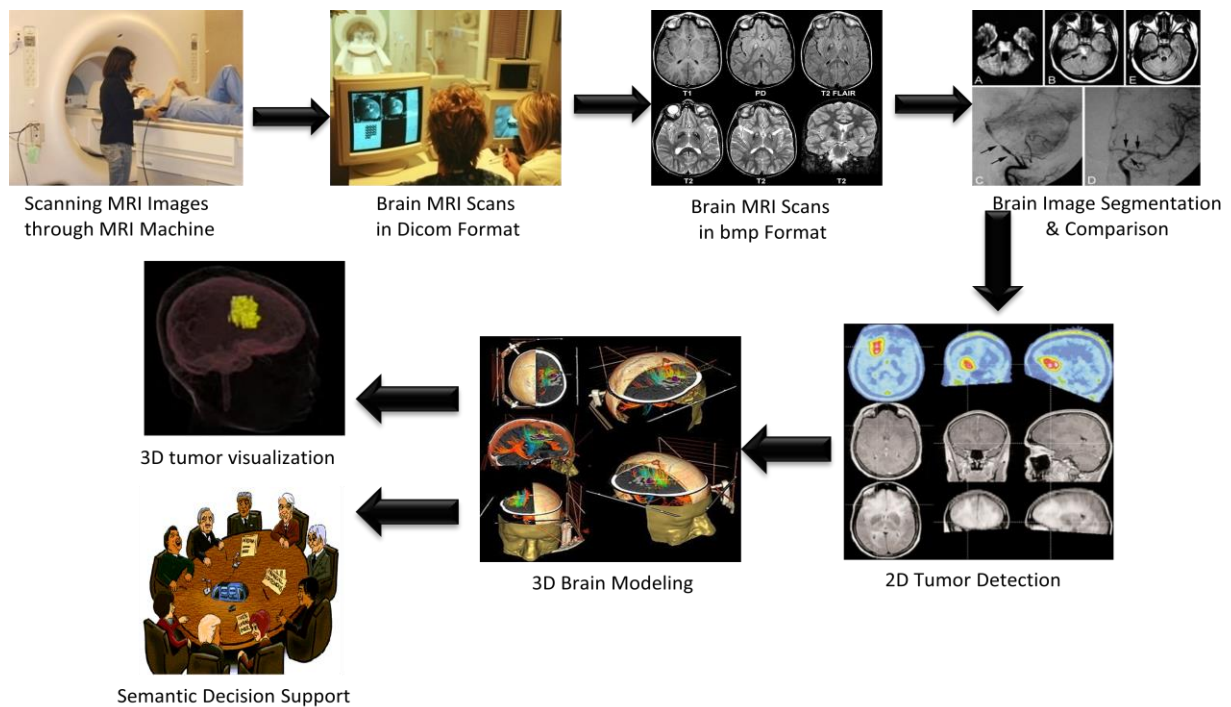
Figure 1.1: Brain Inspector Process

1.8 Data Acquisition

For brain biomedical information and patients MRI data, we contacted with Department of Radiology, Pakistan Institute of Medical Sciences Islamabad. For biomedical information, two meetings were held with Dr. Shazia Faruqui (MBBS and FCRS, London) currently working as Associate Professor and Head of Radiology Department in Pakistan Institute of Medical Sciences, Islamabad. For Brain MRI scans of different patients, we contact with Muhammad Amjad Ali, who is currently working as administrator of the PIMS IT Server. We are also in contact with Dr. Syeda Fizza Tauqir (MBBS, Nishter Medical College Multan and Post Graduate in Radiology, RMC Rawalpindi) who is Radiologist at Holy Family Hospital Rawalpindi for understanding the detection of brain tumor and analyzing results. Dr. Mirza Aqeel (MBBS from DOW Medical College Karachi) working at Abrar MRI Centre, Rawalpindi helps us by providing Brain MRI Datasets.

Chapter 2

Brain Image Segmentation

Fully Automatic Segmentation of Brain in MRI

Outline

In this chapter, we discuss:

- ➢ Introduction
- ➢ Proposed Method
- ➢ Segment Head
    - ✓ Noised Segment
    - ✓ Final Head Mask
    - ✓ Head Boundary Detection
- ➢ Generate Initial Brain Mask
    - ✓ Non-Linear Anisotropic Diffusion
    - ✓ Automatic Threshold
    - ✓ Binary Conversion
    - ✓ Region Filling
    - ✓ Erosion
    - ✓ Eliminating Non-Brain parts
    - ✓ Dilation
    - ✓ Initial Brain Mask
- ➢ Generate Final Brain Mask:
- ➢ Results
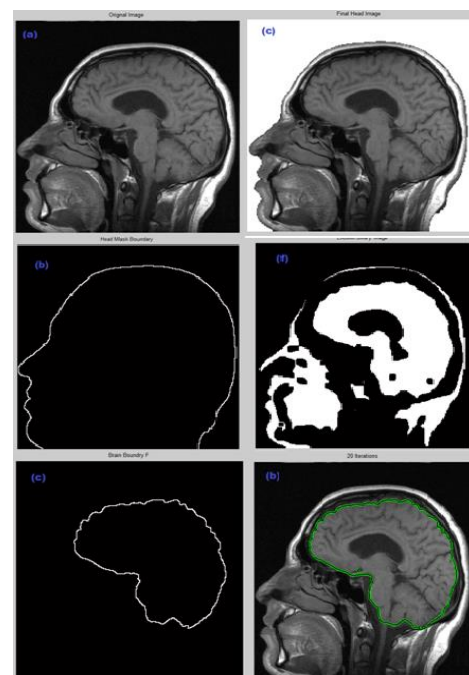
2.1   Introduction

This part is related to the segmentation of human brain MRI scans. Taking MRI scans produce pictorial representation of processes, forming a complete image of a brain. In order to perform detailed studies of these images we need to distinguish the patterns of brain and segmentation of brain from the rest of the head from its MRI. Here is the methodology adopted for distinguishing the brain from the rest of the image.

2.2 Proposed Method

We use a 3 stage method to segment the brain which is shown in Fig. 2.1. First we remove the background noise, and then we generate an initial mask for the regions of interest. Then we refine the mask for the final segmentation.
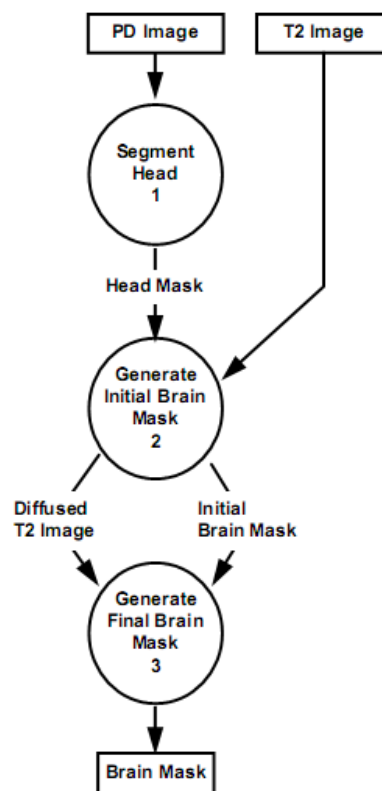
Figure 2.1: PC and PE Graph

The method is distributed in the following steps:

2.3 Segment Head

We use a three stage process to segment head which are explained below:

2.3.1 Noised Segment

Owing to the high similarity between the gray levels of the lungs and the image background (see Fig. 2.2(a)), we cannot eliminate background by simply applying threshold to the image. For this reason we used an operator, starting from the two corners of the image and moves along the two opposite

directions identifying as background pixels those pixels with a gray level within a range fixed in the configuration phase of the system [1].

2.3.2 Final Head Mask

Threshold would produce speckles inside and outside the mask so we use morphological operations (erosion and dilation) to get a perfect binary image without any noise and distortions. This is shown in Fig. 2.2(b).

2.3.3 Head Boundary Detection

In third step we generate the boundary of the head mask. For that purpose we use the image under application of erosion and subtract it from the mask to get a boundary of the head. The detected head boundary is shown in Fig. 2.2(c).
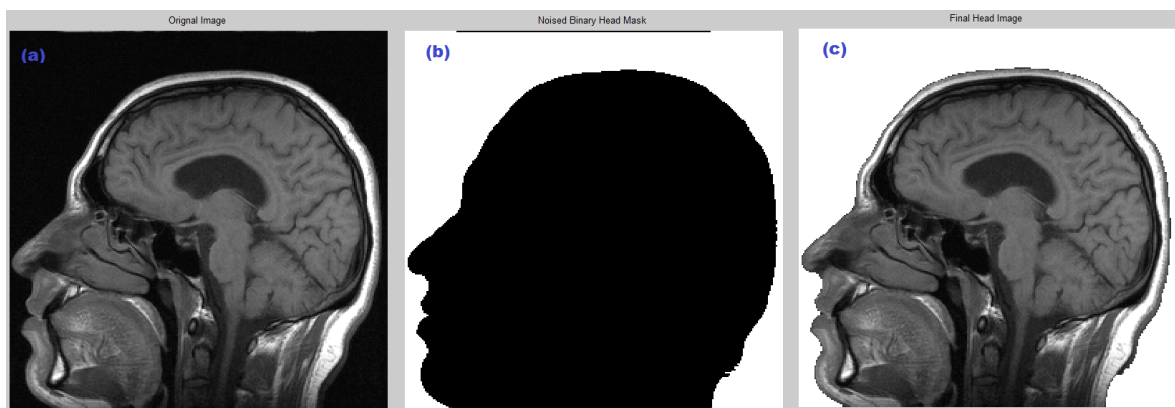
Figure 2.2: (a) Original Image, (b)
Noised Binary Image, (c) Head Mask

2.4   Generate Initial Brain Mask

After the head segmentation we need to generate an initial brain mask that would help us to distinguish only the brain part from the rest of the head's image. It uses anisotropic diffusion and then Gaussian filter will be applied to the background noise removed image of the head. Then centering and locating origins on the image will help to detect only the brain part. Let's see how it works:

2.4.1 Non-Linear Anisotropic Diffusion

This is a type of filter applied on images to make their edges smoother and fuzzier. A diffusion function is used to monotonically degrade the image gradient. The process consists of updating each pixel of the image by an amount equal to the flow contributed by the four nearest neighbors of the

pixels. We use 2-D anisotropic diffusion to attenuate the non-brain part. This enables the brain to be segmented using a simple threshold.

Perona and Malik formulated the anisotropic diffusion filter as a diffusion process that encourages integration smoothing while inhabiting integration smoothing [2]:

$$\frac{\partial}{\partial t}I(\overline{x},t) = \nabla \bullet \left(c(\overline{x},t)\nabla I(\overline{x},t) \right)$$

In our case $I(x',t)$ is the MR Image. X' refers to the image axes *(i.e x, y)* and t refers to the number of iteration steps. $c(x', t)$ is called the diffusion function. We use the following diffusion function:

$$c(\overline{x},t) = \exp\left(- \left(\frac{|\nabla I(\overline{x},t)|}{\sqrt{2}\,\mathcal{K}} \right)^2 \right)$$

K refers to as the diffusion constant and the behavior of filter depends upon the value of K. Fig. 3(c) shows the resultant image after applying the anisotropic diffusion.

2.4.2 Automatic Threshold

We segment the brain using a threshold value which is found by fitting a Gaussian curve to the histogram of the diffused volume. The Fig. 2.3(d) shows the resultant image after applying Gaussian filter [3].

2.4.3 Binary Conversion

After applying the Gaussian filter, we convert the gray level image into binary level image by using automatic threshold technique. It is shown in the Fig. 2.3(e).

2.4.4 Region Filling

The binary mask produced by automatic threshold has gaps; these gaps are filled by using morphological operations. The resultant image is shown in Fig. 2.3(g).

2.4.5 Erosion

Erosion is performed on the image after filling the gaps and spaces. This erosion cuts the portion of the image of eyes and other non-brain parts and what we get is a distinguished brain shape. Fig. 2.3(f) shows the resultant image after applying erosion.

