CHAPTER 6

6.1 GENERAL DESCRIPTION

A brain cancer is a disease in which cells grow uncontrollably in the brain. Brain tumors are of two main types:

a. **Benign tumors** are incapable of spreading beyond the brain itself. Benign tumors in the brain usually do not need to be treated and their growth is self-limited. Sometimes they can cause problems because of their location and surgery or radiation can be helpful.

b. **Malignant tumors** are typically called brain cancer. These tumors can spread outside of the brain. Malignant tumors of the brain will always develop into a problem if left untreated and an aggressive approach is almost always warranted. Brain malignancies can be divided into two categories:

c. **Primary brain cancer** originates in the brain.

d. **Secondary or metastatic brain cancer** spreads to the brain from another site in the body

Cancer occurs when cells in the body (in this case brain cells) divide without control or order. Normally, cells divide in a regulated manner. If cells keep dividing uncontrollably when new cells are not needed, a mass of tissue forms, called a growth or tumor. The term cancer usually refers to **malignant tumors**, which can invade nearby tissues and can spread to other parts of the body. A **benign tumor** does not spread.

Figure 6.1 shows the cut section of brain & brain tumor.

![Fig. 6.1 Cut section of brain showing tumor](image-url)
Causes

The cause of primary brain cancer is unknown. The causes of secondary brain cancers are those that caused the malignancy at the site of origin (e.g., lung or breast).

Risk Factors

A risk factor is something that increases your chance of getting a disease or condition.

Risk factors for primary brain cancer include:

- Radiation
- Immune system dysfunction
- Family history of rare types of cancer

Risk factors for metastatic brain cancer include:

Any cancer throughout the body can ultimately spread to the brain. The following is a list of the most common tumors that may spread to the brain at some point:

- Lung cancer
- Breast cancer
- Malignant melanomas
- Gastrointestinal tract cancer
- Genital or urinary tract cancer

Tests may include:

**fMRI Scan** – a test that uses magnetic waves to make pictures of structures inside the body.

**CT Scan** – a type of x-ray that uses a computer to make pictures of structures inside the body.

**PET Scan** – a test that detects the level of metabolic activity in the brain and other organs by tracking a radioactive sugar molecule that is injected into the bloodstream. Pet scans are not approved to look at primary brain tumors, but can be very helpful if the doctor is trying to determine if symptoms are related to a growing tumor or injury from treatment (surgery or radiation) [1].
Arteriography – a test that uses x-rays to make pictures of the vasculature in the brain after injection of contrast material into an artery.

Biopsy – removal of a sample of brain tissue to test for cancer cells.

Stereotaxis – use of a computer-assisted CT or fMRI scan to locate the tumor and take a biopsy. The doctor drills a small hole in the skull, inserts a needle and withdraws the sample tissue.

6.2 TYPES OF BRAIN CANCERS

♦ Acoustic neurinoma – Benign tumor occurring in the 8th cranial nerve (the acoustic nerve) between the pons and the cerebellum. Possibly associated with neurofibromatosis.

♦ Astrocytoma – Tumor arising from astrocyte cells, which form part of the brain's supportive (neuroglial) tissue. See also Glioblastoma Multiforme.

> Figure 6.6 shows the anatomy of the brain.

![Brain Anatomy](image)

**Fig. 6.2 Anatomy of the Brain**

♦ Ependymoma – Tumor arising from the ependymal cells found along the ventricles and central canal of the spinal cord.

♦ Glioblastoma Multiforme – Grade IV astrocytoma able to spread widely throughout the brain and marked by areas of necrosis (dead tumor cells). Approximately 65% of all primary brain tumors are glioblastoma multiforme [2].
♦ **Meningioma** – Benign tumor arising from the meninges, the membranes covering the brain and spinal cord. Meningiomas represent approximately 60% of all primary brain tumors and occur most commonly in middle-aged women.

♦ **Metastatic Tumor** – Tumor formed by cancer cells that spread (metastasize) to the brain from elsewhere in the body. They can appear anywhere in the brain or spine.

