

Brain Tumor Detection In MRI Images Using Morphological Operations And Its Texture Analysis

A Dissertation submitted in partial fulfilment of the requirements for the award of degree of

**Master of Engineering
in
Electronic Instrumentation and Control**



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DECLARATION


I hereby certify that the work is being presented in this thesis work entitled “**Brain Tumor Detection In MRI Images Using Morphological Operations And Its Texture Analysis**” in partial fulfilment of award of degree of **Master of Engineering in Electronics Instrumentation & Control** submitted in Electrical & Instrumentation Engineering Department, Thapar University, Patiala is an authentic record of my own work carried under the supervision of **Dr. Sunil Kumar Singla**, Assistant Professor, Department Of Electrical & Instrumentation Engineering, Thapar University, Patiala, Punjab.

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ABSTRACT

Now a days Medical Image Processing is one of the most challenging and emerging fields .In every hospital we use some machines to diagnose the condition of the patient like MRI, CT scan ,ultra scan ,X-rays .etc. All these machines produce images. Based on the information provided by the images the doctor will diagnose the patient condition .The pre-processing of these images are very important for radiologists and doctors for proper diagnosis of the patient .

Brain tumor is one of the severe problems in the medical science. To diagnose the tumor in early stage a proper diagnosis is required. There are so many machines which produces the images to diagnose the brain tumor some of them are CT(computed tomography) scan, MRI(magnetic resonance imaging)..etc. Here in this dissertation the detection of Brain tumor in MRI images has been presented for the proper visualization and diagnosis of patient to make ease for radiologists and doctors ,and in this work the analysis of normal MR images and tumor detected images has also been carried out.

The proposed algorithm consists of five stages pre-processing, noise reduction, enhancing, segmentation and morphological operations. The developed algorithm is very simple and effective for the detection of brain tumor, this algorithm is tested on 50 images obtained from the different hospitals and from Internet. The good results have been obtained with the proposed scheme.

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List of Abbreviations

MRI	Magnetic resonance imaging
CT	Computed tomography
RGB	Red Green Blue
GLCM	Grey level Co-occurrence Matrix
CSF	Cerebral Spinal fluid

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Chapter 1

INTRODUCTION

1.1 BRAIN

The brain is the one that serves as the center of the nervous system in all vertebrate and most invertebrate animals. It is located in the head, close to the primary sensory organs for such senses as vision, hearing, balance, taste, and smell. The brain is the most complex organ in a human body. In a typical human, the cerebral cortex (the largest part) is estimated to contain 15–13 billion neurons each connected by synapses to thousands of other neurons. These neurons are communicated by the means of a long protoplasmic fibers named axons, which carry numerous signal pulses called action potentials to different parts of the brain.

1.1.1 Cell Structure of Brain

Brain is primarily composed of two classes of cell named neurons and glial cells. Glial cells which also known as glia or neuroglia come in many types, which performs a numerous critical functions, structural support, insulation, metabolic support and guidance of development. Neurons are the most important cells in the human brain. Neurons have the unique property that have ability to send the signals to the particular target cells over long distances. These neurons send the signals by means of axon. The axon is a thin protoplasmic fiber which extends from the cell body having many branches, to different areas, sometimes nearby, sometimes in distant parts of the brain or body. The length of the axon is very long it may extends in the range of km. These axons transmits the signals in the form of electrochemical pulses called as action potentials, these last very minute amount of time with a speed of 1-100 meters per second. Some of the neurons emit action potentials at a constant rate in irregular patterns, the other neurons are quiet for some time [1].

Axons transmit signals to the neurons by means of junctions called synapses. A single axon can make numerous synaptic connections with other cells. When an action potential is traveling along an axon which arrives at a synapse, it causes a chemical called a neurotransmitter to be

released. The neurotransmitter binds to the receptor molecules in the membrane of the target cell.

Structure of a Typical Neuron

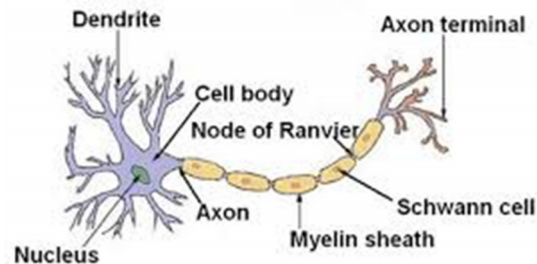


Figure1: Structure of neuron [2]

Neurons have so many networks of dendrites, which receives the synaptic connections. Synapses are the main functional elements of the brain. The main and essential function of the brain is cell-to-cell communication, and synapses are the points at which communication occurs. The human brain consists of approximately 100 trillion synapses. The functions of these synapses are in multiform : some are excitatory , others are inhibitory. A large number of synapses are dynamically modifiable, they are capable of changing strength in a way, when a signal passes through them these are controlled by patterns of the signals. Activity dependent modification of the synapses is the primary mechanism of the brain for learning and memory [2].

1.2 BRAIN TUMORS AND ITS TYPES

The brain is a soft and spongy mass of tissue which is protected by:

- The bones of the skull
- Three thin layers of the tissue(meninges)
- Watery fluid(cerebrospinal fluid) which flows through spaces between meninges and through spaces (ventricles) with in the brain.

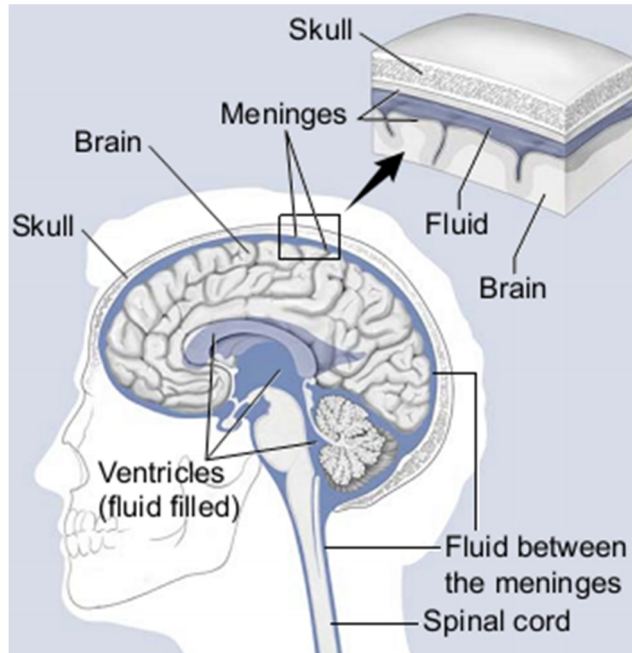


Figure2: Brain and its nearby structures [4]

The brain tells to the organs what we have to do what we have to choose like walking, talking running etc. , the body does some things without thinking like breathing. For all our emotions like and our senses the brain is the in charge of everything.

A network of nerves carries messages between the brain and the rest of the body. Some nerves go directly from the brain to the eyes, ears, and other parts of the head. Other nerves run through the spinal cord to connect the brain with the other parts of the body. Within the brain and spinal cord, *glial cells* surround *nerve cells* and hold them in place.

The three major parts of the brain that control the different activities are

Cerebrum: The cerebrum uses information from our senses to tell us what is going on around us and tells our body how to respond. It controls reading, thinking, learning, speech, and emotions.

The cerebrum is divided into the left and right cerebral hemispheres. The right hemisphere controls the muscles on the left side of the body. The left hemisphere controls the muscles on the right side of the body.

- **Cerebellum:** The cerebellum controls balance for walking and standing, and other complex actions.
- **Brain stem:** The brain stem connects the brain with the spinal cord. It controls breathing, body temperature, blood pressure, and other basic body functions.

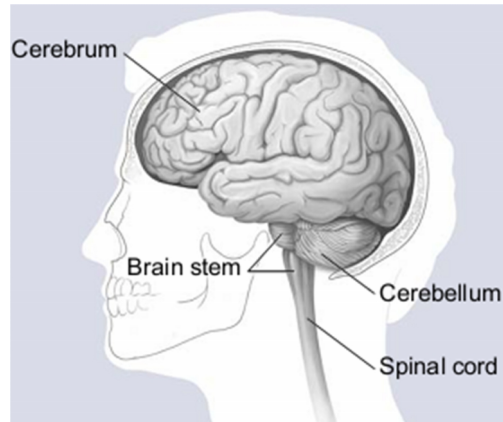


Figure3: Brain and its nearby structures [4]

1.3 TUMOR GRADES AND TYPES

When most normal cells grow old or get damaged, they die, and new cells take their place. Sometimes, this process goes wrong. New cells form when the body doesn't need them, and old or damaged cells don't die as they should. The buildup of extra cells often forms a mass of tissue called a growth or tumor.

Primary brain tumors can be Benign or Malignant:

- Benign brain tumors do not contain cancer cells:
 1. Usually, benign tumors can be removed, and they seldom grow back.
 2. Benign brain tumors usually have an obvious border or edge. Cells from benign tumors rarely invade tissues around them. They don't spread to other parts of the body.

However, benign tumors can press on sensitive areas of the brain and cause serious health problems.

3. Unlike benign tumors in most other parts of the body, benign brain tumors are sometimes life threatening.

Benign brain tumors may become malignant.

Malignant brain tumors (also called brain cancer) contain cancer cells

1. Malignant brain tumors are generally more serious and often are a threat to life.
2. They are likely to grow rapidly and crowd or invade the nearby healthy brain tissue.
3. Cancer cells may break away from malignant brain tumors and spread to other parts of the brain or to the spinal cord. They rarely spread to other parts of the body.

1.3.1 Grades of Tumor

Doctors group brain tumors by grade. The grade of a tumor refers to the way the cells look under a microscope

Grade I: The tissue is benign. The cells look nearly like normal brain cells, and they grow slowly.

Grade II: The tissue is malignant. The cells look less like normal cells than do the cells in a Grade I tumor.

Grade III: The malignant tissue has cells that look very different from normal cells. The abnormal cells are actively growing (anaplastic).

Grade IV: The malignant tissue has cells that look most abnormal and tend to grow quickly.

Cells from low-grade tumors (grades I and II) look more normal and generally grow more slowly than cells from high-grade tumors (grades III and IV).

Over time, a low-grade tumor may become a high-grade tumor. However, the change to a high-grade tumor happens more often among adults than children.

1.3.2 Types of Primary Brain Tumors

There are many types of primary brain tumors.

Primary brain tumors are named according to the type of cells or the part of the brain in which they begin.

For example, most primary brain tumors begin in glial cells. This type of tumor is called a glioma.

Among adults, the most common types are:

Astrocytoma: The tumor arises from star-shaped glial cells called astrocytes. It can be any grade. In adults, an astrocytoma most often arises in the cerebrum.

Grade I or II astrocytoma: It may be called a low-grade glioma.

Grade III astrocytoma: It's sometimes called a high-grade or an anaplastic astrocytoma.

Grade IV astrocytoma: It may be called a glioblastoma or malignant astrocytic glioma.

Meningioma: The tumor arises in the meninges. It can be grade I, II, or III. It's usually benign (grade I) and grows slowly.

Oligodendroglioma: The tumor arises from cells that make the fatty substance that covers and protects nerves. It usually occurs in the cerebrum. It's most common in middle-aged adults. It can be grade II or III.

Among *children*, the most common types are:

Medulloblastoma: The tumor usually arises in the cerebellum. It's sometimes called a primitive neuroectodermal tumor. It is grade IV.

Grade I or II astrocytoma: In children, this low-grade tumor occurs wherever in the brain. The most common astrocytoma among children is juvenile pilocytic astrocytoma. It's grade I.

Ependymoma: The tumor arises from cells that line the ventricles or the central canal of the spinal cord. It's most commonly found in children and young adults. It can be grade I, II, or III.