2.4.6 Eliminating Non-Brain parts

Once these parts are separated from the brain they are made to disappear using spatial information. Here we define origin in the brain part of the image. Using that origin as reference point we eliminate those areas that do not fall under the brain part and are irrelevant for our use. The resultant image is shown in Fig. 2.3(h).

2.4.7 Dilation

Having separated the brain image from the original we need to dilate it in order to get a bigger image. This image would be subtracted from the eroded mask we just found. This is how we get the boundary of the brain finally. The resultant image is shown in Fig. 2.3(i).

2.4.8 Mapping the initial Brain Mask

Now we can map the boundary on the original image. We can also extract the boundary of the initial brain mask. The Fig. 2.3(j) shows the initial brain mask.

Figure 2.3: (a) Noised Removed Image, (b) Head Mask Boundary, (c) Apply Anisotropic Diffusion, (d) Apply Gaussian Filter, (e) Binary Conversion, (f) Apply Erosion, (g) Region Filled, (h) Eliminating non brain parts, (i) Apply dilation, (j) Initial Brain Mask
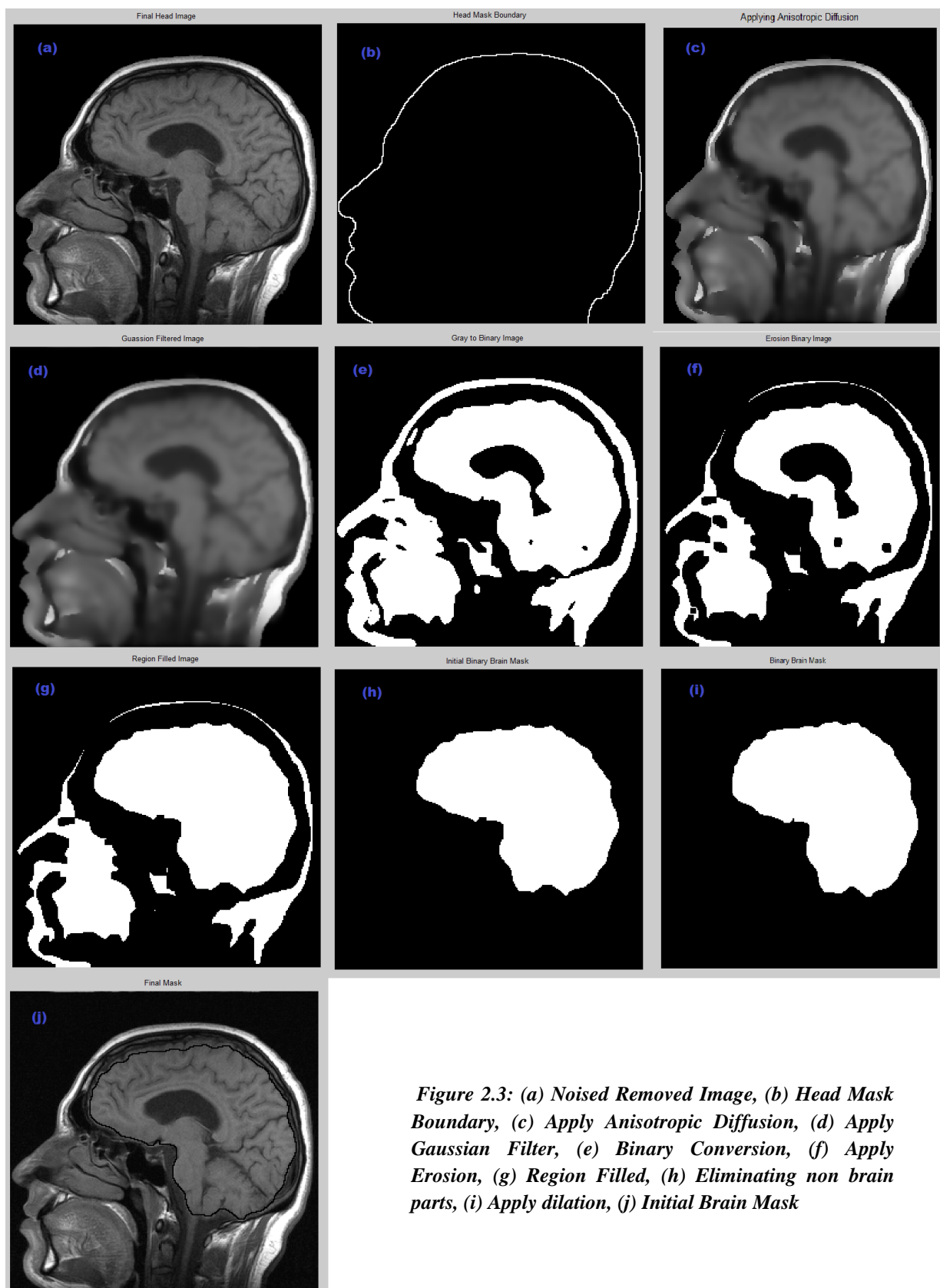
2.5   Generate Final Brain Mask

But this still has a problem. The mask that is produced doesn't fit very nicely on the brain part. There are some parts of the brain that fall outside the boundary. To eradicate this problem another process is applied. We use active contour model algorithm extended from the "snakes" algorithm introduced by Kass et al [4].

Figure 2.4: (a) Initial Brain Mask, (b) Final Brain Mask, (c) Brain Boundary

2.6 Results

The Fig. 5 shows the results of fully automated segmentation of brain MRI's after applying it on different MRI scans.
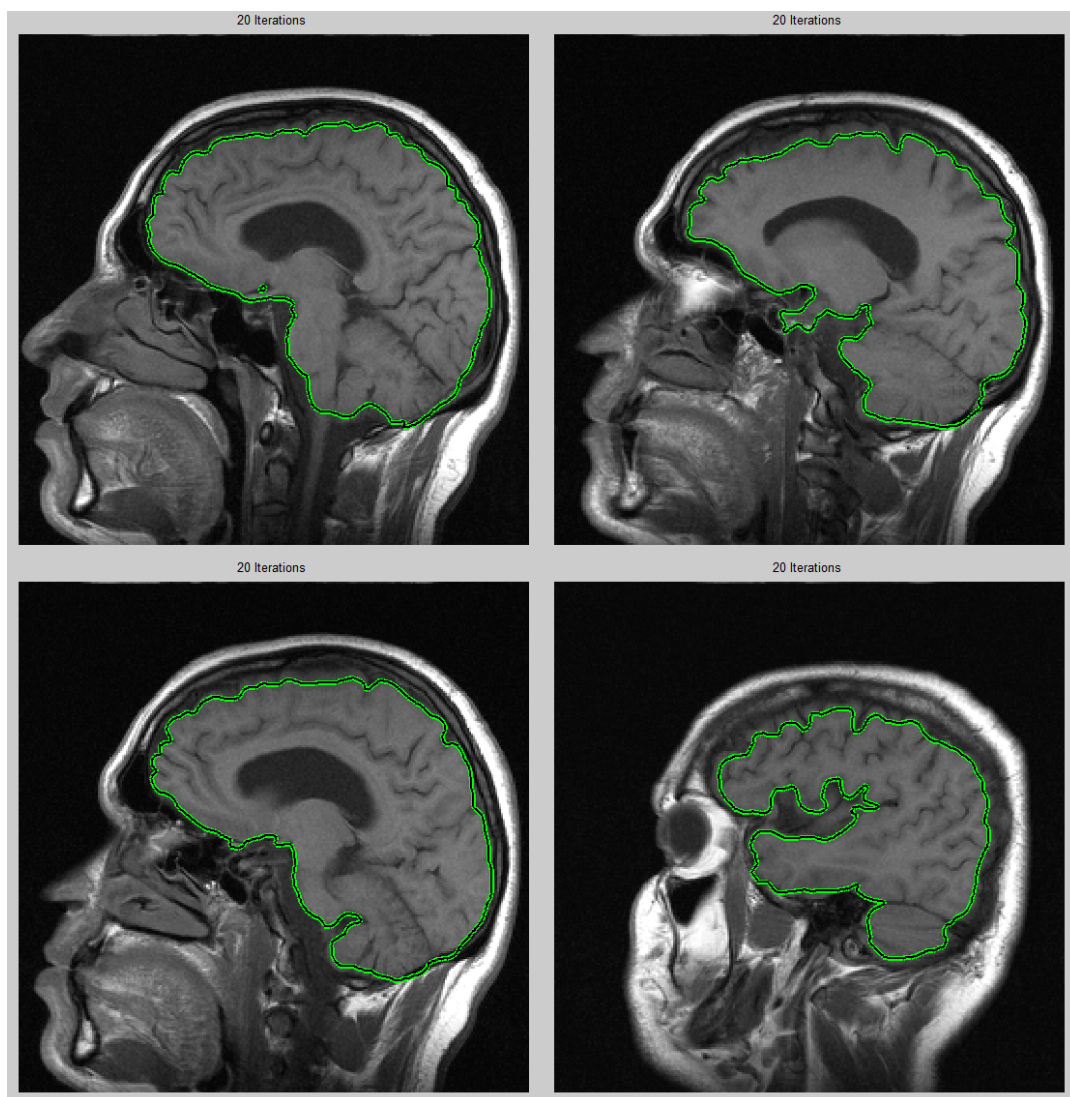
Figure 2.5: Final Brain Boundary Results

Chapter 3

Brain Image Classification

Fully Automatic MRI Brain Images Classification

Outline

In this chapter, we discuss the

- ➢ Introduction
- ➢ Related Work
- ➢ The Proposed Hybrid Techniques
- ➢ Feature Extraction Scheme Using DWT
- ➢ Feature reduction scheme using PCA
  - ✓ K-Nearest Neighbors Based Classifier
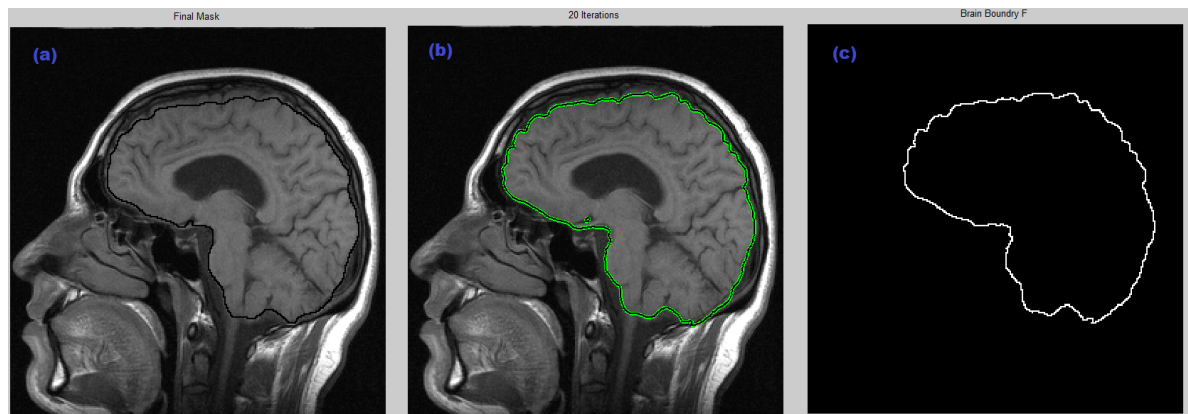 - ✓ Artificial Neural Network Based Classifier
- ➢ Case study
- ➢ Results and Discussions
- ➢ Conclusion
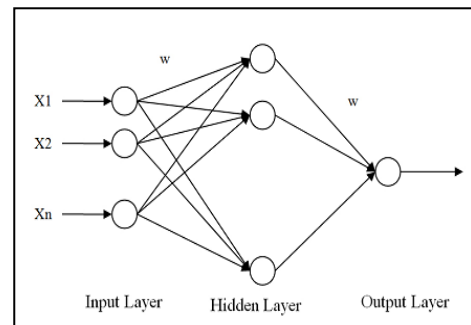
3.1 Introduction

Magnetic resonance imaging (MRI) is often the medical imaging method of choice when soft tissue delineation is necessary. This is especially true for any attempt classify brain tissues. The use of computer technology in medical decision support is now widespread and pervasive across a wide range of medical areas, such as in cancer research, gastroenterology, diseases and brain tumors. Fully automatic normal and diseased human brain classification from magnetic resonance images (MRI) is of great importance for research and clinical studies. This paper presents two hybrid techniques for the classification of the magnetic resonance human brain images. The proposed hybrid technique consists of three stages, namely, feature extraction, dimensionality reduction and classification. In the first stage, the feature related with MRI images using discrete wavelet transformation is obtained. In the second stage, the features of magnetic resonance images (MRI) have been reduced using principles component analysis (PCA) to the more essential features. In the classification stage, two classifiers based on supervised machine learning have been developed. The first classifier based on

feed forward back-propagation artificial neural network and the second classifier based on k-nearest neighbor.