♦ **Mixed Glioma** – Tumor containing astrocytic and neuronal elements as well as oligodendroglial cells. Mixed gliomas confuse many neuropathologists who diagnose them as astrocytomas, oligodendrogliomas or even "ganglioglioneurocytomas."

♦ **Oligodendroglioma** – Tumor arising from oligodendrocytes, a type of supportive brain tissue. They occur most frequently in young and middle-aged adults. Tumors often contain both oligodendrocytes and astrocytes. These mixed gliomas are much more common than pure oligodendrogliomas.

♦ **Pineal Region Tumor** – Tumor occurring in the area of the pineal gland. Germinomas, teratomas, pineocytomas, pineoblastomas, mixed tumors and astrocytomas can occur in the pineal region. Pineal tumors represent fewer than 1% of all primary brain tumors and 3-8% of childhood brain tumors.

### 6.3 BRAIN CANCER CHARACTERISTICS

**Glial cell tumors or Gliomas**

There are two types of cells that make up the nervous system: neurons and neuroglia. Neurons send and receive nerve messages. Neuroglia, otherwise known as glial cells, often surround the neurons. Glial cells play a supportive role by nourishing, protecting and supporting neurons. There are six kinds of glial cells: oligodendrocytes, astrocytes, ependymal cells, Schwann cells, microglia, and satellite cells [3].

A brain tumor that develops from glial cells is called a glioma. About half of all primary brain tumors and one-fifth of all primary spinal cord tumors form from glial cells. Gliomas tend to grow in the cerebral hemispheres, but may also occur in the brain stem, optic nerves, spinal cord, and cerebellum. Gliomas are divided into subgroups depending on the origin of the glial cells. The most common type of glioma is an astrocytoma.
Astrocytoma

An astrocytoma develops from star-shaped glial cells (astrocytes) that support nerve cells. These tumors can be located anywhere in the brain, but the most common location is in the frontal lobe. Astrocytomas are the most common primary CNS tumor.

The physician, usually the neurosurgeon or neuro-oncologist, will discuss the type and location of an astrocytoma. The pathologist will assign it a grade. Astrocytomas are generally classified as low or high grade. Low-grade astrocytomas are slow growing. High-grade astrocytomas (grades three and four) grow more quickly. The main tumor type is listed for each grade. There are additional tumor types in each of these grades [4].

The WHO classification divides astrocytomas into four grades:

- Grade I, Pilocytic Astrocytoma
- Grade II, Low-Grade Astrocytoma
- Grade III, Anaplastic Astrocytoma
- Grade IV, Glioblastoma Multiforme (GBM or Glioblastoma).

Characteristics

The characteristics of an astrocytoma vary depending on the tumor’s grade and location. Most people are functioning normally when diagnosed with a low-grade astrocytoma. Symptoms tend to be subtle and may take one to two years to diagnose. This is because the brain can often adapt to a slow-growing tumor for a period of time. High-grade tumors may present with changes that are sudden and dramatic.

Types of Astrocytomas:
Pilocytic Astrocytoma, Low Grade Astrocytoma, Anaplastic (High Grade) Astrocytoma, and Glioblastoma Multiforme (GBM).

Pilocytic Astrocytoma (Grade I)

This tumor is also known as a juvenile pilocytic astrocytoma, or by the initials JPA.

Characteristics

- Slow growing, with relatively well-defined borders
• Grows in the cerebrum, optic nerve pathways, brain stem and cerebellum
• Occurs most often in children and teens
• Accounts for two percent of all brain tumors

**Treatment**

Surgery is the standard treatment. If the tumor cannot be completely resected, radiation or chemotherapy may be given. Chemotherapy may be given to very young children instead of radiation therapy to avoid damage to the developing brain. Some of these tumors can progress to a higher grade, so it is important to be diligent about following up with the medical team after treatment [5].

**Low-Grade Astrocytoma (Grade II)**

**Characteristics**

• Slow growing
• Rarely spreads to other parts of the CNS
• Borders not well defined
• Common among men and women in their 60s-50s

**Treatment**

Treatment depends on the size and location of the tumor. The doctor will most likely perform a biopsy or surgery to remove the tumor. Partial resections or inoperable tumors may be treated with radiation. Recurring tumors may require additional surgery, radiation and/or chemotherapy.