Brain stem glioma: The tumor occurs in the lowest part of the brain. It can be a low-grade or high-grade tumor. The most common type is diffuse intrinsic pontine glioma.

1.4 SYMPTOMS OF BRAIN TUMOR

The symptoms of a brain tumor depend on tumor size, type, and location. Symptoms may be caused when a tumor presses on a nerve or harms a part of the brain. Also, they may be caused when a tumor blocks the fluid that flows through and around the brain, or when the brain swells because of the buildup of fluid. These are the most common symptoms of brain tumors:

- Headaches (usually worse in the morning)
- Nausea and vomiting
- Changes in speech, vision, or hearing
- Problems balancing or walking
- Changes in mood, personality, or ability to concentrate
- Problems with memory
- Muscle jerking or twitching (seizures or convulsions)
- Numbness or tingling in the arms or legs

1.5 DIAGNOSIS OF BRAIN TUMORS

If you have symptoms that suggest a brain tumor, your doctor will give you a physical exam and ask about your personal and family health history. You may have one or more of the following tests:

1.5.1 Neurologic exam

Doctor checks the vision, hearing, alertness, muscle strength, coordination, and reflexes. The doctor also examines your eyes to look for swelling caused by a tumor pressing on the nerve that connects the eye and the brain.

1.5.2 Magnetic Resonance Imaging (MRI)

A large machine with a strong magnet linked to a computer is used to make detailed pictures of areas inside your head. Sometimes a special dye is injected into a blood vessel in your arm or hand to help show differences in the tissues of the brain. The pictures can show abnormal areas, such as a tumor.

1.5.3 CT scan

An x-ray machine linked to a computer takes a series of detailed pictures of your head. You may receive contrast material by injection into a blood vessel in your arm or hand. The contrast material makes abnormal areas easier to see.

1.5.4 Angiogram

Dye injected into the bloodstream makes blood vessels in the brain show up on an x-ray. If a tumor is present, the x-ray may show the tumor or blood vessels that are feeding into the tumor

1.5.5 Spinal tap

The Doctor may remove a sample of cerebrospinal fluid (the fluid that fills the spaces in and around the brain and spinal cord). This procedure is performed with local anesthesia. The doctor uses a long, thin needle to remove fluid from the lower part of the spinal column. A spinal tap takes about 30 minutes. You must lie flat for several hours afterward to keep from getting a headache. A laboratory checks the fluid for cancer cells or other signs of problems.

1.5.6 Biopsy

The removal of tissue to look for tumor cells is called a biopsy. A pathologist looks at the cells under a microscope to check for abnormal cells. A biopsy can show cancer, tissue changes that may lead to cancer, and other conditions. A biopsy is the only sure way to diagnose a brain tumor, learn what grade it is, and plan treatment

Surgeons can obtain tissue to look for tumor cells in two ways:

Biopsy at the same time as treatment: The surgeon takes a tissue sample when you have Surgery to remove part or all of the tumor.

Stereotactic biopsy: Patient may get local or general anesthesia and wear a rigid head frame for this procedure. The surgeon makes a small incision in the scalp and drills a small hole (a burr hole) into the skull. CT or MRI is used to guide the needle through the burr hole to the location of the tumor.

The surgeon withdraws a sample of tissue with the needle. A needle biopsy may be used when a tumor is deep inside the brain or in a part of the brain that can't be operated on.

However, if the tumor is in the brain stem or certain other areas, the surgeon may not be able to remove tissue from the tumor without harming normal brain tissue. In this case, the doctor uses MRI, CT, or other imaging tests to learn as much as possible about the brain tumor [4].

Here in this proposed work we uses the MRI images to detect the brain tumors hence we should know more about the MRI

1.6 Magnetic Resonance Imaging (MRI)

MRI is a medical imaging technique which is used in radiology to know about the anatomy and function of the body. The scanners of MRI use strong magnetic fields and radio waves to form the images of the body. This kind of imaging technique is widely used in hospitals for the diagnosis, to know about which stage they are in the disease etc.

MRI has the wide range of application in the medical field. Especially in producing the images of neuroimaging, cardiovascular, musculoskeletal, liver and gastro intestinal etc

1.6.1 Working of MRI

To get the analysis of the patient, the patient is supposed to sit in the MRI scanner which forms a strong magnetic field to produce the images. Most of the medical applications depends up on the emitting of hydrogen atoms present in the body is detected by a radio frequency signal using energy from an oscillating magnetic field applied at the appropriate resonant frequency. By varying the main magnetic field using gradient coils the orientation of the image is

controlled .by switching on and off these coils rapidly they create the characteristic repetitive noises of an MRI scan.

MRI requires a magnetic field that is both strong and uniform. The field strength of the magnet is measured in tesla – and while the majority of systems operate at 1.5T commercial systems are available between 0.2T–7T.

1.6.2 Contrast in MRI

Image contrast is used to give some weight to visualize the different anatomical structures. After excitation by the independent processes of T1 (spin-lattice) and T2 (spin-spin) relaxation each tissue will return to its equilibrium state .

In order to create a T1-weighted image, by changing the repetition time before measuring the signal we have to wait for different amounts of magnetization to recover . For identifying the fatty tissue and accessing the cerebral cortex the image weighting is very useful for analysis and characterizing focal liver lesions and for post- contrast imaging

In order to create a T2-weighted image, we wait for different amounts of magnetization to decay before measuring the MR signal This image weighting is useful for detecting edema, revealing white matter lesions and assessing zonal anatomy in the prostate and uterus.

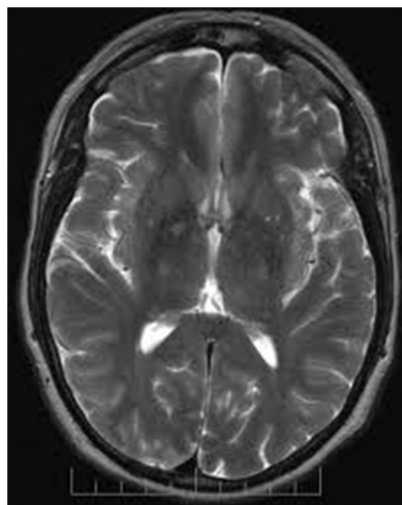


Figure 4: MRI image of brain (chronal cross section) [4]

Here in this image we can see in the image we have gray matter which is the gray outline in the image, the outside border is nothing but the skin surface, whereas the white inside the image is called the white matter and the black color present in the image is called the cerebral spinal fluid (CSF). It means here if you want to segment the MRI image we have the three things they are white matter, gray matter and cerebral spinal fluid where segmentation will be discussed in the next chapter.

1.7 OBJECTIVE OF THE DISSERTATION

Imaging is one of the important and essential aspects in the medical field. To analyze and diagnose any part of the human body one depends upon some machines such as CT scan, MRI scan, X-rays etc. which produce images. In this work MRI has been used as an imaging technique. The main objective of this dissertation are

- 1) Study the literature review for the present tumor detection technique
- 2) Development of a simple and effective algorithm for brain tumor detection.
- 3) Analysis of normal MRI and the tumor detected image.

Chapter 2

LITERATURE REVIEW

This chapter deals with different research works that were carried out in past and contributed to this field of Brain Tumor Detection. So many approaches are developed for the Detection of Brain Tumor which were played important role to carry out this work. Some of the related research work is described below

Sahar Ghanavati et.al., were discussed about the Automatic Brain Tumor Detection In Magnetic Resonance Images in which a multi-modality framework for automatic tumor detection is presented, fusing different Magnetic Resonance Imaging modalities including T1-weighted, T2-weighted, and T1 with gadolinium contrast agent. The intensity, shape deformation, symmetry, and texture features were extracted from each image. The AdaBoost classifier was used to select the most discriminative features and to segment the tumor region. Multi-modal MR images with simulated tumor have been used as the ground truth for training and validation of the detection method. Preliminary results on simulated and patient MRI show 100% successful tumor detection with average accuracy of 90.11% [9].

Manoj K Kowar et.al., were discussed about Brain Tumor Detection and Segmentation Using Histogram Thresholding in this they were main focusing about brain segmentation using the histogram thresholding where segmentation is done by histogram thresholding that means by analyzing the histogram shape they will select one of the thresholded value for the segmentation. This method is successfully applied to detect the contour of the tumor and its geometrical dimension. This technique can be proved to be handy tool for the practitioner's especially the physicians engaged in this field [10].

J.Vijay et.al., presented an approach for finding the brain tumor detection in different methods in different approach named An Efficient Brain Tumor Detection Methodology Using K-Means Clustering Algorithm in this paper they were detected the Brain Tumor In MRI images using some clustering methods which named as K-means clustering. Here they were used the task of

labeling the tissue type named white matter ,gray matter ,cerebrospinal fluid etc. In this paper they were discussed about the segmentation that is carried out using the K-means clustering for the better performance, which enhances the tumor boundaries more and is very fast compared to the other clustering algorithms, which produced a better results [11].

Pavel Dvorak et.al., explored the views regarding the Automatic Detection of Brain Tumors in MR Images in which they proposed the automatic detection in Magnetic Resonance Images in which there goal is to determine whether the tumor is present in the brain or not . They proposed a method which works with T2-weighted magnetic resonance images, where the head is vertically aligned. The detection is based on checking the left-right symmetry of the brain, which is the assumption for healthy brain. The algorithm was tested by five-fold cross-validation technique on 72 images of brain containing tumors and 131 images of healthy brain [12].

K. M. Iftexharuddin et.al., proposed a method for Brain Tumor Detection in MRI: Technique and Statistical Validation in this they used Two novel fractal-based texture features are exploited for pediatric brain tumor segmentation and classification in MRI. One of the two texture features uses Piecewise-Triangular-Prism-Surface-Area (PTPSA) algorithm for fractal feature extraction. The other texture feature exploits the novel fractional Brownian motion (FBM) framework that combines both fractal and wavelet analyses for fractal wavelet feature extraction. Three MRI modalities such as T1 (gadolinium-enhanced), T2 and Fluid-Attenuated Inversion-Recovery (FLAIR) are exploited in this work. The Self-Organizing Map (SOM) algorithm is used for tumor segmentation. Two classification methods, multi-layer feed-forward neural network and Support Vector Machine (SVM), are used to classify the tumor regions from non-tumor regions. For neural network classifier, at a threshold value of 0.7, the True Positive Fraction (TPF) values range from 75% to 100% for different patients, with the average value of 90% [13].

Rajesh C. Patil et.al.,proposed an algorithm for the detection of Brain Tumor Extraction In MRI Images which in corporates with some noise removal functions, segmentation and morphological operations which are the basic concepts of Image Processing. Detection and extraction of tumor from MRI scan images of the brain have done by using MATLAB software [14].

Rachana Rana, et.al., discussed about the Brain Tumor Extraction from MRI Images Using Bounding-Box with Level Set Method in which they discussed about the implementation of Simple Algorithm for locating and segmenting tumor in brain MR images. Here they were mixed the two algorithms which allows the segmentation of tumor tissue with precision and consistency in comparison with manual segmentation. Also, it also reduces the time for analysis. At the end, the tumor is extracted from the MR image and its exact position and the shape is also determined [15].

Amitava Halder et.al., explores the views about the Brain Tumor Detection using Segmentation based Object Labeling Algorithm which extracts the tumor by using K-means algorithm followed by Object labeling algorithm. Also, some preprocessing steps named median filtering and morphological operation were used for tumor detection purpose [16].

M. Usman Akram et.al.,proposed an approach for detection of brain tumor in their paper named Computer Aided System for Brain Tumor Detection and Segmentation in which the detection process is of two stages where first stage is the preprocessing stage in which they acquired the MR image of brain is acquired and preprocessing is done to remove the noise and to sharpen the image. In the second stage, global threshold segmentation is done on the sharpened image to segment the brain tumor. In the third stage, the segmented image is post processed by morphological operations and tumor masking in order to remove the false segmented pixels [17].