3.2 Related work

The classification of human brain in magnetic resonance (MR) images is possible via supervised techniques such as artificial neural networks and support vector machine and unsupervised classification techniques unsupervised such as self-organization map (SOM) and fuzzy c-means combined with feature extraction techniques [12]. Other supervised classification techniques, such as k-nearest neighbors (k-NN) also group pixels based on their similarities in each feature image can be used to classify the normal/pathological T2-wieghted MRI images. Supervised machine learning algorithms (ANN and k-NN) are used to obtain the classification of images under two categories, either normal or abnormal [13].

3.3 The Proposed Hybrid Techniques

The proposed hybrid techniques based on the following techniques, discrete wavelet transforms DWT, the principle components analysis PCA, FP-ANN, and k-NN. It consists of three stages:

    (1) Feature extraction stage.

    (2) Feature reduction stage.

    (3) Classification stage.
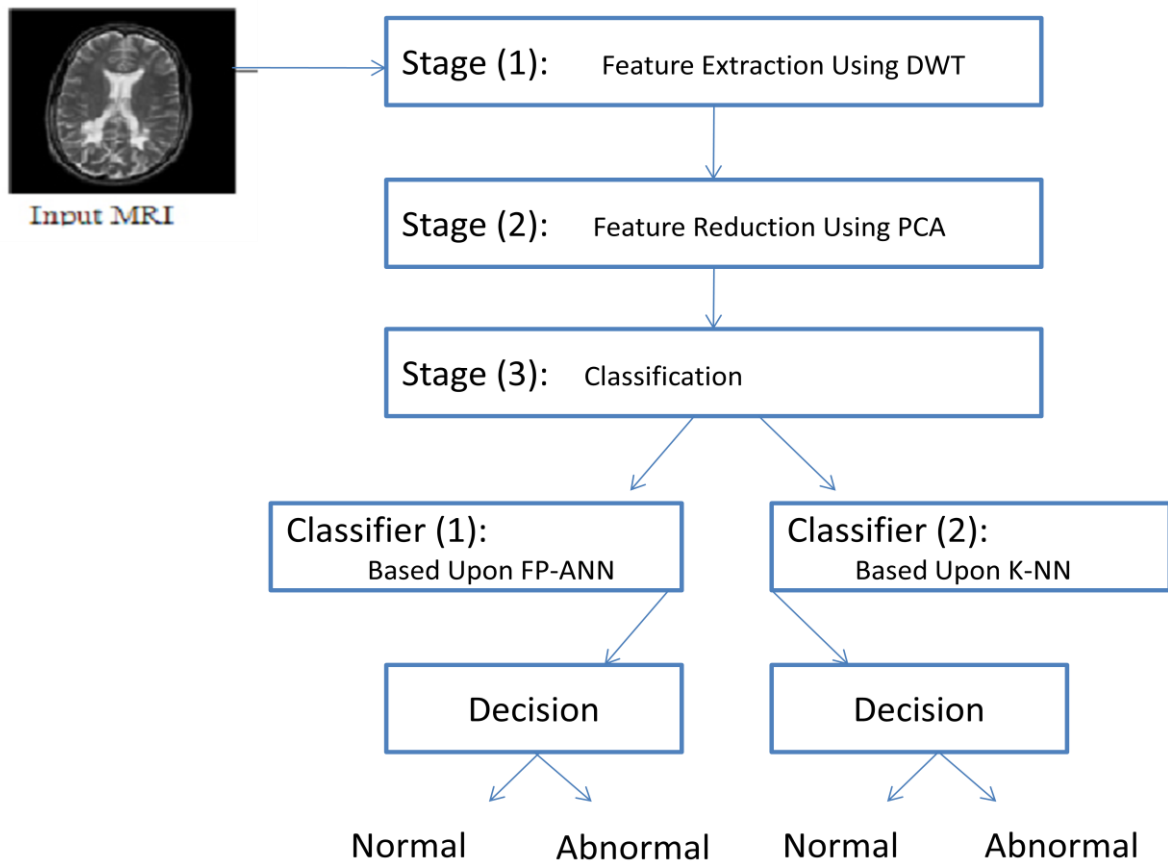
Figure 3.1: Block Diagram of the Proposed System

3.3.1 Feature Extraction Scheme Using DWT

The proposed system uses the Discrete Wavelet Transform (DWT) coefficients as feature vector. The main advantage of wavelets is that they provide localized frequency information about a function of a signal, which is particularly beneficial for classification. Discrete wavelets transform can analyze any image or signal at multi resolution [14]. It helps us in seeing at different zooming level. From each image we are extracting only useful information and leaving any redundant data. Wavelets decompose an image into LL, LH, HL, and HH. But here we are using only LL part of image. Because it contains over all important data and chance of noise in this band is really less as noise mostly lies in HH or HL bands.
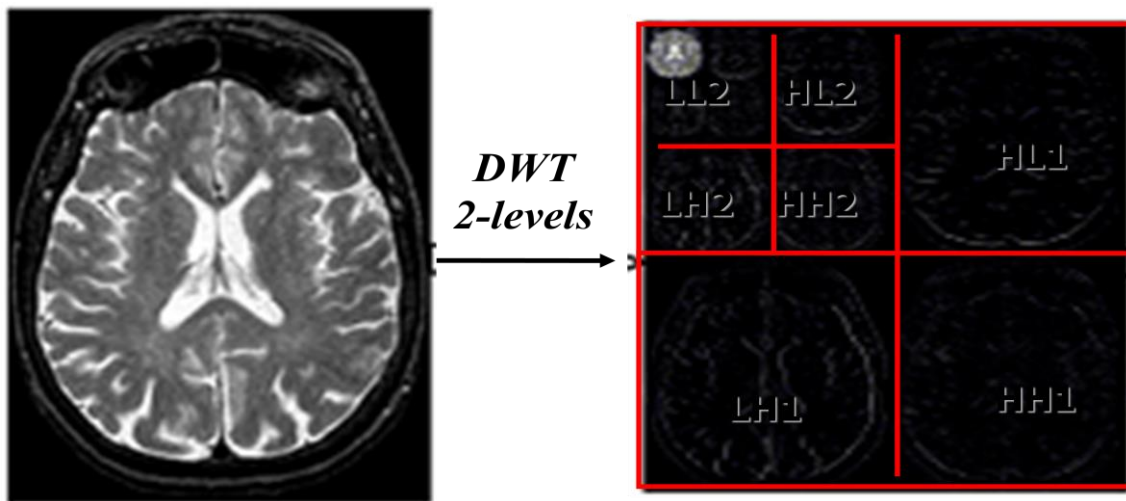
Figure 3.2: DWT Schematically

3.3.2 Feature reduction scheme using PCA

One of the most common forms of dimensionality reduction is principal components analysis. PCA find the linear lower-dimensional representation of the data. The main idea behind using PCA in this approach is to reduce the dimensionality of the wavelet coefficients. This leads to more efficient and accurate classifier. As there is 300 to 400 images for each patient and we have to analyze most of them. Thus by extracting useful information from image we can make our system fast [15].

Figure 3.3: Schematic diagram for the used feature extraction

3.3.3 K-Nearest Neighbors Based Classifier (K-NN):

One of the simplest classification techniques is the k- Nearest Neighbor classifier. In the training phase, data points are given in an n-dimensional space. These training data points have labels

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associated with them that designate their class [16]. In the testing phase, unlabeled data are given and the algorithm generates the list of the k nearest (already classified) data points to the unlabeled point.

3.3.4 Artificial Neural Network Based Classifier (F-ANN)

An ANN is a mathematical model consisting of a number of highly interconnected processing elements organized into layers, geometry and functionality of which have been resembled to that of the human brain. The ANN may be regarded as possessing learning capabilities in as much as it has a natural propensity for storing experimental knowledge and making it available for later use. The most frequently used training algorithm in classification problems are the back-propagation (BP) algorithm. The neural network has been trained to adjust the connection weights and biases in order to produce the desired mapping. In this case we have multi-layer perceptions having three layers. First layer is called input layer consisting of 7 neurons. Second layer is hidden layer with 4 neurons [17]. Third layer is output layer consisting of 1 neuron. It gives us binary result 1 for normal and 0 for abnormal patient.
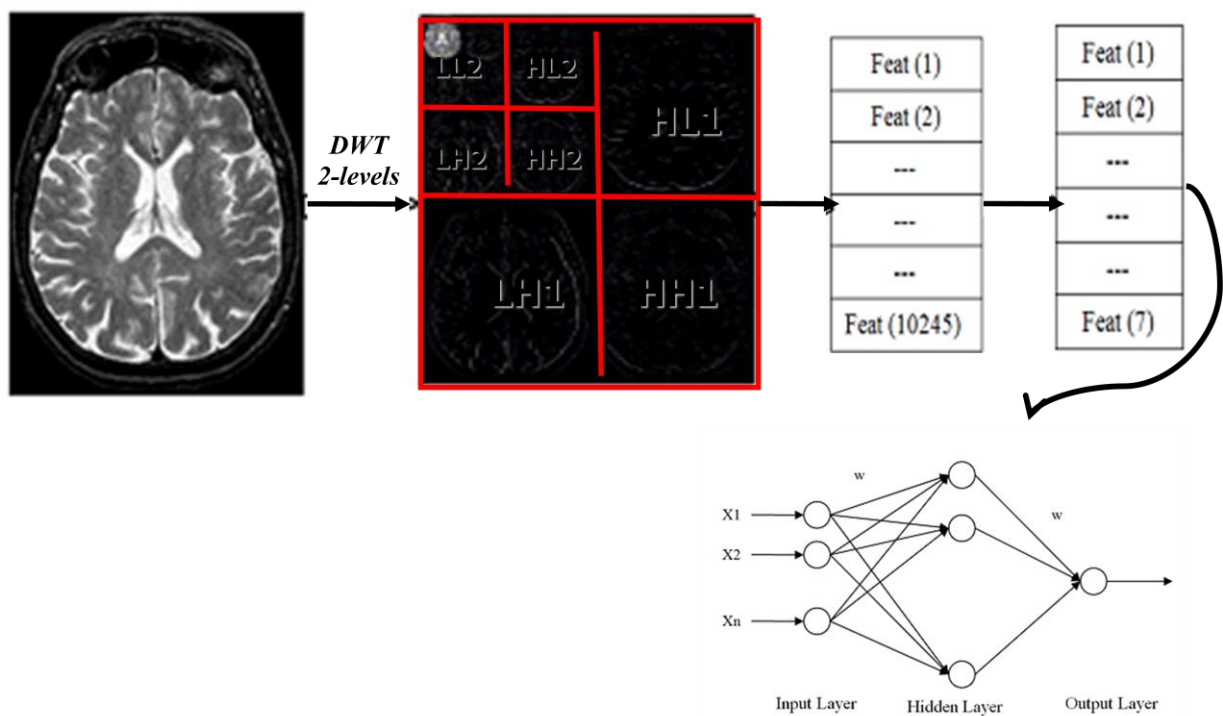

Figure 3.4: The architecture of used ANN

3.4 Case study

The proposed hybrid techniques have been implemented on a real human brain MRI dataset. All the input dataset (total images is 70: 60 images are abnormal and 10 normal) used for classification consists of axial, T2-weighted, 288x288 pixels MR brain images [18]. The algorithm is developed locally and successfully trained in MATLAB version 7.1 using a combination of the Image Processing Toolbox, Wavelet toolbox (The Math Works) for MATLAB.