**Anaplastic Astrocytoma (Grade III)**

**Characteristics**

• Grows faster and more aggressively than grade II astrocytomas
• Tumor cells are not uniform in appearance
• Invades neighboring tissue
• Common among men and women in their 30s-50s
• More common in men than women
• Accounts for four percent of all brain tumors
Treatment

Treatment depends on the location of the tumor and how far it has progressed. Surgery and radiation therapy, with chemotherapy during or following radiation, are the standard treatments. If surgery is not an option, then the doctor may recommend radiation and/or chemotherapy. Many clinical trials (experimental treatments) using radiation, chemotherapy, or a combination are available for initial and recurrent anaplastic astrocytomas [5,6].

Glioblastoma Multiforme (GBM) (Grade IV)

Characteristics

- Most invasive type of glial tumor
- Commonly spreads to nearby tissue
- Grows rapidly
- May be composed of several different kinds of cells (i.e., astrocytes, oligodendrocytes)
- May have evolved from a low-grade astrocytoma or an oligodendroglioma.
- Common among men and women in their 50s-70s
- More common in men than women
- Accounts for 63 percent of all primary brain tumors

Treatment

Standard treatment is surgery followed by radiation therapy. If surgery is not an option, the doctor may administer radiation therapy. Chemotherapy is sometimes given during or after radiation therapy or if the tumor recurs. Many clinical trials (experimental treatments) using radiation, chemotherapy, or a combination are available for initial and recurrent GBM.

The astrocytoma is derived from a normal supporting cell in the brain called the astrocyte. In a patient with one of these tumors, the cells in the astrocytoma tumor are no longer normal; and the degree of this abnormality is used to determine the tumor's grade. The tumor's grade determines the prognosis of the tumor. Astrocytomas are graded from 1 to 4, with grade 1 being the slowest growing and grade 4 being the most rapidly growing and malignant lesions. The following descriptions refer to the appearance of the tumor under the pathologist's microscope [7].
**Grade 1:** In these tumors astrocytic tumor cells are usually normal in appearance except that there are more of them than normally seen in microscopic examinations of brain tissue. Usually grade 1 astrocytomas produce epileptic seizures as their only symptom since their presence is irritating to surrounding brain tissue. They can also become quite large since they are well tolerated by the brain. However, when the mass effect of the tumor and the mass of the brain combine within the non-yielding skull cavity; a rise in pressure inside the skull results. The prognosis for grade 1 astrocytomas is generally good. Sometimes surgery to reduce mass effect is required, however. Patients with grade 1 astrocytomas have been known to live 30 years or more following diagnosis. Radiation therapy is probably not appropriate in these tumors.

The CT and fMRI appearance of these lesions is shown in Figure 6.3.

![CT and fMRI images](image)

*Fig. 6.3 a, b: Representation of Lesions*

Pilocytic astrocytomas: These benign astrocytomas tend to occur in children and young adults, are histologically circumscribed. Despite the fact that many are located in the thalamus and other important sub cortical locations, they can be completely resected by computer assisted stereotactic technique with excellent postoperative results. These lesions exhibit prominent enhancement on CT or on MR imaging with gadolinium (as shown in Figures 6.4 a and b). The histologic borders are usually defined accurately by the contrast enhancement [8].

![CT and fMRI images with gadolinium enhancement](image)

*Fig. 6.4 a, b: Contrast Enhancement*

**Grade 6:** In grade 6 tumors, tumor cells are slightly abnormal in appearance as well as increased in number. The variation in appearance of these cells is referred to as pleomorphism. There should be no mitotic figures (indications that the cells are dividing) and no necrosis (dead tissue).
In general, these tumors are made up of isolated tumor cells within functioning brain tissue. On imaging studies these lesions show hypo density on CT and prolongation of T1 and T6 on fMRI as shown in Figures 6.5. They only very rarely exhibit contrast enhancement.

Removal of the tumor is, in fact, removal of this "sick" brain tissue. These tumors are, therefore, usually biopsied only; unless they are located in unimportant brain tissue- in which case they can be removed (as in the case shown in Figure 6.5). In addition, these lesions (tumors) rarely produce paralysis.