Ankit Vidyarthi et.al.,proposed a paper named CLAP: Closely Link Associated Pixel based Extraction of Brain Tumor in MR Images which describes about how to extract the brain tumor in a different approach called as CLAP which means Closely Link Associated Pixel which describes a new bi-clustering algorithm has been proposed to cluster out the maximum abnormality area from the brain MR image without any predefined threshold. The algorithm is based on the closely link associated pixel (CLAP) mechanism for tumor segmentation [18].

M. Sasikala et.al., explores the views about the Comparison of Feature Selection Techniques for Detection of Malignant Tumor in Brain Images in which they describes about the feature selection algorithm for the detection of the glioblastoma multiforme in brain Images and the

texture features are extracted from the normal and tumor detected regions using spatial gray level dependence method and wavelet transform [19].

Ahmed kharrat et.al., described about the Detection of Brain Tumor in Medical Images, which introduces an efficient detection of brain tumor from cerebral MRI images. This algorithm consists of three stages named enhancement segmentation and morphology and after that they apply the wavelet transform in the segmentation process to decompose MRI images ,k-means algorithm is also used to extract the tumors [20].

XieMei, et.al., proposed an algorithm for the Detection Of Edge In The Brain Tumor in this they proposed a canny algorithm for detecting the weak edge of the brain and they used the 8 connected edge for this. After that they detected the sole weak edge by the histogram segmentation [21].

Satish Chandra, et.al. explored the view about A PSO Based method for Detection of Brain Tumors from MRI in which they emphasis on brain tumor detection based on particle swarm Optimization, which finds the centroids of number of clusters, where each cluster groups together brain tumor patterns, obtained from MR Images. The results obtained from these is compared with the support vector machine and ada boost, gives a better results compared to SVM (support vector machine) [22].

IMAGE PROCESSING

3.1 INTRODUCTION

Humans are commonly visual creatures. In order to sense the world around us we depend up on our vision .we have a god's gift that we can visualize ,identify, classify and scan the things and also we call feel the things around us.

Humans have precise visual skills eg: we can identify the face, we can differentiate the colors we can process the information. Suppose if you stare a house or building for a long time it will change in some way .suppose a large solid structure like a building or a rock will change its appearance depends on the time of the day like in the morning or evening the appearance of the particular building will differs.

Image processing deals with changing the scenes. In our context an image is a single picture which provides the information. It may be a picture of building, of animals or of plants or the medical images. Even if the picture is not immediately recognizable, it will not be just blur.

3.2 IMAGE PROCESSING

Image processing involves changing the nature of the image to improve its pictorial information for human interpretation and render it more suitable for automatic machine detection.

Here in this the main theme is concerning about the digital image processing in which there is an involvement of computer to change the nature of the digital image.

There are two aspects in the image processing which having much more importance these are

1. A procedure which makes an image look better
2. May be the worst procedure for satisfying condition

Humans used to like their images to be sharp whereas machines used to prefer their images to be simple

To make the image sharper we have to enhance the edges of the image which is shown in figure



Figure 5: Original Image [6]



Figure 6 Image after sharpening[6]

here we can see that the second image is very clear and clean compared to the first image in order to appear the image in its best way we have to sharp the edges

- Removal of noise from an image is one of the methods to enhance the image for the better visualization. In every image noise is the common problem especially while data transmission. Due to electronic components the additional noise will be added to the images to make the images clear we have to remove the noise for better visualization. In this figure 7 shows the original image and the figure 8 shows the noise removed image
- Motion blur removing in an image this is also one of the image processing techniques to remove the motion blur in an image for the better visualization of the image .motion blur may occurs due to shutter speed of the camera is much long for the speed of the object. while taking the photos of athletes , moving objects ..etc. these blurs may occur. Here figure 9 shows the blurred image and figure 10 shows the removal of blur in the image .



Figure 7: Original image [6]



Figure 8: Image after removing noise [6]



Figure 9: Original Image[6]



Figure 10: Image after removing the blur [6]

The above examples comes under the first category for the better visualization

Here the second category comes that where the measurements can be done by the machine detection in this category .

- Obtaining the edge of the image for the detection of the image by the machine ,if you need area contained in them for automatic detection .we can use the edge detection as the first step for the enhancement the edge. Here in figure 11 shows the original image and figure 12 shows edge detected image for the automatic detection and classification of the images



Figure 11: Original image [6]



Figure 12: Image after edge detection [6]

3.3 IMAGE AND DIGITAL IMAGE

If you take an image from the camera, assume that it is black and white . we may consider that the image is having a two dimensional which is having values that gives the brightness of the image at any instant .we may assume that the image having the brightness value as ‘0’ for black and ‘1’ for white. The ranges of ‘x’ and ‘y’ values will depends up on the image brightness as shown in figure 13.

Digital image will be differs from a photo in general the photo which having the values a discrete whereas in the digital images we are having the real values which is varying in between 0(black) to 255(white). A digital image is the one which is considered as a large array of discrete dots. These dots are called as pixels(picture elements).the surrounding of the pixels are called as neighborhood. A neighborhood can be characterized by its shape like we speak as the 5x5 neighborhood, 7x7 neighborhood. Neighborhoods have odd numbers of rows and columns, this ensures that the current pixel is in the Centre of the neighborhood as shown in the figure14. If a neighborhood has an even number of rows or columns (or both), it may be necessary to specify which pixel in the neighborhood is the current pixel[6].

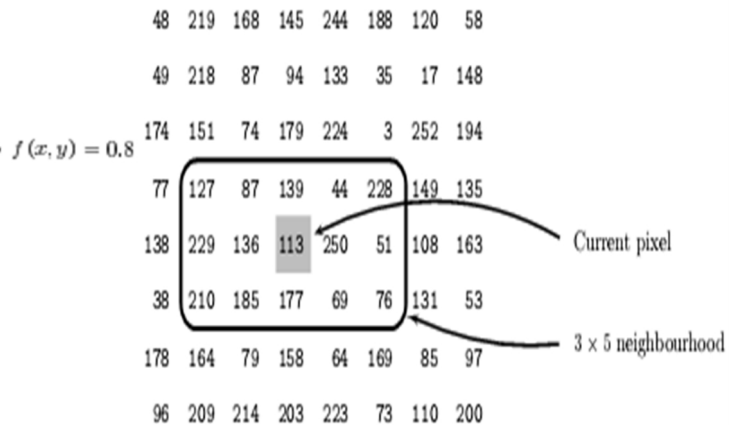
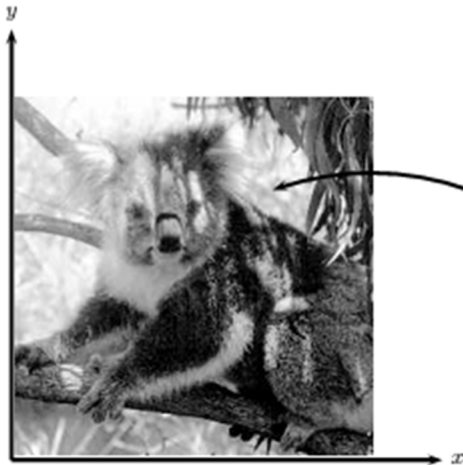


Figure 13: Image as a function [6]

Figure 14: Pixels with neighborhood [6]

3.4 DIFFERENT ASPECTS OF IMAGE PROCESSING

There are distinct algorithms for different tasks and problems. In order to classify these algorithms we have to know about that which task that we are doing

3.4.1 Image enhancement

The main things that comes under the image enhancement is

- Highlighting the edges
- Improving the brightness and contrast
- De-blurring and sharpening
- Removing of the noise

3.4.2 Image restoration

It can be considered as reversing the damage done to an image by a known cause

- Removal of distortions
- Removal of interferences
- Removal of blur..etc

3.4.3 Image segmentation

It is nothing but the dividing the image in to different sub images ,one of the difficult tasks in the image processing which includes

- Finding the circles ,lines, different types of shapes in an image
- Identifying tumors, different objects ,detections in an image

Here in this thesis segmentation plays a predominant role for the detection of tumor present in the human brain

3.5 TYPES OF DIGITAL IMAGES

Basically we have four types of digital images they are as follows

3.5.1 Binary: Here in this binary image each pixel is either 0(black) or 1(white). Here we have only two possibilities of each pixels either 0 or 1 hence it is called as binary image. These images are very efficient in terms of storage

Eg: Here in this figure15 the edges shows as 1 whereas the black represents 0

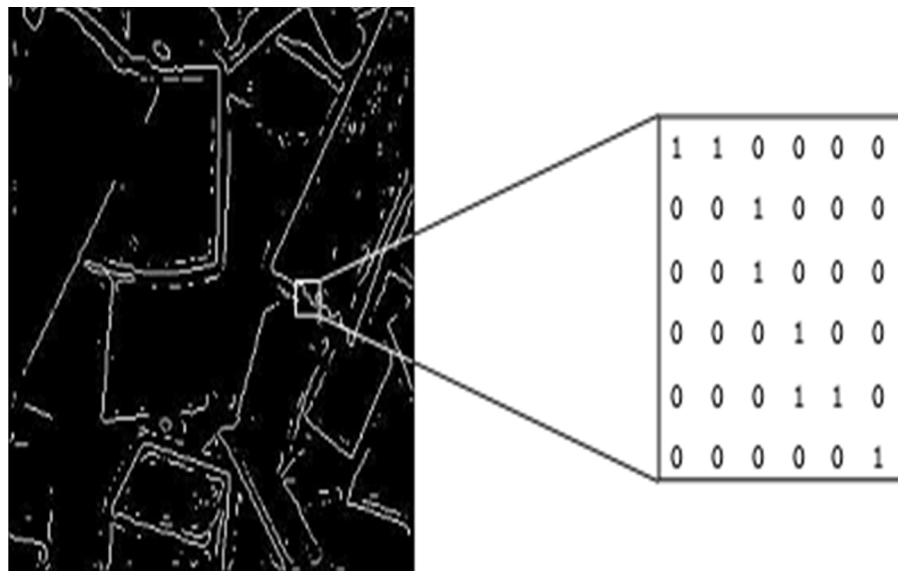


Figure 15: Binary Image [6]

3.5.2 Gray scale Image : Here in this each pixel represents different shade of gray. Normally these images are in the range of 0(black) to 255(white) .it can be represented by 8 bits .it is the

natural range for image file handling. The examples of these images are medical images ,Mostly all the medical images like X-rays ,MRI images all the images in medical field produces the medical images.

Eg: Here in this figure16 we can see the MRI gray scale image

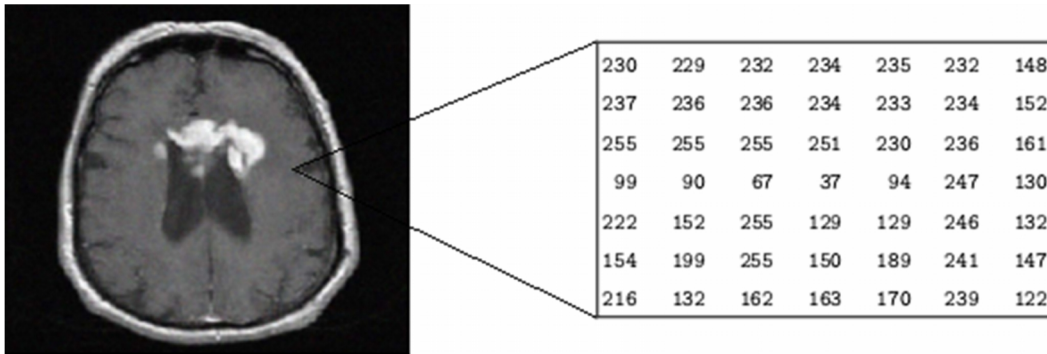


Figure 16: Gray Scale Image [6]

3.5.3 RGB or True color Image : Here in this each pixel has different color .this color is described by amount of red, green,and blue in it. These components has a range of 0-255 gives the total of $255^3 = 16,777,216$ different possible colors in the image. Because the total number of bits required for each pixel is 24. such images are called as 24-bit color images. The figure17 shows how the RGB image will be.