3.5 Results and Discussions

- ✓ The performance of the proposed method is given in terms of confusion matrix, sensitivity, specificity and accuracy.
- ✓ Sensitivity (true positive fraction) is the probability that a diagnostic test is positive, given that the person has the disease.
- ✓ Specificity (true negative fraction) is the probability that a diagnostic test is negative, given that the person does not have the disease.
- ✓ Accuracy is the probability that a diagnostic test is correctly performed.

3.6 Conclusion

The benefit of the system is to assist the physician to make the final decision without hesitation. ANN method gained the worst sensitivity and specificity rate. The classification performance of this study shows the advantages of this technique: it is easy to operate, noninvasive and inexpensive. The limitation of this work is that it requires fresh training each time whenever there is an increase in image database. The extension of the developed techniques for processing the pathological brain tissues (e.g. lesions, tumors) is the topic of future research.

Chapter 4

Brain Tumor Detection

Outline

In this chapter, we discuss the

- ➢ Introduction
- ➢ Primary Tumors
- ➢ Metastatic brain tumors
- ➢ Tumor Detection
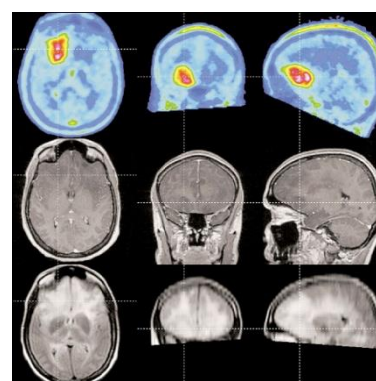
4.1 Introduction

Abnormal growths of brain tissues are popularly called brain tumors; Cancer is a one term reserved for malignant tumors. Malignant tumors grow and spread aggressively, overpowering healthy cells by taking their space, blood, and nutrients. (Like all cells of the body, tumor cells need blood and nutrients to survive.) Tumors that do not spread aggressively are called benign. In general, a benign tumor is less serious than a malignant tumor. But a benign tumor can still cause many problems in the brain.

4.2 Primary Tumor

The brain is made up of different types of cells. As these abnormal cells grow, they become a mass of cells, or tumor. Brain tumors that result from this transformation and abnormal growth of brain cells are called primary brain tumors because they originate in the brain. The most common primary brain tumors are gliomas, meningiomas, pituitary adenomas, vestibular schwannomas, and primitive neuroectodermal tumors (medulloblastomas). The term gliomas include astrocytomas, oligodendrogliomas, ependymomas, and choroid plexus papillomas. Most of these primary tumors are named after the part of the brain or the type of brain cell from which they arise.

4.3 Metastatic Brain Tumor

Metastatic brain tumors are made of cancerous cells from a tumor elsewhere in the body. The cells spread to the brain from another tumor in a process called metastasis. About 25% of tumors elsewhere in the body metastasize to the brain.

The following factors have been proposed as possible risk factors for primary brain tumors. Whether these factors actually increase the risk of a brain tumor is not known for sure.

- ✓ Radiation to the head
- ✓ An inherited (genetic) risk
- ✓ HIV infection

4.4 Tumor Detection

Sophisticated imaging techniques can pinpoint the tumor and determine whether it's growing or shrinking. Diagnostic tools include computed tomography (CT or CAT scan) and magnetic resonance imaging (MRI). MRI is also used during surgery to guide tissue biopsies and tumor removal. Magnetic resonance spectroscopy (MRS) is used to examine the tumor's chemical profile and see whether the tumor is responding to treatment. Positron emission tomography (PET scan) can help detect recurring brain tumors.

After brain region extraction brain tumor is extracted using FCM. For accurately finding the number of clusters, FCM algorithm is iterated for a range of hypothesized numbers of clusters. And best option for cluster is chosen based on cluster validity measure. Some cluster validity measures, the partition coefficient (PC) and the partition entropy (PE), Bezdek [106][108] yielded amazingly good results for some of the test images. This might be partially due to the special nature of the data, which is not common in clustering problems: the data is 1-D and at least one entry exists at each possible point. On the other hand, accepting the fact that different values might fit the

Figure 4.1: Points Placement and Model Construction

given data (e.g., for segmentation at different detail), a threshold on the validity measure should be chosen below/above which is accepted.

We have used a technique based upon fuzzy entropy that locates optimal and dynamic threshold according to the clusters find out by using eminent method of FCM (Fuzzy C-Mean). Input of this phase is fuzzy membership matrix from prior phase. It also gives an objective function that is used to find out adaptive, optimal and dynamic threshold which is used in the next phase to segment the image.

4.4.1 Fuzzification

FCM algorithm was used to create a fuzzy partition. This illustrates the image using only the pixel intensity feature. For accurately finding the number of clusters, FCM algorithm is iterated for a range of hypothesized numbers of clusters. And best option for cluster is chosen based on cluster validity measure. Some cluster validity measures, the partition coefficient (PC) and the partition entropy (PE), Bezdek **Error! Reference source not found.Error! Reference source not found.** yielded amazingly good results for some of the test images. This might be partially due to the special nature of the data, which is not common in clustering problems: the data is 1-D and at least one entry exists at each possible point. On the other hand, a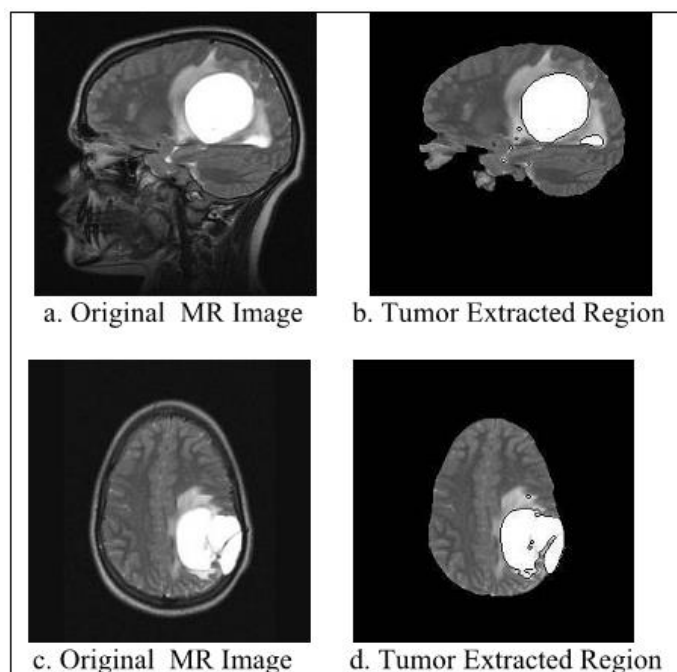ccepting the fact that different values might fit the given data (e.g., for segmentation at different detail), a threshold on the validity measure should be chosen below/above which is accepted.

4.4.2 Thresholding

We have used a technique based upon fuzzy entropy that locates optimal and dynamic threshold according to the clusters find out by using eminent method of FCM (Fuzzy C-Mean). Input of this phase is fuzzy membership matrix from prior phase. It also gives an objective function that is used to find out adaptive, optimal and dynamic threshold which is used in the next phase to segment the image. We have used logarithmic fuzzy entropy based error functions **Error! Reference source not found.** equation (4.1) that is depicted in Figure 4.3. The thresholds values are obtained from the objective function, as the gray levels with the maximal levels of fuzziness respectively.

$$H(A) = -\frac{1}{n\ln(2)}\sum_i \left[\mu_A \left(\begin{array}{c} x_i \ln \mu_A(x_i) + \\ (1-\mu_A(x_i))(1-\ln \mu_A(x_i)) \end{array} \right) \right] \qquad (4.1)$$
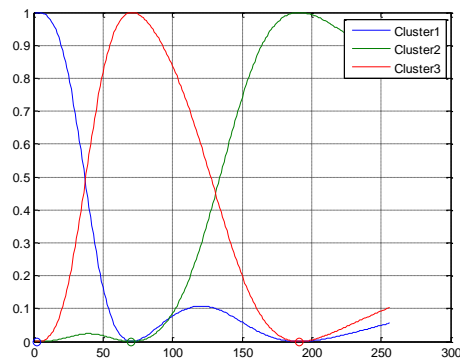
(a) Fuzzy membership
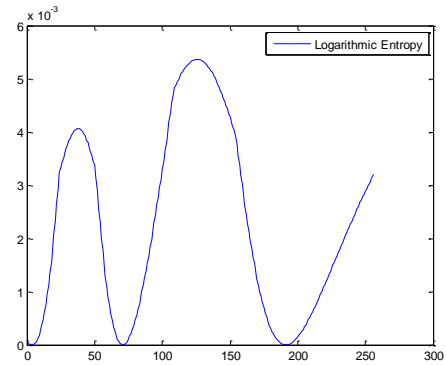
(b) Fuzzy Entropies by equation (4.5)
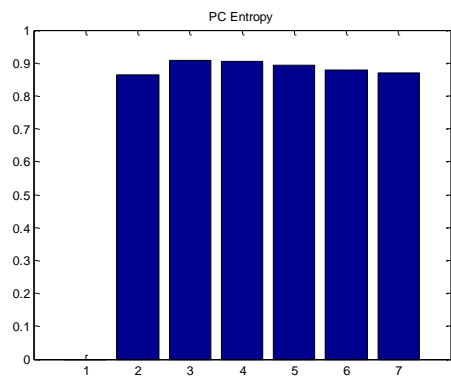
(c) Cluster Validity
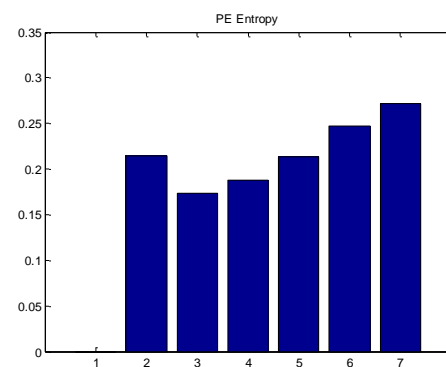
(d) Cluster Validity

Figure 4.4.2: Fuzzy Membership, Entropies and Cluster Validities

4.5   Results

Original Image   *Tumor Mask*   *Tumor Mask Boundary*
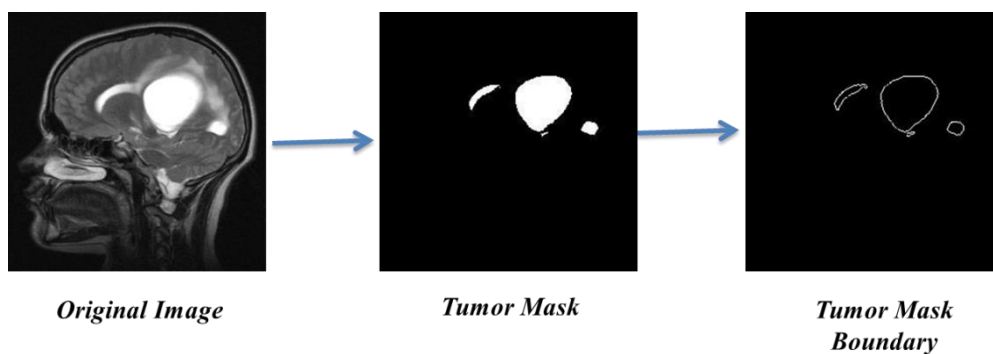
Figure 0.3: Brain Tumor Detection Results

Chapter 5
3D Brain Modeling

Construction of Head and Brain Model in openGL

Outlines

In this section we discuss the following topics:

- ➢ Introduction
- ➢ Preprocessing
- ➢ Boundary Detection
- ➢ Issues
- ➢ Meshing
  - ✓ Volume Element Method
    - ▪ Algorithm
  - ✓ Interpolation Method
    - ▪ Algorithm
- ➢ Rendering
- ➢ Limitations
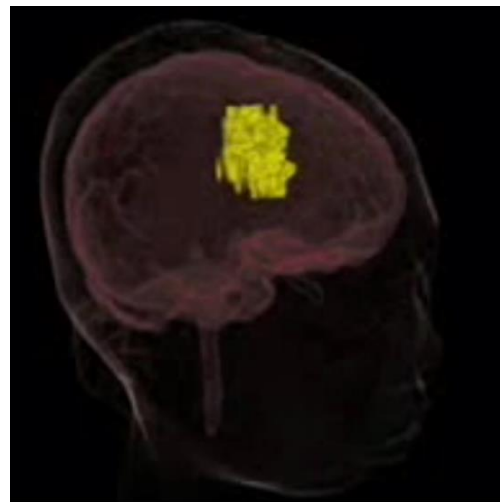
5.1 Introduction

In computer graphics, 3D modeling is the process of developing a mathematical representation of any three dimensional object via specialized software and programming languages. The final product is called a 3D model. It can be displayed as a two-dimensional image through a process called 3D rendering or used in a computer simulation of physical phenomena.