There remains some debate on the place for radiation therapy and chemotherapy in these tumors. However, recent studies have shown that 5 year survival in grade 6 astrocytomas without treatment is about 34%; and with treatment (radiation therapy): about 70%. Therefore most centers recommend radiation therapy after a grade 6 astrocytoma is diagnosed by biopsy or some other surgical procedure [8,9].

**Grade 3:** These and Grade 4 astrocytomas are frequently referred to as malignant astrocytomas. They exhibit contrast enhancement on imaging studies. Frequently, the contrast enhancing mass is surrounded by a zone of hypo density on CT and prolonged T1 and T6 on fMRI as shown in Figure 6.6. This zone is frequently called "edema" and it is edematous brain parenchyma infiltrated by isolated tumor cells.

**Fig. 6.5 a, b, c :** T1 and T6 Representation

**Fig. 6.6 a, b, c :** Edematous Brain Parenchyma Infiltrated by Isolated Tumor Cells
In another classification scheme these are referred to as anaplastic astrocytomas. In grade 3 tumors, cells are not only abnormal in appearance but some show evidence of mitosis. Mitosis is the cellular process by which cells divide; where one cell becomes two. Mitoses are apparent to the pathologist as the surgical specimen is reviewed under the microscope.

When the tumor tissue is formed in important brain areas, neurological deficits corresponding to that area result because the brain tissue in that area is destroyed by the evolving tumor tissue mass. For example, a grade 3 astrocytoma forming in the central area of the brain, with formation of solid tumor tissue in the motor area will produce weakness and paralysis on the opposite side of the patient's body.

Treatment for grade 3 astrocytomas involves establishing the diagnosis by surgery or stereotactic biopsy and follow-up with radiation therapy and chemotherapy. The average survival of patients with grade 3 astrocytomas is 18 months with treatment [10].

Grade 4: Grade 4 astrocytomas (frequently referred to as glioblastomas or glioblastoma multiforme) are the most malignant variety of these tumors. They are made up of cells which infiltrate brain tissue with a region (and in some cases regions) of solid tumor tissue within the zone of infiltrated brain tissue. Mitoses are frequently noted by the pathologist as the surgical specimen is examined. In addition, regions of necrosis (dead tissue) are also noted—where the tumor has grown so fast that parts of it has outpaced its blood supply. These tumors induce the formation of new but abnormal blood vessels which when identified are also important in establishing the diagnosis. The CT and fMRI demonstrate a contrast enhancing mass with a hypodense center (which corresponds to necrosis) surrounded by a zone of hypodensity on CT and prolonged T1 and T6 on fMRI which corresponds to infiltrated parenchyma as shown in Figure 6.7.

![Fig. 6.7 a, b, c – Infiltrated Parenchyma](CT) ![fMRI) ![fMRI)
The grade 4 astrocytoma has the worst prognosis of all: 17 weeks average (mean) survival after diagnosis without treatment; 30 weeks average survival with biopsy followed by radiation therapy; 37 weeks average survival following surgical removal of most of the tumor tissue component of the tumor and radiation therapy and 51 weeks average survival following stereotactic volumetric resection of the tumor tissue component and radiation therapy. The prognosis for any patient with a malignant astrocytoma (grade 3 or 4) is also very dependent upon age (older people do not live as long as young patients) and performance status (patients who are neurologically normal and independent live longer than patients who have a neurological deficit). Chemotherapy has been shown to add several weeks on to the survival. Radiation implants (brachytherapy) have also been shown to increase survival but more than half of these patients require another operation to remove dead tissue resulting from the radiation.

6.4 BRAIN CANCER FACTS

Brain cancer is a complex disease, classified into 160 different types. So-called non-malignant (benign) brain tumors can be just as life-threatening as malignant tumors, as they squeeze out normal brain tissue and disrupt function. The glioma family of tumors comprises 44.4% of all brain tumors. Glioblastoma is the most common glioma at 51.9%, followed by astrocytoma at 61.6%. Brain tumors are the leading cause cancer death in children under the age of 60. They are the second leading cause of cancer death among 60-69 year old males. Metastatic brain tumors result from cancer that spreads from other parts of the body into the brain. About 10-15% of people with cancer will eventually develop metastatic brain tumors [11].