3.5.4 Indexed Image : In the color images we have 16 million possible colors. For storage and file handling image has an associated color map, simply a colors used in that image . Each pixel has a value which does not give its color, but an index to the color in the map.

If the image has the 256 colors or less it will be convenient to store. The index values only requires a byte to store some file formats like GIF uses the index imaging

Here the figure18 shows the index image

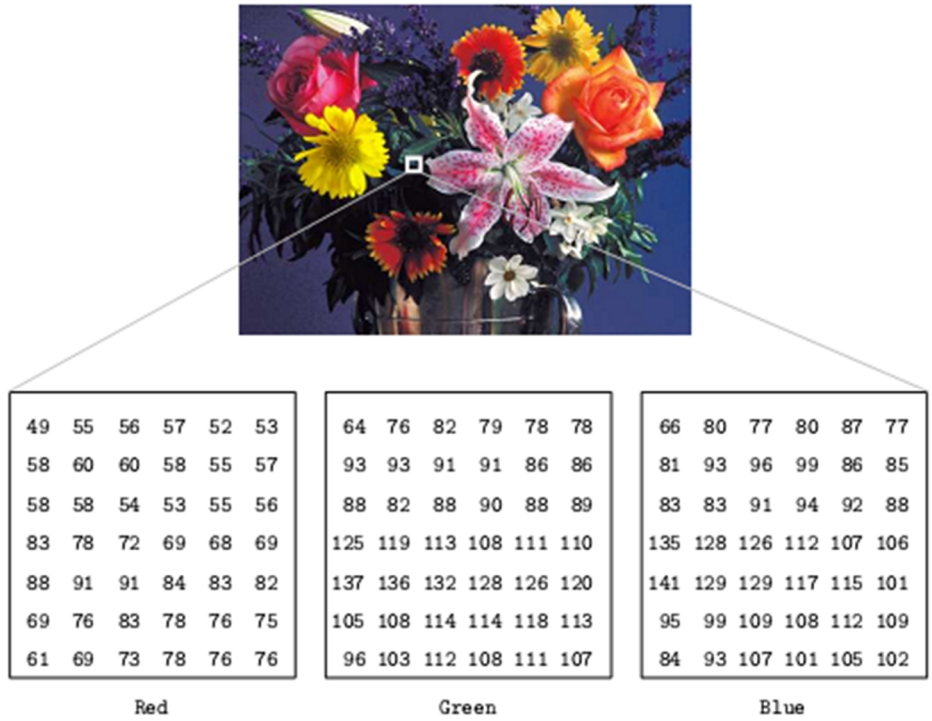


Figure 17: RGB Image [6]



Figure 18: Index Color Image [6]

METHODOLOGY

4.1 DATABASE

The database used in the work is obtained from the different hospitals and the brain tumor MRI data base in the internet. In this work we took different grades of brain tumors like benign , malignant and different types of astrocytoma's. Here around 50 different types of images has been taken and then detection of tumor present in the images has been done. The analysis of original image and the tumor detected image also been done by using the texture parameters.

4.2 METHODOLOGY& FLOW CHART OF PROPOSED METHOD

The algorithm has been developed on the MRI images from the database as shown in figure 19

In this proposed algorithm consists of five stages in which initially we have the read the MR image taken from the MRI scanner. In general the MRI scan images are gray scale images if the image is taken from the internet it may be in jpg format if it is in jpg format we have to convert that image to gray scale. The next step is as if the image consists of any noise the Gaussian filter to remove the noise if there is no noise present in the image the next will be follows as enhancing the image with the median filter.

After enhancing the image the next step is to convert the gray scale image in to binary image by a process called thresholding which comes under segmentation. The next is to detect a tumor present in the MR image which detects by using the morphological operations which will be the next step. Later the analysis of the tumor detected image is done by using the texture parameters.

The detailed process is shown in flow chart and explained in the following sections

Flowchart: The Flow chart for the proposed approach is shown in figure 19

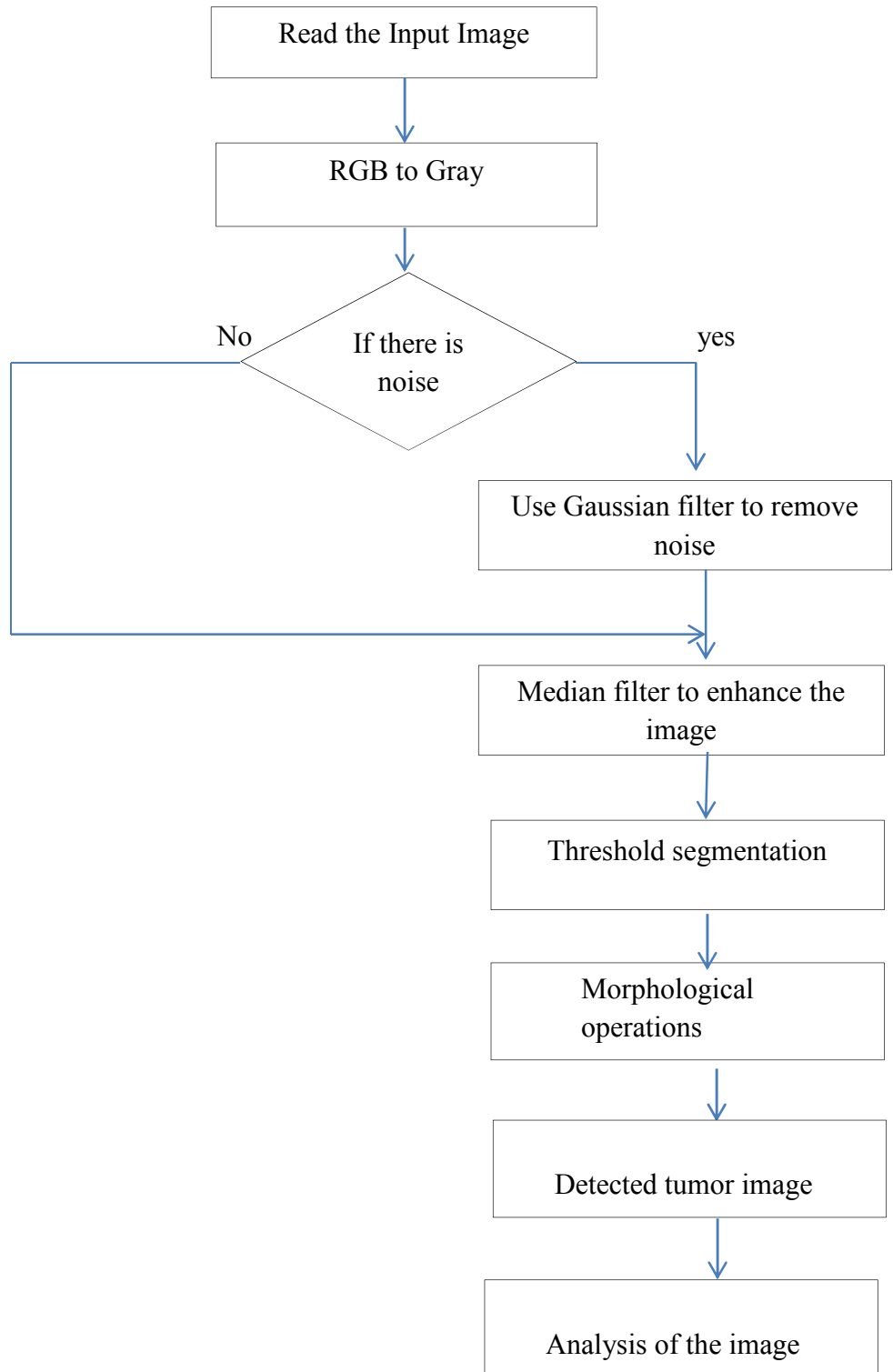


Figure 19: Flowchart for showing the methodology for the proposed approach

4.2.1 RGB to Gray scale conversion

In general the medical images are all gray scale images in some cases if the image is present in available in the RGB pattern we have to convert these RGB image to the gray scale image. Here as in the chapter 4 we discussed about the different types of images RGB images have different colors for every pixels here in this conversion it converts every pixels in to certain range 0(black) -255(white) which uses the 8 bits to storage this image. The question is why we are converting the RGB image to the gray scale image is for storage and to do process easily.

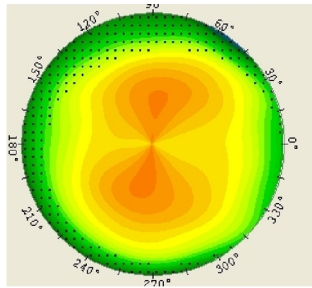


Figure 20: RGB Image

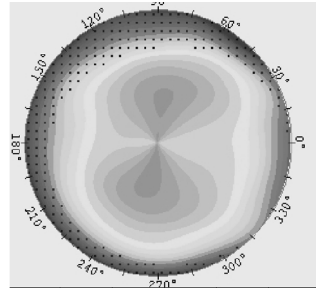


Figure 21: Gray Scale Image

4.2.2 Removing Noise

If our image consists of any noise like arrows, text and any other high frequency components we can remove those noises using the Gaussian filter, which can made our image blur without losing any information. The main advantage of the Gaussian filter is we can blur the image so that if there is any noises in the image will be vanished .it works based on the following equation

$$G(x,y) = \frac{1}{2\pi\sigma^2} e^{-\frac{x^2+y^2}{2\sigma^2}}$$

Where x is the distance from origin in the horizontal axis, y is the distance from origin from the vertical axis and σ is the standard deviation of the Gaussian distribution [4].

4.2.3 Enhancing the Image

For the better visualization of the image we have to enhance the image it means we have to increase the intensity of the every pixel of the image for this in this proposed algorithm we are using the median filter to enhance the image . The main idea of the median filter is to run to each and every pixel of the image and replaces the each pixel by the median of all neighboring pixels, so that every pixel will be enhanced by some value and hence the intensity distribution is done to each and every pixel. The main purpose of the median filter is to enhance the image.

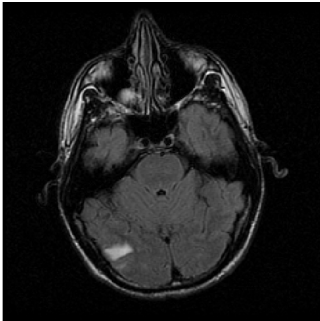


Figure 22: Original image

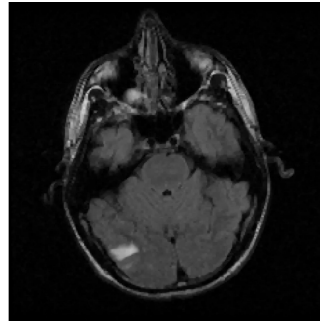


Figure 23: Image after Enhancing

4.2.4 Segmentation

Segmentation subdivides an image in to its constituent regions or objects. Segmentation plays a predominant role for detecting or extracting of any object in the given image. Better segmentation gives the better results .Segmentation of non-trivial images is one of the difficult task in image processing. There are so many segmentation Algorithms are there in image processing and all these are based on two properties of image intensity values, discontinuity and similarity. In this work we used the segmentation algorithm based on similarity. The main principle behind this is partitioning the image in to regions that are similar according to a set of predefined criteria. In this paper we uses a simple segmentation algorithm called thresholding segmentation in which we can divide the image in to different levels based on the predefined value called threshold. We have so many thresholding algorithms like otsu method, global thresholding, adaptive thresholding etc. but here we are using the local thresholding method which is convenient here to convert gray scale image to binary image for the detection of tumor.