Today, 3D models are used in a wide variety of fields. For example, the movie industries use them as characters and objects for animated and real-life motion pictures. The video game industry uses them as assets for computer and video games. The science sectors use them as highly detailed models of chemical compounds. 3D modeling is also used in medical science for detailed models of organs.

Due to the importance of 3D modeling we tried to make the brain 3D model which help to analyze the patient tumor detected through the segmentation of MRI scans.

5.2 Pre-processing

We have used MRI scans and we use 100 to 250 images of different dimensions of head like front, back, side or top to down. More the number of images of MRI scan more precise the model will be. Then we have preprocessed the scans to eliminate noise from them.

5.3 Boundary Detection

For this purpose we, first of all have used threshold to detect boundaries and then applied eroding to get one pixel wide boundary as it gives us the exact direction and number of pixels on boundary. Also eliminates abnormalities in modeling. If we do not read pixels in appropriate order then meshing cannot be performed accurately [2].

5.4 Issues

There are some issues we have to deal in order to model human brain accurately and to make it look more realistic. In our work we have about 240 MRI scans and their skull and brain boundary size increase or decrease in certain way. For example if we are reading images from top to bottom of head then points on boundary of images increases and at a certain level number of points on boundaries start decreasing. Thus we need to find a way to efficiently connect these different numbers of points. We want to connect image[i]'s point[j] to image[i]'s point[j+xincrement],point[j-xincrement] and image[i+1]'s point[j+xincrement], point[j-xincrement].This group of neighboring points is known as face. Also we want to keep order of each point on a

Figure 5.1: Points Placement and Model Construction

face as this will help us in finding normal of a face. This face will be used to render the model as shown in figure 5.1.

5.5 Meshing

A polygon mesh or unstructured grid is a collection of vertices, edges and faces that defines the shape of a polyhedral object in 3D computer graphics and solid modeling. The faces usually consist of triangles, quadrilaterals or other simple convex polygons, since this simplifies rendering, but may

Face-Vertex Meshes
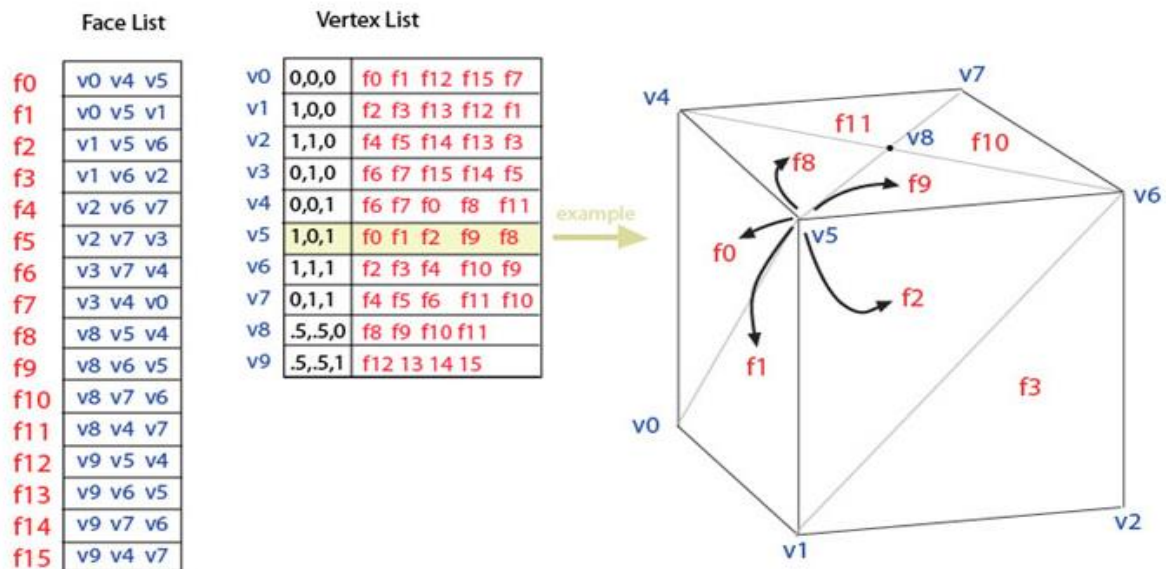
Figure 5.2: Face-Vertex Meshes

also be composed of more general concave polygons, or polygons with holes. The study of polygon meshes is a large sub-field of computer graphics and geometric modeling. Different representations of polygon meshes are used for different applications and goals. In meshing we have used triangles because they give more smoothness in modeling as compared to other geometric figures [5].

In meshing we have used two methods to connect neighboring points more precisely .We will explain them in more detail in later discussion.

5.5.1 Using Volume Element

A voxel (volumetric pixel) is a volume element, representing a value on a regular grid in three dimensional spaces. This is analogous to a pixel, which represents 2D image data in a bitmap [6]. A volume containing voxels can be visualized either by direct volume rendering or by the extraction of polygon iso-surfaces which follow the contours of given threshold values. This uses dataset of multiple images in the form of 2D; combine these images in a sequence that represents 3D model [7]. In this method we have used a volume element as shown in figure 5.3.

Figure 5.3: Volume Element

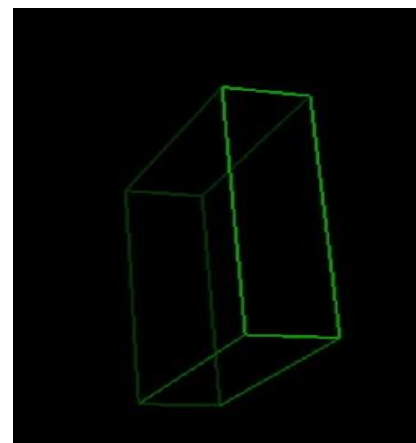This volume element has dimension as x belongs to [x, x+ x increment] and y belongs to [image height/2, 0]. Width of this volume element can be adjusted to find best matching neighbors.

Algorithm:

for i varies from 1 to total number of images

for y varies from 0 to image height/2.
for x varies from 0 to image width

> Take first point as p1_initial on image i which lies inside the volume element on x-axis on left most side take second point as p1_final on image I which lies inside the volume element on x-axis on right most side. Similarly for image i+1 take point's p2_initial and p2_final.

> But if any one of initial or final points does not exist move volume window one step ahead along x-axis.

end of x's for loop
end of y's for loop

for y varies from image height/2 to image height.
for x varies from 0 to image width

> Take first point as p3_initial on image i which lies inside the volume element on x-axis on left most side take second point as p3_final on image I which lies inside the volume element on x-axis on right most side. Similarly for image i+1 take point's p4_initial and p4_final. But if any one of initial or final points does not exist move volume window one step ahead along x-axis.

> *end of x's for loop*
> *end of y's for loop*
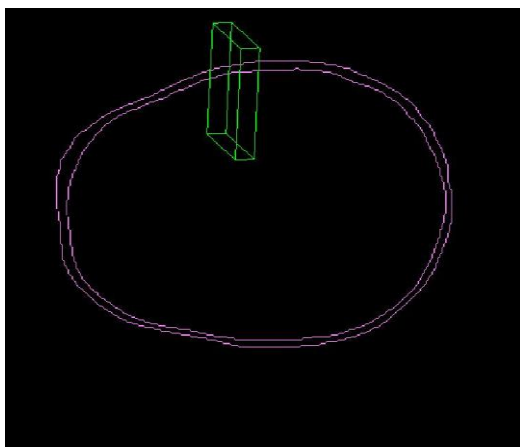> *end of i's for loop.*

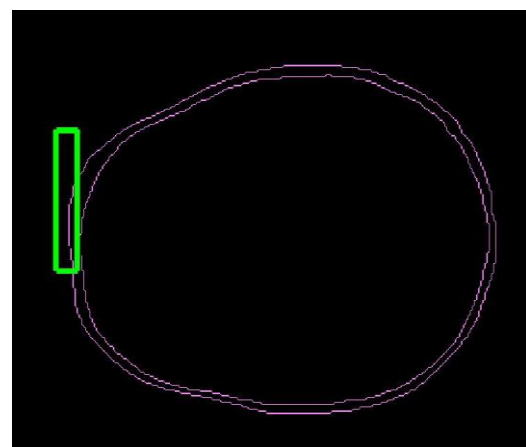*Figure 5.1: Volume Element at boundary*

Figure 5.2: Brain Model after applying volume element

The gives good results and chooses neighboring points more accurately and efficiently but it has problem in certain situation where it has to deal with pixels lying on vertical lines. Because it is picking points in an interval of length x_increment = 2 or 3 pixels. The result of this method is shown in following fig (5.6).
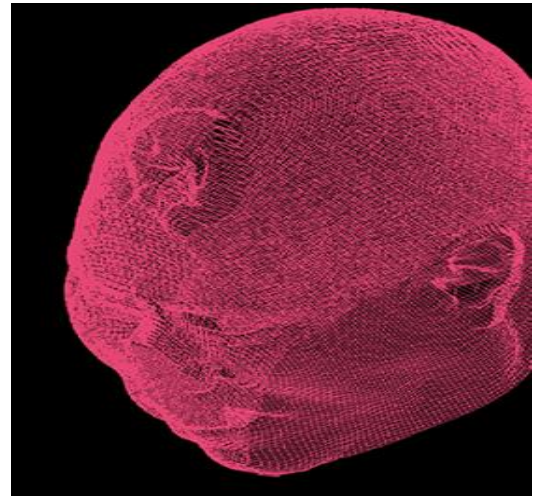
Figure 5.6: Volume Element Working

5.5.2 Using interpolation

It is not a good choice to simply connect the all points on boundary of one image to all points of boundary of image lying below or up of this image. Because this will give really bad result and model will not look realistic. Thus to overcome this problem we have used interpolation to map points on boundary of one image to points on boundary of another image [8].

Algorithm:

For i=0 to total number of images

> Count1=points on boundary of ith image
> Count2=points on boundary of (i+1)th image

if count1 is less than count2

  P1=count1 and p2=count2 and increment=count2/count1;

else

P1=count2 and p2=count1 and increment=count1/count2;

> > *for p = 0 to p<p1; p++*
> >
> > > Store points in an array
> >
> > *end*
> >
> > *for p = 0; p < p2; p += increment*
> >
> > > Store points in another array
> >
> > *end*

end of i's for loop.