The five-year survival rate following diagnosis of a primary malignant brain tumor is about 36.7%.

6.5 BRAIN CANCER CLASSIFICATION TECHNIQUE

For the recognition of given query sample five invariant features are evaluated.

For the evaluation of these features, the image is processed through:

1) Histogram Equalization
2) Binarization
3) Morphological Operations
4) Region Isolation
5) Feature Extraction

The above stated methods are used for both query images & the database images.

6.6 THE BRAIN CANCER DATABASE

The above mentioned process is applied on a clustered database consisting of 60 distinct fMRI images categorized into 4 classes.

The database classes are:

**Class I –**

![Class I images](image_url)
Class II –

Class III –
Class IV –
6.7 BRAIN CANCER RECOGNITION METHOD

Biological Early Brain Cancer Detection is fundamentally been classified into 6 major parts [12]:

1) Histogram Equalization
2) Binarization
3) Morphological Operations
4) Region Isolation
5) Feature Extraction
6) Classification

1) Histogram Equalization

The given fMRI is equalized using histogram. The Histogram of an image represents the relative frequency of occurrences of pixel in a given image. The non-uniform varying image due to external conditions is equalized to a uniform variation.

2) Binarization

For the equalized image the pixels are represented in a 0 to 655 gray level intensity. As the process is to extract the affected region or the accumulated region, a 6-level image representation would be sufficient for better computation.

3) Morphological Operations

This is used as a image processing tools for sharpening the regions and filling the gaps for binarized image. The dilation operator is used for filling the broken gaps at the edges and to have continuities at the boundaries. A structuring element of 3x3 square matrix is used to perform dilation operation.

4) Region Extraction

Onto the dilated image a filling operator is applied to fill the close contours. To filled image, centroids are calculated to localize the regions as shown beside. The final extracted region is then logically operated for extraction of Massive region in given fMRI image.
5) Feature Extraction

To the extracted region the feature extraction process is applied for the calculation of 5 invariant features.

1) Area
2) Homogeneity
3) Contrast
4) ASM (Angular second moment)
5) Entropy

The above mentioned process is applied on a clustered database consisting of 60 distinct fMRI images categorized into 4 classes.

6) Classification

For the automated recognition of tumor cell in given fMRI image a neuro-classifier is realized. The classifier module implements a hybrid algorithm integrating neural network using BSS. BSS based neural approach found to have more accurate decision making as compare to their counterparts. The obtained features are processed using BSS based Neuro-classifier before passing it to neural network.
6.8 EARLY TUMOR DETECTION SYSTEM

Fig 6.8 Block Diagram of the Implemented Design
6.8.1 Image Preprocessing

Image preprocessing consists mainly of two steps. Image segmentation to isolate the brain tumor from the given fMRI sample and image enhancement to increase the contrast between the whole brain and the tumor.

6.8.2 Image Segmentation

The first step is to segment the fMRI image. Segmentation subdivides an image into its constituent parts or objects. The level to which this subdivision is carried depends on the problem being solved, that is, the segmentation should stop when the edge of the tumor is able to be detected, i.e. the main interest is to isolate the tumor from its background [13].

The main problem in the edge detection process is that the tumor appears very dark on the fMRI image which is very confusing in the edge detection process. To overcome this problem, two steps were performed. First, histogram equalization has been applied to the image to enhance the gray level near the edge. Second, Thresholding the equalized image in order to obtain a binarized image with gray level 1 representing the tumor and gray level 0 representing the background.