Where the local thresholding is the simple process in which we are just dividing the image in to two distinct levels based on the intensity values

4.2.4.1 Thresholding

A grey scale image is turned in to a binary (black and white) image by first choosing a grey level in the original image, and then turning every pixel black or white according to whether its grey value is greater than or less than T

Thresholding is a vital part of image segmentation, where we wish to isolate objects from the background. It is also an important component of robot vision.

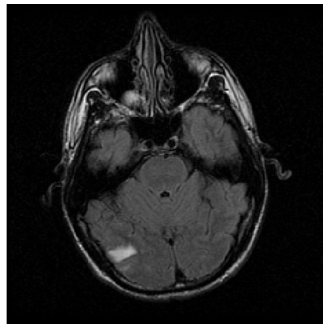


Figure 24: Original Image

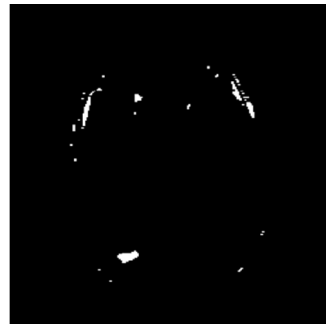


Figure 25: Image after Thresholding

4.2.5 Morphological Operations

The term *Morphology* denotes a branch of biology that deals with the form and structure of animals and plants. To detect and extract boundaries, skeletons, shapes the morphological operations plays an important role. Here in this morphological image processing the image is traversed with a block called as structural element. When this structural element traversed over the image and is compared with the neighborhood pixels of the image. We can do the morphological operations on the binary images and it results the binary images. Here in this proposed algorithm

1. we uses erosion operation followed by dilation as the structural element as disk with radius 5
2. We uses the **bwareaopen** command to reduce smaller area pixel and **bwlabel** command to label the connected elements present in the image

4.2.5.1 Dilation

The main features of the dilation is as follows

1. It is an operation that grows or thickens objects in an image.
2. The specific manner and extent of this thickening is controlled by a shape referred to as a structuring element.
3. The dilation of A by B is defined as the set operation

$$A \oplus B = \{z | (\hat{B})_z \cap A \neq \emptyset\} = \{z | (\hat{B})_z \cap A \subseteq A\}$$

Where B is the structuring element.

Eg: If you take the structuring element as 3×3 square .

Note that in subsequent diagrams, foreground pixels are represented by 1's and background pixels by 0's.

To compute the dilation of a binary input image by this structuring element, we superimpose the structuring element on top of the input image so that the origin of the structuring element coincides with the input pixel position.

If the center pixel (defined origin) in the structuring element coincides with a foreground pixel in the image underneath, then the input pixel is set to the foreground value.

Structuring element is =

1	1	1
1	1	1
1	1	1

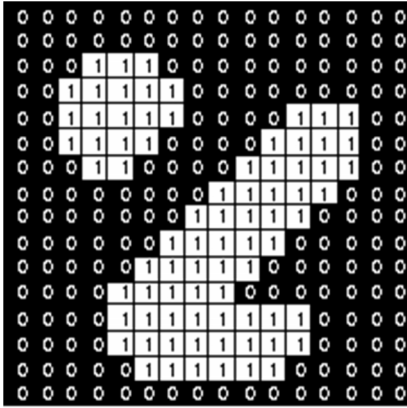


Figure 26: Image before Dilation [6]

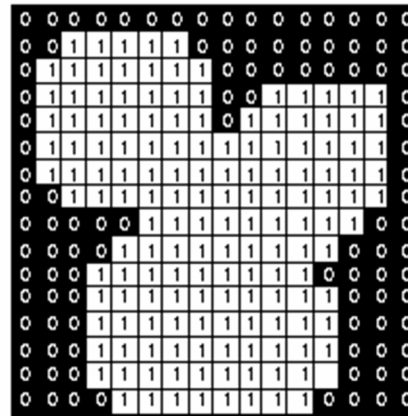
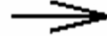


Figure 27: Image after Dilation [6]

4.2.5.2 Erosion

It shrinks or thins objects in a binary image. The manner and extent of shrinking is controlled by a structuring element.

The erosion of A by B is the set of all points x such that B, translated by x, is contained in A.

$$A \ominus B = \{x \mid (B)_x \subseteq A\}$$

The basic effect of the operator on a binary image is to erode away the boundaries of regions of foreground pixels. Thus areas of foreground pixels shrink in size, and holes within those areas become larger. Eg: If you take the structuring element as 3×3 square.

Note that in subsequent diagrams, foreground pixels are represented by 1's and background pixels by 0's.

The structuring element is now superimposed over each foreground pixel (input pixel) in the image. If all the pixels below the structuring element are foreground pixels then the input pixel retains its value. But if any of the pixels is a background pixel then the input pixel gets the background pixel value.

If the structural element is same as in the figure above then

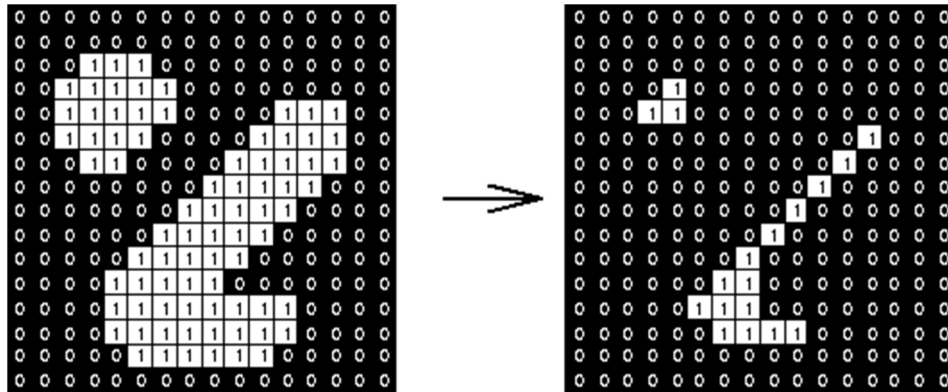


Figure 28: Image before Erosion [6]

Figure 29: Image after Erosion [6]

After detecting the tumor present in the brain tumor MRI image by performing the morphological operations erosion followed by dilation with the structural element as the disk with radius 5. The original image and the tumor detected image is added for the better visualization of the tumor present in the image. After doing this the last and final operation of this proposed approach is to analyze the original image and the tumor detected image. The analysis of these image are done by the using the texture parameters of the image.

4.2.6 Analysis of the Image

The analysis of the image is based on the texture parameters like homogeneity, contrast ,angular second moment..etc. Before going to deal about these parameters we should know about what is meant by texture and its importance

4.2.6.1 Texture

Texture is a description of the spatial arrangement of color or intensities in an image or a selected region of an image. It is a combination of repeated patterns with regular frequency. There are several types of visual interpretation of texture eg: smooth, fine, coarse etc. Texture analysis is defined as the classification or segmentation of textural features with respect to the shape of a small element, density and direction of regularity. In the case of digital image, it is difficult to treat the texture mathematically because texture cannot be standardized quantitatively and the data volume is so huge

There are several types of texture analysis, in this dissertation statistical approach is used.

4.2.6.2 Gray Level Co-Occurrence Matrix(GLCM):

The gray-level co-occurrence matrix (GLCM), a frequency matrix, is a useful method for enhancing details and is frequently used as an aid for interpretation of an image. The GLCM is a tabulation of how often different combinations of pixel brightness values (grey levels) occur in an image. The GLCM indicates the frequency of a pair of pixels that are at “exactly the same distance and direction of the displacement vector”. From this principal, it uses to computes the relationships of pixel intensity to the intensity of its neighboring pixels which are based on hypothesis that the same gray level configuration is repeated in a texture and pixels that are close together tend to be more related than pixels that are far away from each other.

The GLCM, c , is defined with respect to given (row, column) displacement h and element (i, j) , denoted c_{ij} is the number of times a point having gray level j occurs in position h relative to a point having gray level i . Let N_h be the total number of pairs, then $C_{ij} = c_{ij}/N_h$ is the elements of the normalized GLCM, C

The co-occurrence probabilities provide a second-order method for generating texture features. These probabilities represent the conditional joint probabilities of all pair wise combinations of grey levels in the spatial window of interest given two parameters: inter pixel distance (δ) and orientation (θ). The probability measure can be defined as:

$$\Pr(x) = \{C_{ij} | (\delta, \theta)\}$$

Where C_{ij} (the co-occurrence probability between grey levels i and j) is defined as:

$$C_{ij} = \frac{P_{ij}}{\sum P_{ij}}$$

Where P_{ij} represents the number of occurrences of grey levels i and j within the given window certain (δ, θ) pair

Eg: A=

0	0	1	1
0	0	1	1
0	2	2	2
2	2	3	3

GlcM=

2	2	1	0
0	2	0	0
0	0	3	1
0	0	0	1

Here in this example if you in i(row),j(column) in the horizontal direction here we can see in the Glcm how many times the (0,0) appears it displays in the glcm as '2' as we can see in the original images as follows. It means that glcm is the matrix having the values that how many repeated patterns are there in the image it. In the same way we can change the direction to 45°,90°,135° and we can find out the repeated patterns of the image [7]. The parameters are shown in figure below which are calculated from the Gray Level Co-occurrence Matrix.

<i>PARAMETER</i>	<i>DESCRIPTION</i>	<i>FORMULA</i>
CONTRAST	Returns a measure of the intensity contrast between a pixel and its neighbor over the whole image. Range = $[0 (\text{size}(\text{GLCM}) - 1)^2]$ The Contrast is expected to be low if the gray levels of each pixel pair are similar. Contrast is 0 for a constant image.	$\sum_{i,j} i - j ^2 P(i, j)$
HOMOGENEITY	Measures the local homogeneity of a pixel pair. The Homogeneity is expected to be large if the gray levels of each pixel pair are similar. Range = $[0 1]$	$\sum_{i,j} \frac{P(i, j)}{1 + i - j }$
CORRELATION	Returns a measure of how correlated a pixel is to its neighbor over the whole image. Range = $[-1 1]$ Correlation is 1 or -1 for a perfectly positively or negatively correlated image. The Correlation is expected to be high if the graylevels of the pixel pairs are highly correlated.	$\sum_{i,j} \frac{(i - \mu_i)(j - \mu_j)P(i, j)}{\sigma_i \sigma_j}$
ENERGY	Measures the number of repeated pairs. The Energy is expected to be high if the occurrence of repeated pixel pairs is high. Energy is 1 for a constant image.	$\sum_{i,j} P(i, j)^2$

Figure 30: Texture parameters [5]

Contrast: Contrast is also called "sum of squares variance. Spatial frequency is the difference between the highest and the lowest values of a contiguous set of pixels. A low contrast image presents a GLCM concentration term around the principal diagonal and, consequently, a low value of the GLCM contrast. This result means that high contrast values imply high contrast texture, first-order statistics contrast and GLCM contrast are strongly related. GLCM contrast

and variance were also found to be highly correlated with the first order statistic standard deviation

Homogeneity: It is also called as Inverse Difference Moment. It will tell how much the pixels are uniform in nature.

Correlation: Correlation is a measure of gray tone linear-dependencies in the image; in particular, the direction under investigation is the same as vector displacement. High correlation values (close to 1) imply a linear relationship between the gray levels of pixel pairs. Thus, GLCM correlation is uncorrelated with GLCM energy and entropy, i.e., to pixel pairs repetitions. Correlation reaches its maximum regardless of pixel pair occurrence, as high correlation can be measured either in low or in high energy situations. GLCM correlation is also uncorrelated to GLCM contrast, as high predictability of the gray level of one pixel from the second one in a pixel pair is completely independent from contrast.