Now we have equal number of points for both corresponding images. Connect them to form faces and find their normal. This gives good results as it maps all points on boundaries accurately. The result of this method is shown in figure-5.7.
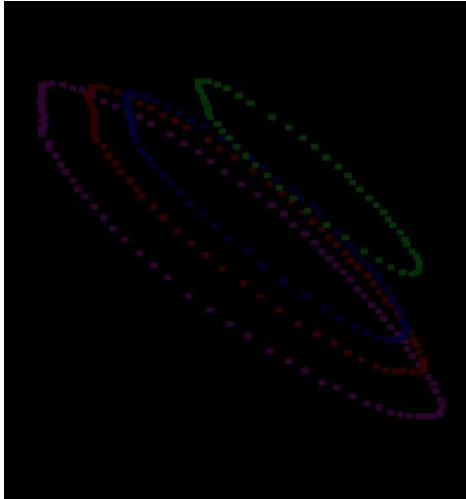
Figure 5.3: Pattern of Boundary pixels
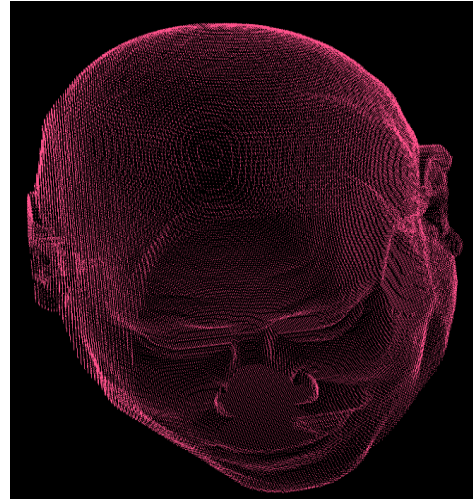
Figure 5.4: 3D brain model after interpolation

5.6   Rendering

Rendering is the process of generating an image from a model, by means of computer programs. The model is a description of three-dimensional objects in a strictly defined language or data structure. It would contain geometry, viewpoint, texture, lighting, and shading information. In the case of 3D graphics, rendering may be done slowly, as in pre-rendering, or in real time. Pre-rendering is a computationally intensive process that is typically used for movie creation, while real-time rendering is often done for 3D video games which rely on the use of graphics cards with 3D hardware accelerators. We have used real time rendering [9].

5.7 Final 3D Results

Initial Brain MRI Image   **Boundary Detection**   **3D Modeling**
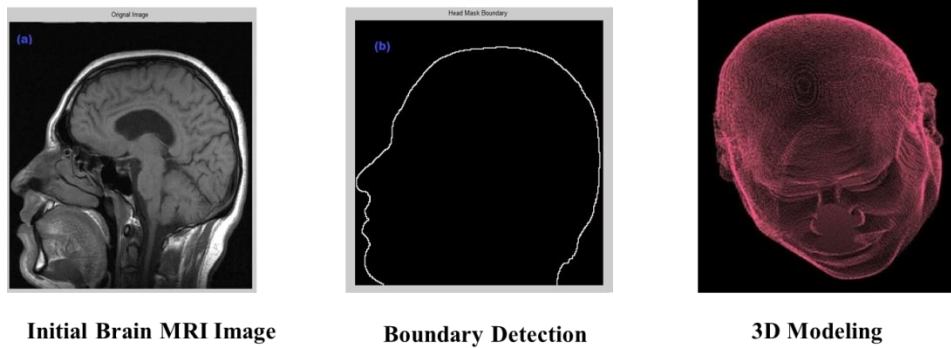
Figure 5.5: 3D Model of Head

Initial Brain MRI Image   **Boundary Detection**   **3D Modeling**

Figure 7.2: 3D Model of Brain

Initial Brain MRI Image   **Boundary Detection**   **3D Modeling**
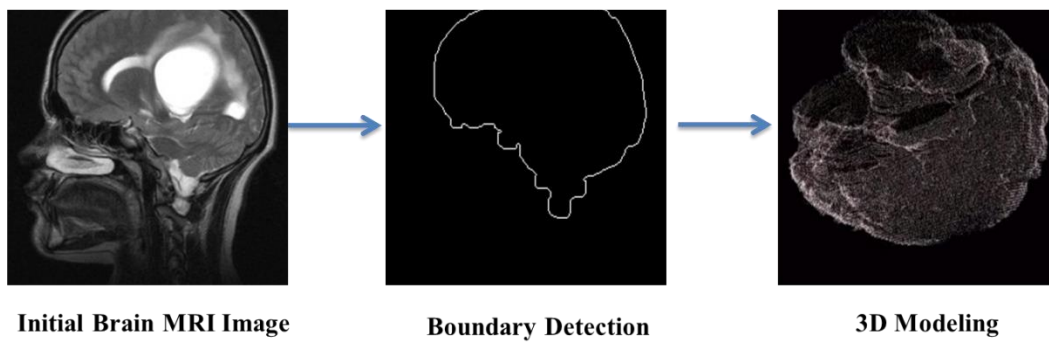
Figure 7.2: 3D Model of Tumor

Figure 7.2: 3D Modeling Final Results

5.8 Limitations

At present we have not worked on handling situations when some severe kind of injury of head takes place and it destroys a part of victim's skull. We are working now on how to make model of head for such cases. Also we are working on making our rendering more realistic and efficient. Rendering will be our next and important step.

Chapter 6

Semantic Web Based Decision Making

Outline

In this chapter, we discuss

➢ Introduction

➢ Semantic Web Knowledge Representation

➢ Query Engine

➢ SPARQL

➢ Role of SPARQL

➢ Brain Tumor Classification

➢ Methods for Treatment

➢

6.1 Introduction

Clinical decision support systems help the medical experts in making decisions to diagnose the diseases. Semantic web plays an important role in decision making. So it can also be used in brain tumor treatment decision making. Semantic Web Technologies (SWT) is gathering more and more attention within the sphere of clinical decision support.

The semantic web based clinical decision support system use a knowledge base to map the medical knowledge in a manner that it is computer process able using the ontological technique of semantic web technology. Using t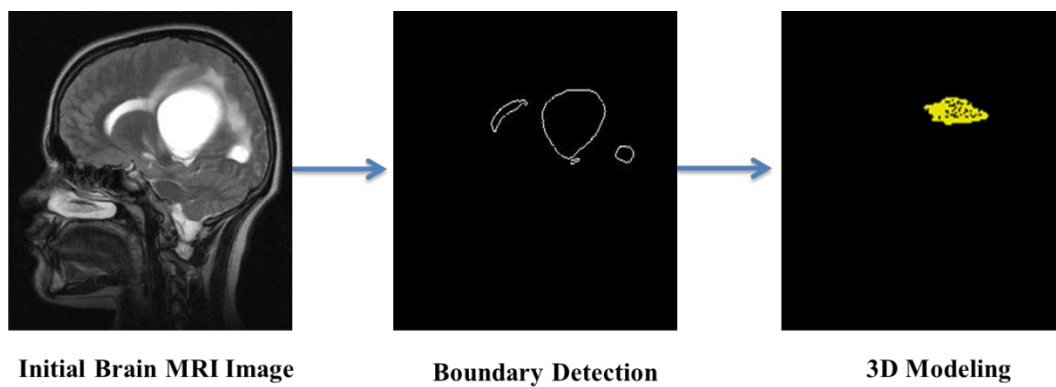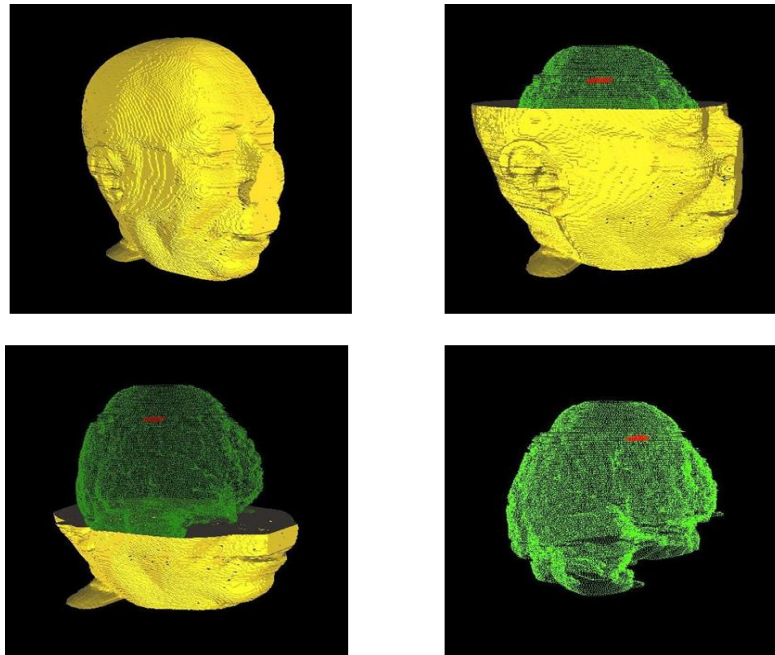he semantic web we make the data process able by our machine which is kept in a knowledge base and then apply SWRL (semantic Web Rule Language) which will then use this process able knowledge to reason, compare and come to a correct conclusion.

6.2 Semantic Web Knowledge Representation

In recent years ontologies are emerging as a powerful knowledge representation formalism which is conceptually equivalent to the frame based and to first order logic approach. The Semantic Web Technology which suggests a list of instruments such as the Web Ontology Language, OWL, for defining ontologies, as the actual standard semantic markup language for this task, and SPARQL as a

language for querying ontologies. Moreover, it recognizes the importance of rules for filling representation lacks of ontologies and in this context a new standard is under development.

Semantic Web Technology provides SWRL (Semantic Web Rule Language). The Semantic Web Rule Language (SWRL) aims to be the standard rule language of the Semantic Web. It provides the ability to write rules expressed in terms of OWL concepts. Interoperability is one of the primary goal of the Semantic Web and that SWRL rules are a key part of those goals. SWRL allows user to write Hornlike rules expressed in terms of OWL concepts to reason about OWL individuals. The rules can be used to infer new knowledge from existing OWL knowledge bases. Such SWRL rules have been applied in project.

6.2.1 Query Engine

The role of the query engine is to run the users query on the ontology and get the answer of the query after going through the designed procedure. The Brain Inspector has a small query engine that contains the capability to capture all the user's queries and get an answer for it.

6.2.2 SPARQL

The query language for our Decision Making part is SPARQL. We will implement all the required queries in SPARQL necessary for the decision support. These queries also help the users to get any related information required.

6.2.3 Role of SPARQL

The view of the central role SPARQL plays in applications based on Semantic Web technologies. SPARQL defines a standard way in which to communicate with RDF-based services on the Web. Up till now, interoperability between different RDF tools was hampered by the lack of such a common standard. Having SPARQL can make sure that a Sesame-based application can freely communicate with, say, a Jena-based application, over the Web, by means of SPARQL queries and answers.
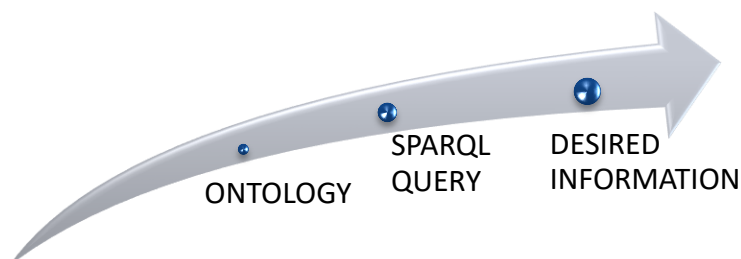

Figure 6.1: SPARQL Query Sequence

SPARQL is used for get the desired knowledge from the knowledge base. Through SPARQL we can find specific information from our domain knowledge model, e.g extract information about the patient disease and his related symptoms from the knowledge base. It is just like retrieving data from the database.

6.3 Brain Tumor Classification

There are more than 120 types of brain tumors. Today, most medical institutions use the World Health Organization (WHO) classification system to identify brain tumors. The classification and grade of an individual tumor help predict its likely behavior. There are different ways to classify the brain tumor.

For decision making we use these three different ways of classification

6.3.1 Classification on the Basis of Brain Cells Behavior

The WHO classifies brain tumors in to two classes on the basis of cell origin and how the cells behave.

6.3.1.1 Benign Brain Tumors

Benign brain tumors do not consist of cancer cells. Benign tumors can be removed, and they rarely grow back. The border or edge of a benign brain tumor can be clearly seen. Cells in benign tumor don't spread to other parts of the body. Benign tumors can cause on sensitive areas of the brain and cause serious health problems. Benign brain tumors is sometimes life threatening. A benign brain tumor may become malignant.

6.3.1.2 Malignant Brain Tumors

Malignant brain tumors consist of cancer cells. Malignant brain tumors are more serious and life threatening as compared to benign tumors. They grow rapidly and spread to the other healthy brain tissue. Sometimes malignant brain tumor spread to other parts of the brain, spinal cord or even to other parts of the body. The spread of cancer is called metastasis. The tumor may be contained within a layer of tissue or the bones of the skull or another part in the head. This kind of tumor is called encapsulated.