Energy: Energy measures textural uniformity, i.e., pixel pair repetitions. Energy is the opposite of entropy. Energy can be used to do useful work. In that sense, it represents orderliness. This is why "Energy" is used for the texture that measures order in the image.

Based on these parameters we can classify images and using these parameters we can be able to know that how the contrast and every parameters are varying from image to image as the normal MRI image and the tumor detected image. The variation of these parameters with respect to different images are shown in the next chapter.

RESULTS AND DISCUSSION

Test Image1 and its Analysis:

Step1: Here the MR image is taken as the test image which consists of tumor is shown in figure below

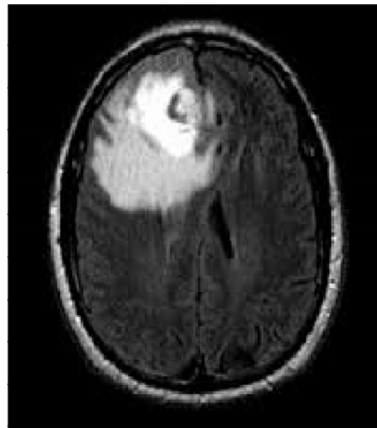


Figure 31: Original Image

Step 2: After performing the filtering operation, the image using the Gaussian filter is shown in figure below

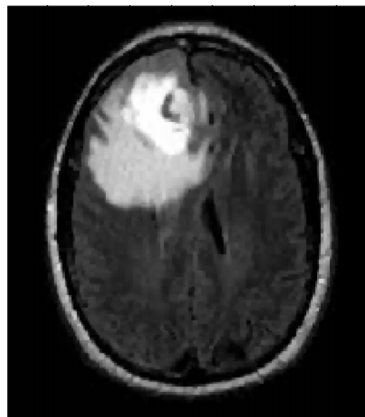


Figure 32: Image after Gaussian filtering

Step 3 : Here in this step Enhancement is done by using the Median Filter which is shown in figure below

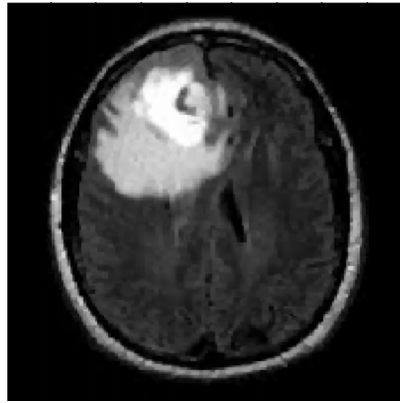


Figure 33: Image after median filtering

Step 4: Here in this we convert the gray image to binary image with a predefined threshold value which is shown in figure below

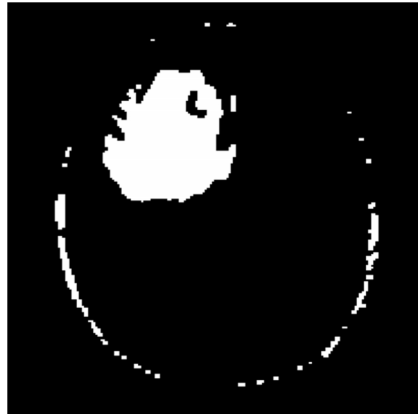


Figure 34: Image after thresholding

Step 5: After getting the threshold image in order to get the tumor and to remove the skin of the brain morphological operations has been used which is shown on figure below.

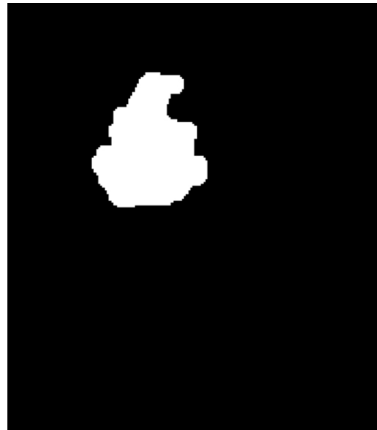


Figure 35: Image after morphological operations

Step 6 : After getting the tumor in the step 5 in order to visualize the tumor exactly the original is combined with the tumor detected image in the step 5 The detected tumor is shown with an arrow as shown in figure.

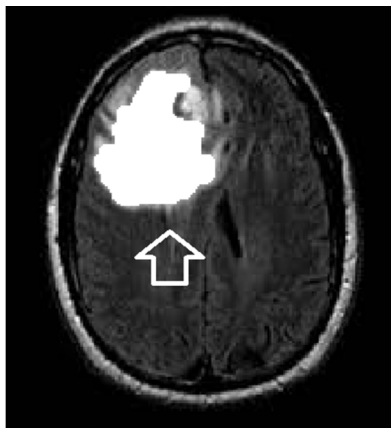


Figure 36: Tumor detected image

Here in order to visualize the image very clear we are just combined the original image in step 1 and the image in step 5. Our next is the analysis of the image which is shown in the table below .

Analysis:

Table no: 1 Analysis of the Image in step1 and the image in step6 and its texture parameters

Original image						Final Image					Improvement factor(%)
Angle	0°	45°	90°	135°	Average	0°	45°	90°	135°	Average	
Contrast	0.3158	0.4154	0.2073	0.4165	0.33875	0.1764	0.2505	0.2073	0.287	0.2303	32.01
Correlation	0.9405	0.922	0.961	0.9218	0.936325	0.9695	0.9569	0.961	0.9507	0.959525	-2.47
Energy	0.2687	0.2579	0.2798	0.2584	0.2662	0.8783	0.8762	0.2798	0.8755	0.72745	-173.2
Homogeneity	0.8999	0.8815	0.9198	0.8833	0.896125	0.9969	0.9955	0.9198	0.9949	0.976775	-8.99

Explanation:

Here in this table by seeing the parameters with different angles the improvement factor for contrast is incremented by 32% it means the visualization of the original image to final image is incremented by 32%.

The second parameter correlation is decremented by 2% with respect to original because in the final image is fused with the tumor detected image (1's) to the original image it means the gray level is faded with the white color hence the co-relation among the pixels were diminished by 2% as the theory explained in chapter 4

The third parameter named energy is diminished by 173% with respect to original image because energy in terms represents the number of repeated pairs in the final image has been increased by seeing the average value .this is because the no of repeated pairs has been increased as explained in chapter 4

The next parameter homogeneity which is it will be large only when the gray levels of each pixel pairs are similar here there are very less gray levels and hence it is decremented by 8% with respect to the original image .

The bar graph for the respected parameters is as shown in the following graph

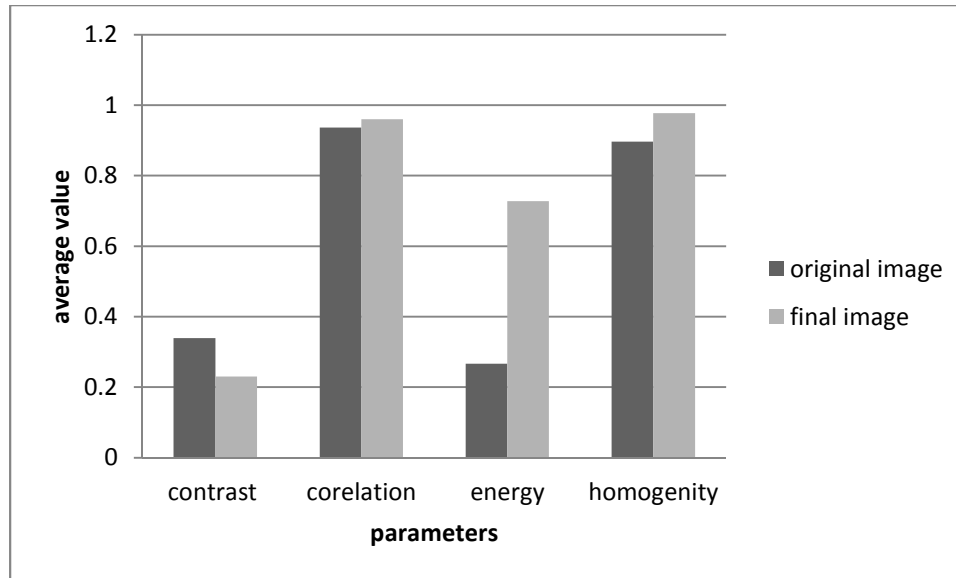


Figure 37: Bar Graph shows the variation of texture parameters from original image to final image

Test Image 2 and its analysis :

Step1: Here the MR image is taken as the test image which consists of tumor is shown in figure below

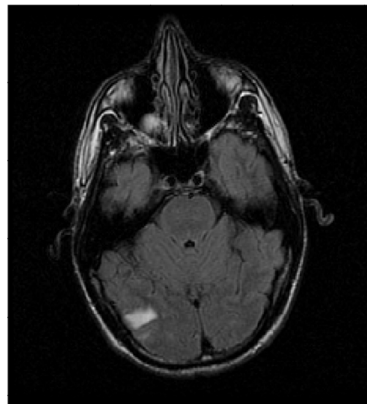


Figure 38: Original Image

Step 2 : Here in this step Enhancement is done by using the Median Filter which is shown in figure below

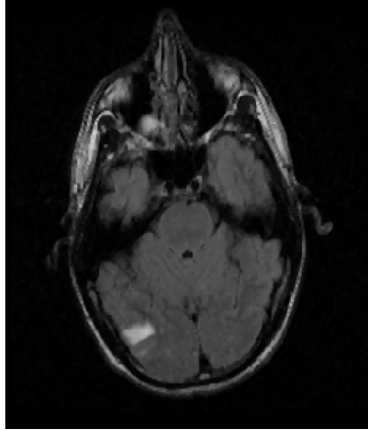


Figure 39: Image after median filtering

Step 3: Here in this we convert the gray image to binary image with a predefined threshold value which is shown in figure below



Figure 40: Image after Thresholding

Step 4: After getting the threshold image in order to get the tumor and to remove the skin of the brain morphological operations has been used which is shown on figure below

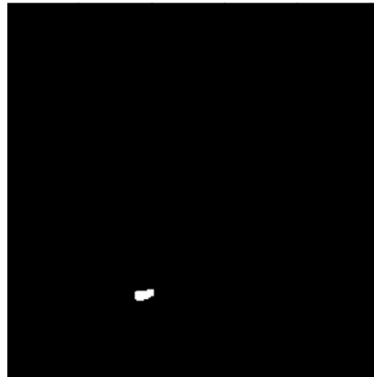


Figure 41: Image after Morphological operations

Step 5 : After getting the tumor in the step 5 in order to visualize the tumor exactly the original is combined with the tumor detected image in the step 5 The detected tumor is shown with an arrow as shown in figure.

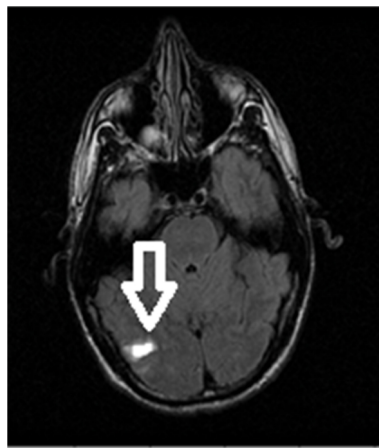


Figure 42: Tumor detected Image

Analysis :

Table no: 2 Analysis of the Image in step1 and the image in step6 and its texture parameters

Original image						Final Image					Improvement factor(%)
Angle	0°	45°	90°	135°	Average	0°	45°	90°	135°	Average	
Contrast	0.2108	0.2681	0.1497	0.2776	0.22655	0.012	0.0226	0.1497	0.0286	0.053225	76.50
Correlation	0.8979	0.8705	0.9275	0.8659	0.89045	0.9011	0.8146	0.9275	0.7651	0.852075	4.309
Energy	0.4288	0.4191	0.4361	0.4191	0.425775	0.9973	0.9971	0.4361	0.9969	0.85685	-101.24
Homogeneity	0.9299	0.9191	0.9411	0.9192	0.927325	0.9998	0.9996	0.9411	0.9995	0.985	-6.219

Explanation :

Here in this table by seeing the parameters with different angles the improvement factor for contrast is incremented by 76% it means the visualization of the original image to final image is incremented by 76%.

The second parameter correlation is increased by 4% with respect to original because in the final image is fused with the tumor detected image (1's) to the original image it means the gray level is faded with the white color hence the co-relation among the pixels were increased by 4% as the theory explained in chapter 4

The third parameter named energy is diminished by 101% with respect to original image because energy in terms represents the number of repeated pairs in the final image has been increased by seeing the average value .this is because the no of repeated pairs has been increased as explained in chapter 4

The next parameter homogeneity which is it will be large only when the gray levels of each pixel pairs are similar here there are very less gray levels and hence it is decremented by 6% with respect to the original image

The bar graph for the respected parameters is as shown in the following graph

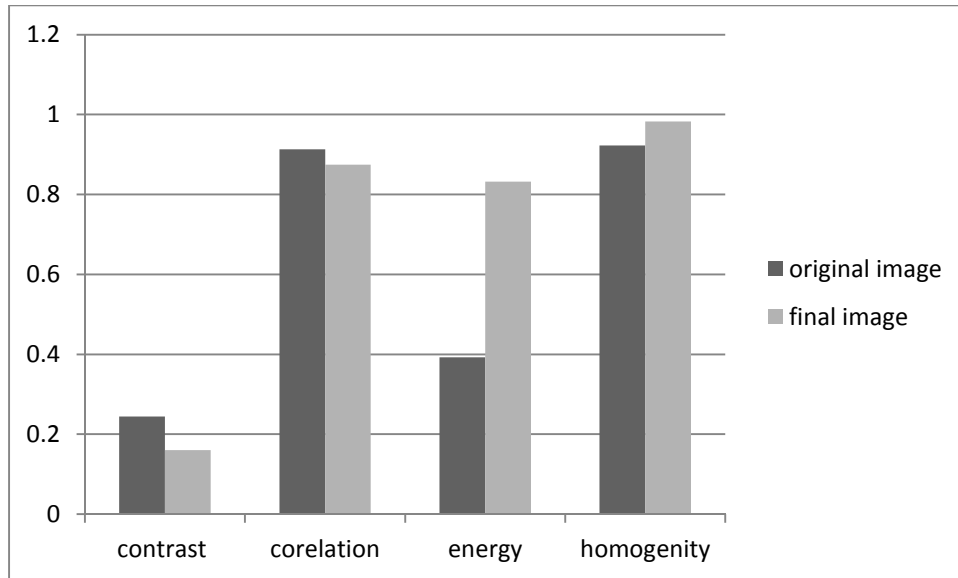


Figure 43: Bar Graph shows the variation of texture parameters from original image to final image

Test Image 3 and Its Analysis

Step1: Here the MR image is taken as the test image which consists of tumor is shown in figure below

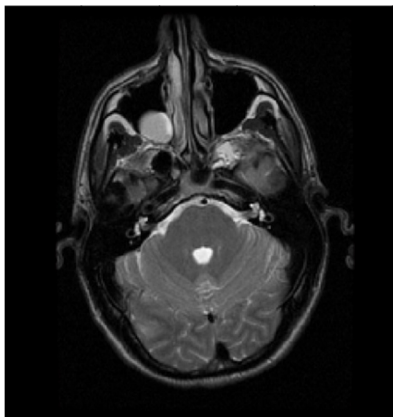


Figure 44 : Original image

Step 2 : Here in this step Enhancement is done by using the Median Filter which is shown in figure below

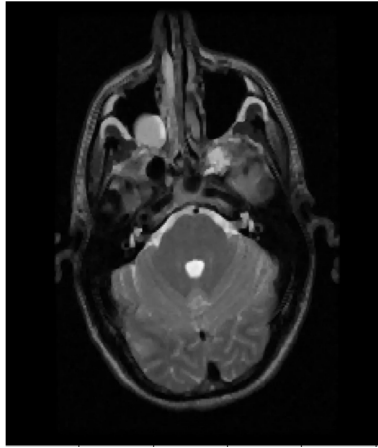


Figure 45: Image after Median Filtering

Step 3: Here in this we convert the gray image to binary image with a predefined threshold value which is shown in figure below



Figure 46: Image after Thresholding

Step 4: After getting the threshold image in order to get the tumor and to remove the skin of the brain morphological operations has been used which is shown on figure below

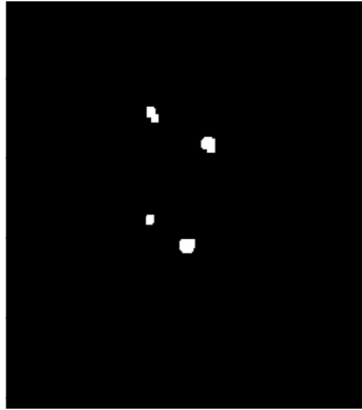


Figure 47: Image after Morphological operations

Step 5 : After getting the tumor in the step 5 in order to visualize the tumor exactly the original is combined with the tumor detected image in the step 5 The detected tumor is shown with an arrow as shown in figure.

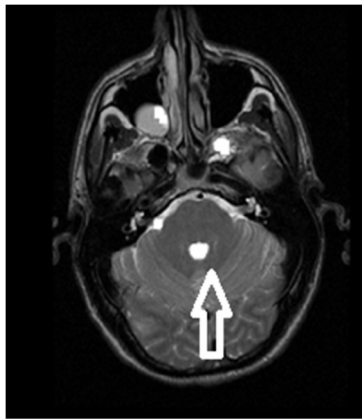


Figure 48: Tumor detected Image

Analysis:

Table no: 3 Analysis of the Image in step1 and the image in step6 and its texture parameters

Original image						Final Image					Improvement factor(%)
Angle	0°	45°	90°	135°	Average	0°	45°	90°	135°	Average	
Contrast	0.2272	0.2972	0.1581	0.2948	0.244325	0.1471	0.208	0.1581	0.1296	0.1607	34.22
Correlation	0.9192	0.8945	0.9437	0.8953	0.913175	0.8751	0.824	0.9437	0.8565	0.874825	4.19
Energy	0.3938	0.3858	0.4036	0.3864	0.3924	0.973	0.9717	0.4036	0.9789	0.8318	-111.97
Homogeneity	0.9235	0.9136	0.9391	0.9136	0.92245	0.9974	0.9963	0.9391	0.9977	0.982625	-6.52

Here in this table by seeing the parameters with different angles the improvement factor for contrast is incremented by 34% it means the visualization of the original image to final image is incremented by 34%.

The second parameter correlation is incremented by 4% with respect to original because in the final image is fused with the tumor detected image (1's) to the original image it means the gray level is faded with the white color hence the co-relation among the pixels were incremented by 4% as the theory explained in chapter 4

The third parameter named energy is diminished by 111% with respect to original image because energy in terms represents the number of repeated pairs in the final image has been increased by seeing the average value .this is because the no of repeated pairs has been increased as explained in chapter 4

The next parameter homogeneity which is it will be large only when the gray levels of each pixel pairs are similar here there are very less gray levels and hence it is decremented by 6% with respect to the original image

The bar graph for the respected parameters is as shown in the following graph

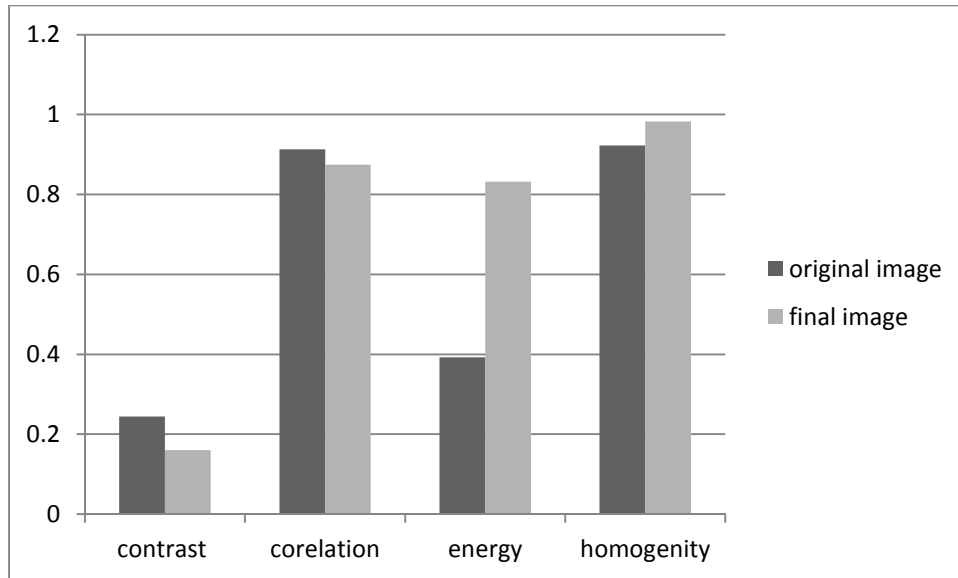


Figure 49: Bar Graph shows the variation of texture parameters from original image to final image

Test Image 4 and its Analysis:

Step1: Here the MR image is taken as the test image which consists of tumor is shown in figure below

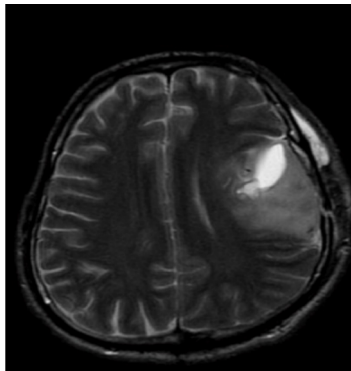


Figure 50: Original Image

Step 2 : Here in this step Enhancement is done by using the Median Filter which is shown in figure below

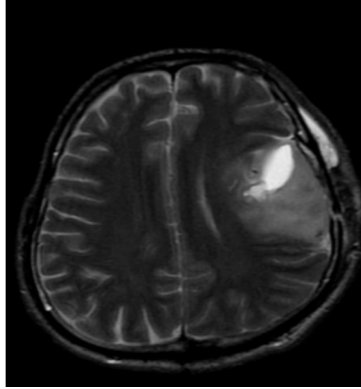


Figure 51: Image after Median Filtering

Step 3: Here in this we convert the gray image to binary image with a predefined threshold value which is shown in figure below

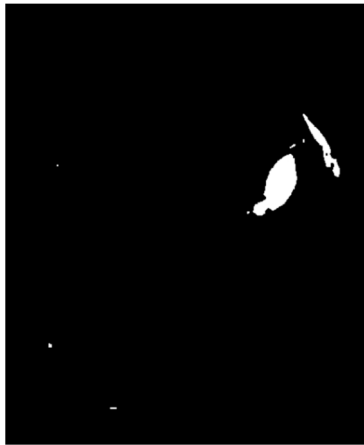


Figure 52: Image after Thresholding

Step 4: After getting the threshold image in order to get the tumor and to remove the skin of the brain morphological operations has been used which is shown on figure below



Figure 53: Image after Morphological Operations

Step 5 : After getting the tumor in the step 5 in order to visualize the tumor exactly the original is combined with the tumor detected image in the step 5 The detected tumor is shown with an arrow as shown in figure.