6.3.2 Classification on the Basis of Tumor Grades

Doctors named grouping of different type tumors into grades. The grades are from low grade to high grade. The diagnoses of tumor grades are the most important thing. There are variations in grading systems, depending on the tumor type. The grade of an individual tumor helps predict its likely behavior.

Brain tumor are grouped in to four grades on the basis of Astrocytomas (Astrocytomas are cancers of the brain that originate in star-shaped brain cells called astrocytes).

- ✓ Grade I - Pilocytic Astrocytoma
- ✓ Grade II - Low-grade Astrocytoma
- ✓ Grade III - Anaplastic Astrocytoma
- ✓ Grade IV - Glioblastoma (GBM)

6.3.3 Classification on the Basis of Tumor Types

Brain tumors are further classified as either *primary* or *secondary* tumors.

6.3.3.1 *Primary brain Tumor*

Tumors that take its place in brain tissue are said to be as primary brain tumor. Primary brain tumors are named according to the type of cells or the part of the brain in which they begin.

- ✓ Astrocytoma
- ✓ Brain stem glioma
- ✓ Ependymoma
- ✓ Oligodendroglioma
- ✓ Medulloblastoma
- ✓ Meningioma
- ✓ Schwannoma
- ✓ Germ Cell Tumor

6.3.3.2 *Secondary brain Tumor*

If the tumor has same kind of abnormal cells and same type of grade, tumor shifted from its central position to some other part of the body than it is said to be secondary brain tumor. Secondary brain tumor is different from primary as it spread to another part of the body. Doctors call secondary brain tumor as metastatic tumor. Secondary tumor is found in large quantity as compare to primary brain tumor. Some types of secondary brain tumors are: melanoma, breast cancer, renal cell carcinoma and colorectal cancer.

6.4 Methods for Treatment

The system prescribes the best method of treatment for the

6.4.1 Surgery

The most usual method for treatment is surgery but before doing surgery there are some operations that should be performed patients over the age of 40 should have their ECG and x rays test. The process craniotomy in which surgeon open the skull and remove the tumor from the brain. Surgery is basically for the removal of tumor. Sometimes it is not possible that without damaging normal tissues of the brain surgery can be performed for that we follow other methods for treatment.

6.4.2 Radiation Therapy

It uses energy rays to kill tumor cells it is also called as radio therapy a large machine aims radiation at the tumor and the tissue close to it. it is used to remove hidden tumor of the brain that are left sometimes during surgery or not possible in surgery. Radio therapy involves particular process patient have to visit doctor daily basis for a specific period of time. The period depends on the type, size and age of the patient.

6.4.3 Chemotherapy

The process in which drugs are use to kill tumor cells is called chemotherapy. The drugs may be given by mouth or by injection. The drugs are usually given in cycles so that a recovery period follows each treatment period. Chemotherapy is used for children for the delay of radiotherapy. In the chemotherapy patient hardly have to stay in hospital.
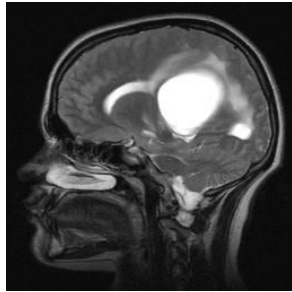
7. Final Results

Figure 1.1: Original Image
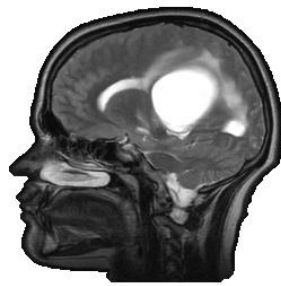
Figure 1.2: Head Mask
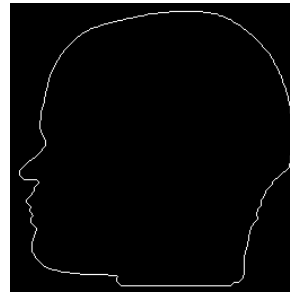
Figure 1.3: Head Mask Boundary
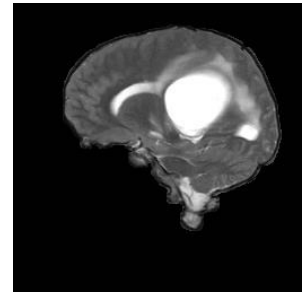
Figure 1.4: Brain Mask
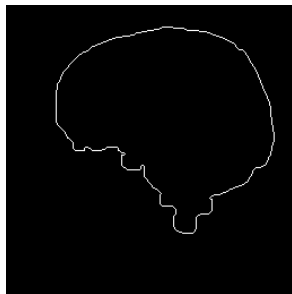
Figure 1.5: Brain Mask Boundary

Figure 1.6: Tumor Mask
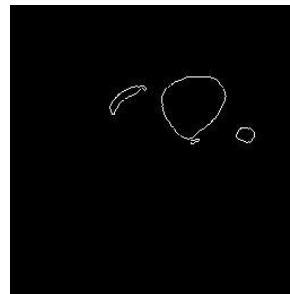
Figure 1.7: Tumor Mask Boundary

Figure 1.8: Pattern of Boundary pixels
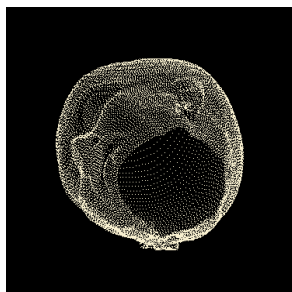
Figure 1.9: Head Boundary Points Placement
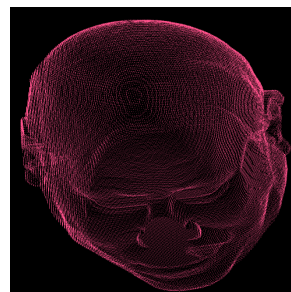
Figure 1.10: Head Boundary Points Placement (Other View)
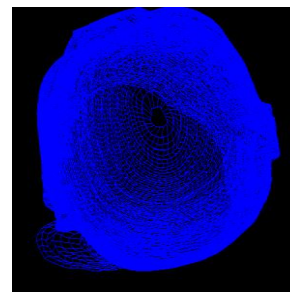
Figure 1.11: Head Mesh Model after interpolation
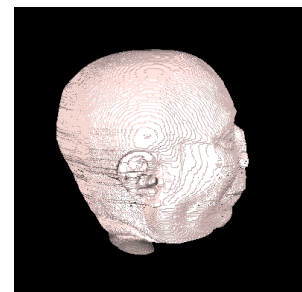
Figure 1.12: Rendered 3D Head Model

Figure 1.13: Brain 3D Model
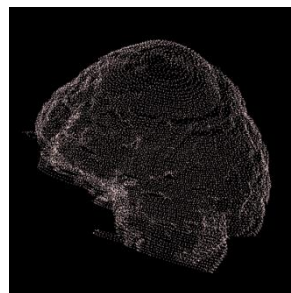
Figure 1.14: Brain 3D Model (Another View)

Figure 1.15: Tumor 3D Model

Figure 1.16: Final Integrated 3D Model

Figure 7.1: Extraction of Head, Brain and Tumor Boundaries and their 3D Modeling

8. Conclusion

By implementing Brain Inspector, this will be helpful for the Neurosurgeons for analysis and detecting the tumor from MRI scans. They can check the position, size and type of the tumor by using the Brain Inspector application. They can also see the patient brain and tumor in 3D view. The system will give suggestions about treatment and further tests for patient. Indeed it will be a great application in medical sector.

Appendix A

Brain Anatomy:

The central nervous system (CNS) consists of the brain and spinal cord. The brain is an important organ that controls thought, memory, emotion, touch, motor skills, vision, respirations, temperature, hunger, and every process that regulates throughout our body [20].

The brain can be divided into the cerebrum, the brainstem, and the cerebellum:
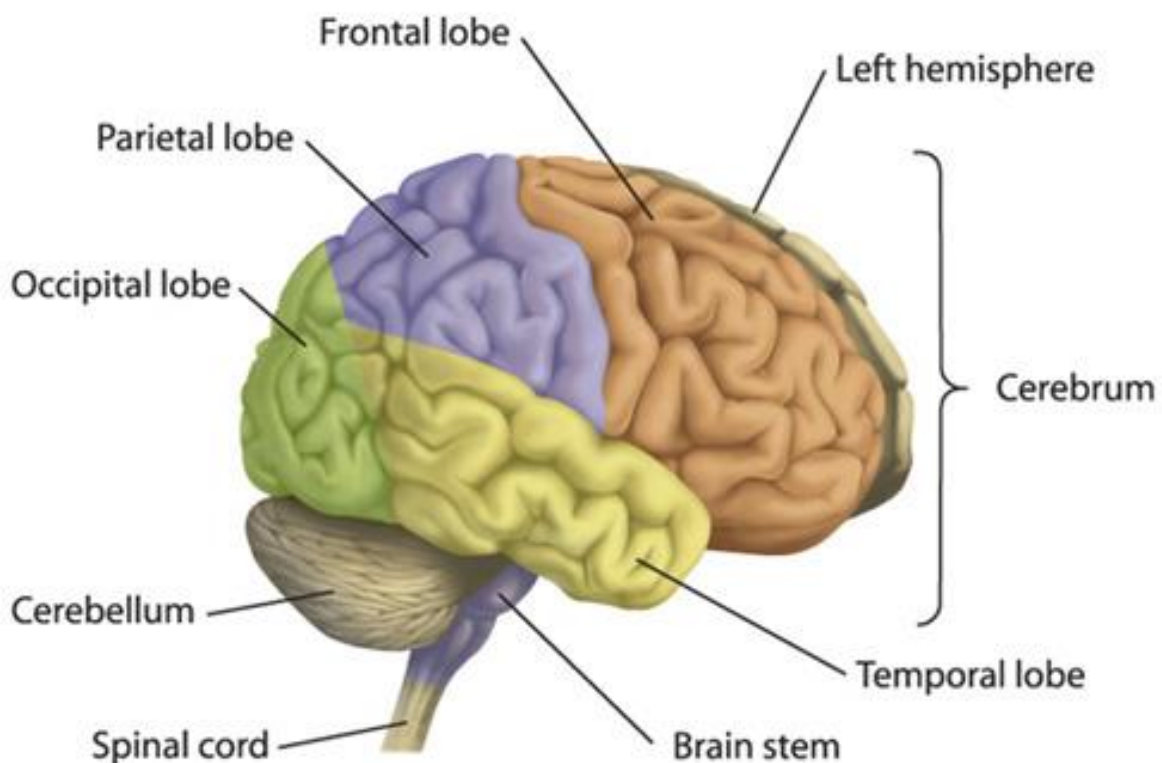
Figure: Brain Anatomy

Cerebrum (Supratentorial or Front of Brain):

Composed of the right and left hemispheres. Functions of the cerebrum include: initiation of movement, coordination of movement, temperature, touch, vision, hearing, judgment, reasoning, problem solving, emotions, and learning.

Brainstem (Midline or Middle of Brain):

It includes the midbrain, the pons, and the medulla. Functions of this area include: movement of the eyes and mouth, relaying sensory messages (i.e., hot, pain, loud), hunger, respirations, consciousness, cardiac function, and body temperature, involuntary muscle movements, sneezing, coughing, vomiting, and swallowing.

Cerebellum (Infratentorial or Back of Brain):

It is located at the back of the head; its function is to coordinate voluntary muscle movements and to maintain posture, balance, and equilibrium.

Causes of Brain Tumor:

The majority of brain tumors have abnormalities of genes involved in cell cycle control, causing uncontrolled cell growth. These abnormalities are caused by alterations directly in the genes, or by chromosome rearrangements which changes the function of a gene.

Patients with certain genetic conditions also have an increased risk to develop tumors of the central nervous system. There have also been some reports of children in the same family developing brain tumors that do not have any of these genetic syndromes.