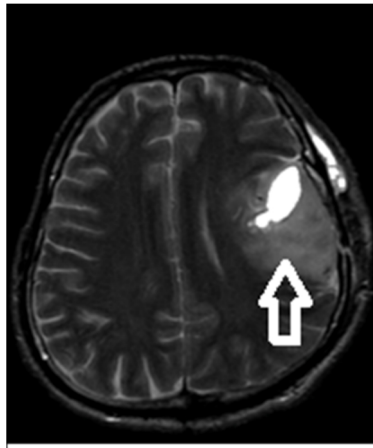


Figure 54: Tumor detected Image

Analysis :

Table no: 4 Analysis of the Image in step1 and the image in step6 and its texture parameters

Angle	Original image					Final Image					Improvement Factor(%)
	0°	45°	90°	135°	Average	0°	45°	90°	135°	Average	
Contrast	0.075	0.0993	0.055	0.0964	0.081425	0.055	0.0628	0.055	0.0674	0.06005	26.25
Correlation	0.9579	0.9443	0.9694	0.9459	0.954375	0.9445	0.9368	0.9694	0.9321	0.9457	0.908
Energy	0.3389	0.3294	0.3429	0.329	0.33505	0.9786	0.9784	0.3429	0.9784	0.819575	-144.61
Homogeneity	0.9689	0.9581	0.9727	0.9588	0.964625	0.999	0.9989	0.9727	0.9988	0.99235	-2.874

Explanation:

Here in this table by seeing the parameters with different angles the improvement factor for contrast is incremented by 26% it means the visualization of the original image to final image is incremented by 26%.

The second parameter correlation is incremented by 1% with respect to original because in the final image is fused with the the tumor detected image (1's) to the original image it means the graylevel is faded with the white color hence the co-relation among the pixels are increased by 1% as the theory explained in chapter 4

The third parameter named energy is diminished by 144% with respect to original image because energy in terms represents the number of repeated pairs in the final image has been increased by seeing the average value .this is because the no of repeated pairs has been increased as explained in chapter 4

The next parameter homogeneity which is it will be large only when the gray levels of each pixel pairs are similar here there are very less gray levels and hence it is decremented by 2% with respect to the original image

The bar graph for the respected parameters is as shown in the following graph

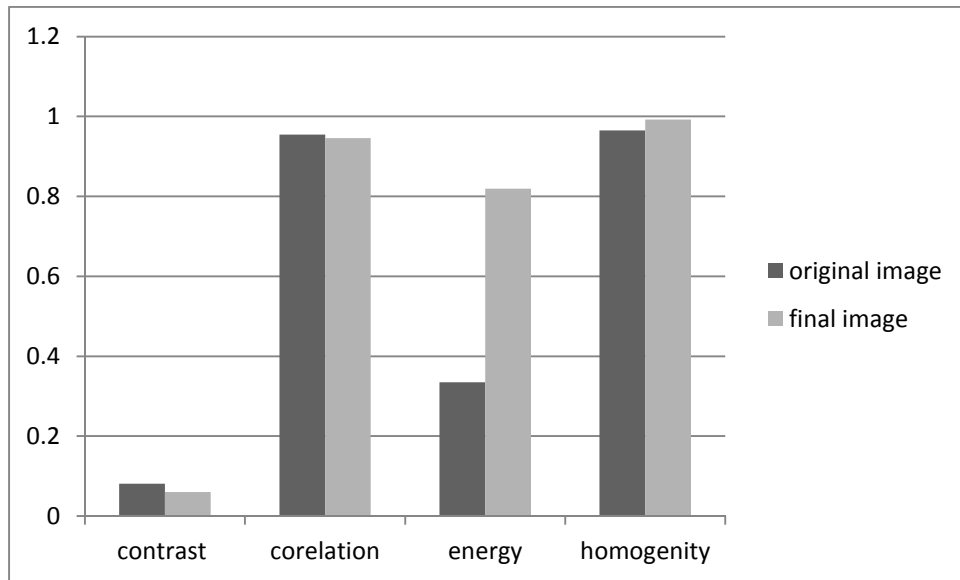


Figure 55: Bar Graph shows the variation of texture parameters from original image to final image

Test Image 5 and Its Analysis

Step1: Here the MR image is taken as the test image which consists of tumor is shown in figure below

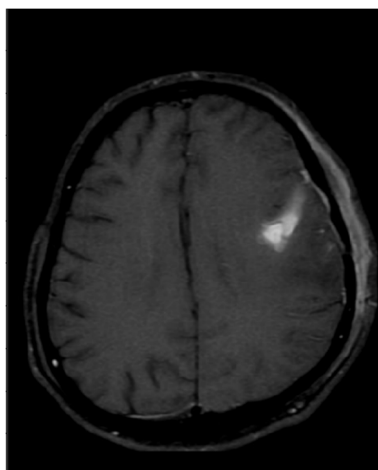


Figure 56: Original Image

Step 2 : Here in this step Enhancement is done by using the Median Filter which is shown in figure below

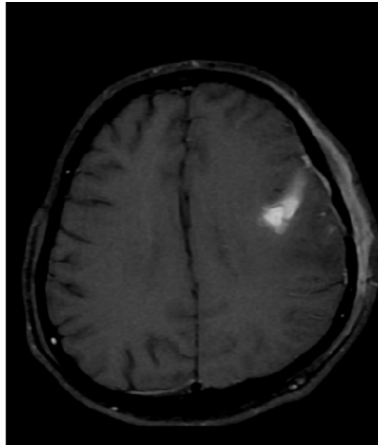


Figure 57: Image after Median Filtering

Step 3: Here in this we convert the gray image to binary image with a predefined threshold value which is shown in figure below

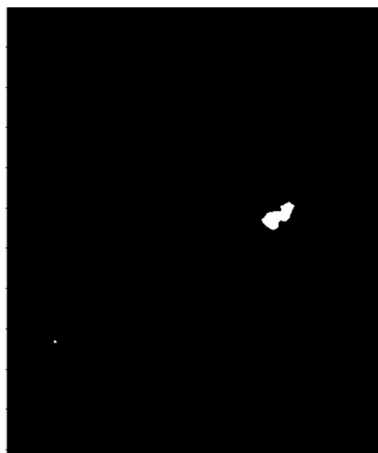


Figure 58: Image after Thresholding

Step 4: After getting the threshold image in order to get the tumor and to remove the skin of the brain morphological operations has been used which is shown on figure below



Figure 59: Image after Morphological Operations

Step 5 : After getting the tumor in the step 5 in order to visualize the tumor exactly the original is combined with the tumor detected image in the step 5 The detected tumor is shown with an arrow as shown in figure.

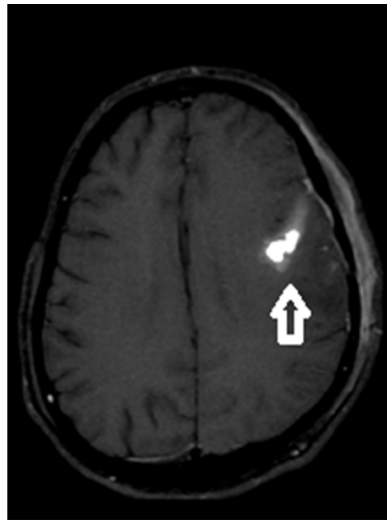


Figure 60: Tumor detected Image

Analysis:

Table no: 5 Analysis of the Image in step1 and the image in step6 and its texture parameters

Original image						Final Image					Improvement factor(%)
Angle	0°	45°	90°	135°	Average	0°	45°	90°	135°	Average	
Contrast	0.1592	0.1779	0.0404	0.1751	0.13815	0.0139	0.0159	0.0404	0.023	0.0233	83.13
Correlation	0.9036	0.8921	0.9765	0.8939	0.916525	0.9448	0.9369	0.9765	0.9086	0.9417	-2.74
Energy	0.352	0.3431	0.3533	0.3436	0.348	0.9946	0.9945	0.3533	0.9944	0.7808	-124.36
Homogeneity	0.9764	0.9675	0.3534	0.9686	0.816475	0.9998	0.9997	0.9799	0.9996	0.99475	-21.83

Explanation:

Here in this table by seeing the parameters with different angles the improvement factor for contrast is incremented by 83% it means the visualization of the original image to final image is incremented by 83%.

The second parameter correlation is decremented by 2% with respect to original because in the final image is fused with the tumor detected image (1's) to the original image it means the gray level is faded with the white color hence the co-relation among the pixels were diminished by 2% as the theory explained in chapter 4

The third parameter named energy is diminished by 124% with respect to original image because energy in terms represents the number of repeated pairs in the final image has been increased by seeing the average value .this is because the no of repeated pairs has been increased as explained in chapter 4

The next parameter homogeneity which is it will be large only when the gray levels of each pixel pairs are similar here there are very less gray levels and hence it is decremented by 21% with respect to the original image

The bar graph for the respected parameters is as shown in the following graph

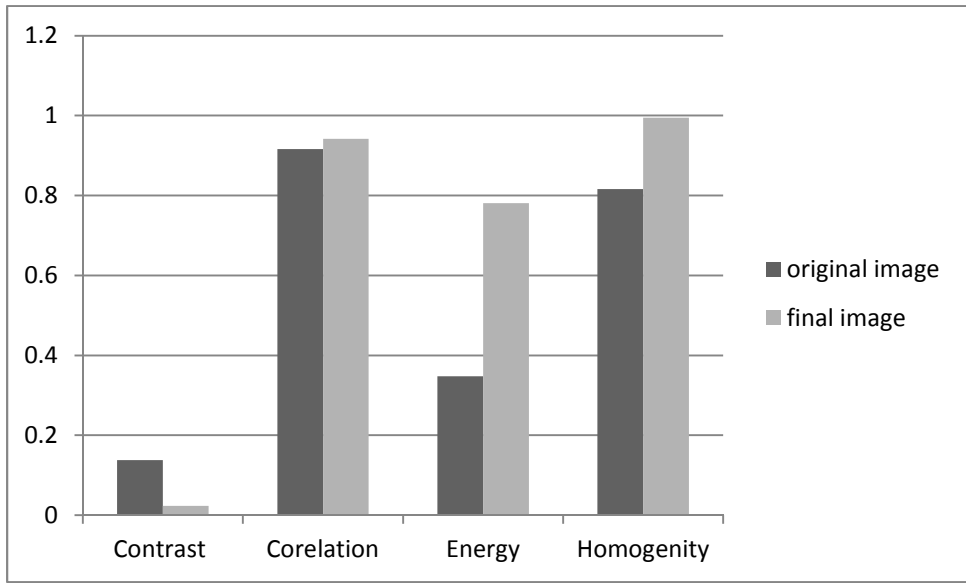


Figure 61: Bar Graph shows the variation of texture parameters from original image to final image

Hence we can say that the result of these test images are good where the tumor detected images are shown in the arrow,, the texture parameters like contrast is incremented in every image for the visualization of tumor whereas the remaining parameters correlation is varied in the range of +/- 4% whereas the energy is always incremented in the final image and the homogeneity is also incremented in the final image. These parameters plays an important role for the image classification

CONCLUSION & FUTURE SCOPE

6.1 CONCLUSION

In this work, imaging is one of the important and essential aspects in the medical field. To analyze and diagnose any part of the human body one depends up on the machines such as CT scan, MRI scan, X-rays etc. which produces images.

In this work, we proposed an efficient and simple algorithm for the detection of brain tumor and analyzed the texture parameters for the normal MRI image and the tumor detected MRI image. This algorithm reduces the steps of the previously proposed algorithms for the brain tumor detection, gives good results for tumor detection. The analysis of texture parameters like contrast is increased in final tumor detected image for the proper visualization of tumor and the other parameters like correlation, homogeneity and energy are also improved, these parameters are useful for the Image classification.

6.2 FUTURE SCOPE

In future the work may be done

1. The tumors may be classified based up on the tumor grade
2. Some image classification techniques may be applied to determine whether the tumor is benign or malignant

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