Research has been investigating parents of children with brain tumors and their past exposure to certain chemicals. Some chemicals may change the structure of a gene that protects the body from diseases and cancer. Workers in oil refining, rubber manufacturing, and chemists have a higher incidence of certain types of tumors. Which, if any, chemical toxin is related to this increase in tumors is unknown.

Children who have received radiation therapy to the head as part of prior treatment for other malignancies are also at an increased risk for new brain tumors.

9. References

[1] Michela Antonelli, Beatrice Lazzerini, Francesco Marcelloni. Segmentation and reconstruction of the lung volume in CT images, 2005 ACM Symposium on Applied Computing.

[2] Pietro Perona and Jitendra Malik. Scale-space and edgue detection using anisotropic diffusion. IEEE Trans. on Pattern Analysis and Machine Intelligence, 12(7):629-639, July 1990.

[3] M. Stella Atkins, Blair T. MAckiewich. Fully Automatic Segmentation of Brain in MRI, Department of Radiology, Fraser University Canada.

[4] Micheal Kass, Andrew Witkin, and Eemetri Terzopoulos. Snakes: Active Contour Models. International Journal of Computer Vision, pages 321-331, 1988.

[5] E. Praun, H. Hoppe, A. Finkelstein. Robust mesh watermarking. ACM SIGGRAPH 1999 Conference Proceedings, 69-76.

[6] "Surface reconstruction from unorganized points" H. Hoppe. PhD Thesis, Dept. of Computer Science and Engineering, University of Washington, June 1994.

[7] H. Hoppe, T. DeRose, T. Duchamp, J. McDonald, W. Stuetzle, Mesh optimization. ACM SIGGRAPH 1993 Conference Proceedings, 19-26.

[8] GT Herman, "Shape-based Interpolation," IEEE CG&A, May 1992

[9] RA Drebin, "Volume Rendering," Computer Graphics, 1988.

[10] M. Masroor Ahmed ,Dzulkifli Bin Mohamad, "Segmentation of Brain MR Images for Tumor. Extraction by Combining Kmeans Clustering and Perona-Malik Anisotropic Diffusion Model". International Journal of Image Processing, Vol .2 : Issue.1

[11] Sriparna Saha and Sanghamitra Bandyopadhyay, "MRI Brain Image Segmentation by Fuzzy Symmetry Based Genetic Clustering Technique", Evolutionary Computation, 2007, CEC 2007, IEEE Congress on Volume , Issue , pp .4417-4424, Sept. 2007

[12] M. Arfan Jaffar, Ayyaz Hussain, and Anwar M. Mirza, Asmat ullah Ch, "Fuzzy Entropy and Morphology based fully automated Segmentation of Lungs from CT Scan Images", International Journal of Innovative Computing, Information and Control (IJICIC) Vol.5, No.12, December 2009 (indexed by ISI Impact factor 2.79).

[13] In 1974, Y. Chien and K. Fu explain a decision function method for boundary detection based upon rules. They have used only right lungs part. They extract right lungs part and used this right lung part to detect abnormalities.

[14] In 1998, S. Armato et. al [29][30][31] proposed ideas for the automatic lung segmentation in digital lateral chest radiographs   [Samuel Armato 1994 to 2009 more than 65 Pub)

[15] M. Arfan Jaffar, Ayyaz Hussain, and Anwar M. Mirza, "Fuzzy Entropy based Optimization of Clusters for the Segmentation of Lungs in CT Scanned Images", Knowledge and Information Systems, (Indexed by ISI Impact factor 1.733)

[16] In 2001, Shiying Hu et al, Automatic Lung Segmentation for accurate Quantitation of Volumetric X-Ray CT Images

[17] In 2002, Ayman El-Baz et al, proposed a method for Detection, Visualization and identification of Lung Abnormalities in Chest Spiral CT Scan: Phase-I

[18] In 2005, R.Wieker, et al, Aspects of Computer-aided detection (CAD) and volumetry of Pulmonary Nodules using Multislice CT

[19] In 2006, S. Armato, The Lung Image Database Consortium (LIDC): An evaluation of radiologist variability in the identification of lung nodules in CT scans.

[20] Brain Anatomy: http://www.rush.edu/rumc/page-1098987366785.html

[21] J. C. Bezdek, Pattern Recognition with Fuzzy Objective Function Algorithms New York: Plenum Press, 1981.

[22] Emmanuel Candes, Laurent Demanet, David Donoho and Lexing Ying,Fast Discrete Curvelet Transforms, in SIAM Multiscale Model, Simulation. 2006.

Main Meetings Minute

Meeting Minutes (1)

Venue: N-215B, FAST NU
Meeting with: Dr. Arfan Jaffar
Start Time: 02:30 PM
End Time: 03:45 PM
Date: July 26, 2009

Agenda:

- ❖ Domain selection for final year project
- ❖ Definition of project scope and objective was defined from set of different projects

Meeting Main Points:

- o We had option of set of projects to choose like games, semantic project etc. From those projects we have chosen brain tumor detection.

- o Project scope was discussed in detail, different parts of the brain and techniques were discussed with the supervisor.

Work Distribution:

- ❖ Assign Ghazanfar and Sarfraz to gather data about MRI scan rays form internet
- ❖ Assign Irfan to clearly define the objective of the project and domain.

Meeting Minutes (2)

Venue: N-115A, FAST NU
Meeting with: Dr. Anwar M. Mirza
Start Time: 11:35 AM
End Time: 12:20 PM
Date: August 2, 2009

Agenda:

❖ Discuss the Project definition, domain and scope

Meeting Main Points:

o We met with Dr. Anwar Majid Mirza (Head of CS Department) to get suggestion about project definition.
o Sir gives suggestion to redefine the project scope in term of detection and 3D visualization of brain tumor from MRI scans.
o Sir told about current works on automatic detection of brain tumor and 3D modeling worldwide.

Work Distribution:

❖ Assign Ghazanfar to write down the summery of project.
❖ Assign Sarfraz to search current related work on brain tumors through internet.
❖ Irfan and Sadia started work on writing introduction of the Brain Inspector

Meeting Minutes (3)

Venue: N-215B, FAST NU
Meeting with: Dr. Arfan Jaffar
Start Time: 01:20 PM
End Time: 02:20 PM
Date: August 19, 2009

Agenda:

- ❖ Clearly defined the scope of brain tumor detection.
- ❖ Supervisor assigned the two research papers fuzzy curvelet based fully automated segmentation of brain from MR images to be implemented.
- ❖ Research paper hybrid technique for automatic MRI brain image classification was also suggested by supervisor to work out.

Meeting Main Points:

- o In fuzzy curvelet based fully automated segmentation research paper block diagram was discussed.
- o Concept of Fuzzification and threshold was theoretically discussed.
- o Technique flow and feature extraction was discussed.
- o K-NN algorithm and FP-ANN algorithm was understand fully.

Work Distribution:

- ❖ Assign Ghazanfar and Sadia to work on fuzzy curvelet research paper.
- ❖ Assign irfan and sarfraz to implement the algorithms.

Meeting Minutes (4)

Venue: N-215B, FAST NU
Meeting with: Dr. Arfan Jaffar
Start Time: 11:10 AM
End Time: 12:00 PM
Date: October 9, 2009

Agenda:

- ❖ Fuzzy curvelet and hybrid technique research paper have to be implemented.
- ❖ To start working on documentation and presentation slides.

Meeting Main Points:

- o Problems in research papers were discussed with the sir and research papers were implemented.

- o Documentation topics and table of content were discussed.

Work Distribution:

- ❖ Assign Ghazanfar to start working on presentation slides.
- ❖ Distribute documentation work to all group members.

Meeting Minutes (5)

Venue: N-115A, FAST NU
Meeting with: Dr. Anwar M. Mirza
Start Time: 09:00 AM
End Time: 10:30 AM
Date: October 20, 2009

Agenda:

- ❖ Understanding the concept of 3D modeling

- ❖ Discussion about how to start work on brain 3D modeling

Meeting Main Points:

- o Dr. Anwar suggested exploring the domain and gives us few name of websites to explore.
- o He recommended research papers and books to read and to clear our concepts related to 3d modeling.

Work Distribution:

- ❖ Assign all groups members to individually to explore the concept of 3d modeling

Meeting Minutes (6)

Venue: N-215B, FAST NU
Meeting with: Dr Arfan Jaffar
Start Time: 01:20 PM
End Time: 01:40 PM
Date: November 6, 2009

Agenda:

❖ Supervisor assigned the research paper. Research paper full automatic segmentation of brain in MRI was given by sir for implementation.

Meeting Main Points:

o Different parts of full automatic segmentation of brain in MRI research paper were discussed like segment head, generate initial brain mask and generate final brain mask.

o Techniques of segmented head were discussed by the group members: noise segment, final head mask and head boundary detection.

Work Distribution:

❖ Techniques of segmentation and implementation were assigned to Ghazanfar.

❖ Assign other group members to work on Detail design of paper in documentation.

Meeting Minutes (8)

Venue: N-115A, FAST NU
Meeting with: Dr. Anwar M. Mirza
Start Time: 12:15 PM
End Time: 12:50 PM
Date: November 13, 2009

Agenda:

- ❖ Discuss the issues of 3D modeling
- ❖ Show of initial 3D head model

Meeting Main Points:

- o Give progress of the 3D model and show the initial working 3D model of brain.

- o We discuss the issues which occurred during the head modeling.

- o Sir recommended few changes in 3D head model and give a new idea of implementation.

Work Distribution:

- ❖ Assign Irfan and Sarfraz to implement 3d model.

Meeting Minutes (8)

Venue: Radiology Department, PIMS
Meeting with: Dr Shazia Faruqui
Start Time: 01:10 PM
End Time: 01:45 PM
Date: December 16, 2009

Agenda:

❖ To Understand the brain structure and tumor growth

Meeting Main Points:

o We meet with Dr. Shazia Faruqui (MBBS and FCRS, London), the Head of Radiology Department in Pakistan Institute of Medical Sciences, Islamabad.
o We gave her the overview of the Brain Inspector project and show a little demo of initial project.
o After that she explained the brain structure and tells us about brain tumor and its growth.

Work Distribution:

❖ Assign each group members to select questions related to brain and tumor which we have to ask to Dr. Shazia Faruqui in next meeting.
❖ During meeting assigns Sarfraz to write main points of the meeting.

<u>Meeting Minutes (9)</u>

Venue: Radiology Department, PIMS
Meeting with: Dr Shazia, Mr. Amjad
Start Time: 09:35 PM
End Time: 01:20 PM
Date: December 17, 2009

Agenda:

- ❖ Collection of patient's brain MRI data
- ❖ To Understand the brain structure and tumor growth

Meeting Main Points:

- o We again meet with Dr. Shazia Faruqui, she asked to Dr. Usman to show us the Radiology Department.
- o Dr. Usman showed us the MRI machine and tools that how it works. He showed the saved brain MRI packs. He also tells us about how we analyze the brain MRI scans.
- o After that Dr. Shazia recommend Mr. Amjad Ali (PIMS IT Administrator) to help us in data collection.
- o We visit HMIS (PIMS IT Department) and meet with Mr. Amjad Ali. We spend nearly 2 hours with him. During this, he showed us the existing software applications which are used in PIMS related to Brain MRI scan analysis.
  .

Work Distribution:

- ❖ Assign Sadia to convert the DICOM formatted data into bmp format.
- ❖ Assign Ghazanfar to extract Head and Brain boundaries of 1 patients MRI dataset.
- ❖ Assign Irfan to generate the 3D model using the new boundaries of MRI dataset.
- ❖ Sarfraz write the main points of the meeting.

Meeting Minutes (10)

Venue: N-215B, FAST NU
Meeting with: Dr Arfan Jaffar
Start Time: 01:20 PM
End Time: 01:40 PM
Date: December 22, 2009

Agenda:

❖ Show the implemented full automatic segmentation of brain.
❖ Demo and front end of research paper was showed to supervisor.

Meeting Main Points:

o Implementation of research paper was discussed with the supervisor.

o Problems that occur during implementation were discussed with the supervisor.

o Points of Documentation part of this research paper were written.

Work Distribution:

❖ Documentation work was assigned to all group members in a final format.