6.8.3 Histogram Equalization

The histogram of an image represents the relative frequency of occurrences of the various gray levels in the image. Histogram modeling techniques (e.g. histogram equalization) provide a sophisticated method for modifying the dynamic range and contrast of an image by altering that image such that its intensity histogram has a desired shape. Unlike contrast stretching, histogram modeling operators may employ non-linear and non-monotonic transfer functions to map between pixel intensity values in the input and output images. Histogram equalization employs a monotonic, non-linear mapping which re-assign the intensity values of pixels in the input image such that the output image contains a uniform distribution of intensities.
6.8.4 Thresholding

In many vision applications, it is useful to be able to separate out the regions of the image corresponding to objects in which we are interested, from the regions of the image that correspond to background. Thresholding often provides an easy and convenient way to perform this segmentation on the basis of the different intensities or colors in the foreground and background regions of an image. Black pixels correspond to background and white pixels correspond to foreground. In simple implementations, the segmentation is determined by a single parameter known as the intensity threshold. In a single pass, each pixel in the image is compared with this threshold. If the pixel’s intensity is higher than the threshold, the pixel is set to white, in the output. If it is less than the threshold, it is set to black. Segmentation is accomplished by scanning the whole image pixel by pixel and labeling each pixel as object or background according to its binarized gray level [20,21,22].

6.8.5 Image Enhancement

The fundamental enhancement needed in fMRI is an increase in contrast. Contrast between the brain and the tumor region may be present on a fMRI but below the threshold of human perception. Thus, to enhance contrast between the normal brain and tumor region, a sharpening filter is applied to the digitized fMRI resulting in noticeable enhancement in image contrast.

6.8.6 Sharpening Filter

Sharpening filters work by increasing contrast at edges to highlight fine detail or enhance detail that has been blurred. It seeks to emphasize changes. The most common sharpening filter uses a neighborhood of 3*3 pixels. For each output pixel it computes the weighted sum of the corresponding input pixel and its eight surrounding pixels. The weights are positive for the central pixel and negative for the surrounding pixels. By arranging the weights so that their sum is equal to one, the overall brightness of the image is unaffected. Weights can be adjusted as follows:

\[
\begin{pmatrix}
-1 & -1 & -1 \\
-1 & 0 & -1 \\
-1 & -1 & -1
\end{pmatrix}
\]
6.8.7 Dilation

For the text region extraction, we use morphological operators and the logical operator to further remove the non-text regions. In text regions, vertical edges, horizontal edges and diagonal edges are mingled together while they are distributed separately in non-text regions. Since text regions are composed of vertical edges, horizontal edges and diagonal edges, text regions can be determined to be the regions where those three kinds of edges are intermixed. Text edges are generally short and connected with each other in different orientation. Morphological dilation operator is used to connect isolated candidate text edges in each detail component sub-band of the binary image.

6.8.8 Feature Extraction

The feature extraction extracts the features of importance for image recognition. The feature extracted gives the property of the text character, which can be used for training in the database. The obtained trained feature is compared with the test sample feature obtained and classified as one of the extracted character.

Texture features or more precisely, Gray Level Co-occurrence Matrix (GLCM) features are used to distinguish between normal and abnormal brain tumors. Five co-occurrence matrices are constructed in four spatial orientations horizontal, right diagonal, vertical and left diagonal (0°, 45°, 90°, and 135°). A fifth matrix is constructed as the mean of the preceding four matrices [20].

6.8.9 Texture Features (Gray Level Co-Occurrence Matrix Features)

From each co-occurrence matrix, a set of five-features are extracted in different orientations for the training of the neural model.

6.8.10 Feature Selection

Feature selection concerns the reduction of the dimensionality of the pattern space and the identification of features that contain most of the essential information needed for discriminating between normal and abnormal cases. Selection of efficient features can reduce significantly the difficulty of the classifier design. Therefore feature selection based on the
correlation coefficient between features is performed. The correlation matrix was calculated for the set of 9 texture features for both normal and abnormal spaces.

Any two features with correlation coefficient that exceeds 0.9 in both spaces can be combined together and thought as one feature reducing the dimensionality of the feature space by one. Therefore the maximum probability and contrast can be removed and the numbers of features are reduced to seven features.

**6.9 IMPLEMENTATION**

**GENERAL IMPLEMENTATION**

For the implementation of the proposed design following functions are realized:

1. **TOP:** The first user interface module for interfacing user data to the implemented design.
   - Function UICONTROL is used to create user interface control.
2. **CALLBACK:** Predefined operator used to call the function for simulation and return the result.
3. **GUI:** Gui is 6th user interface file for reading input and passing to processing unit for further process.
4. **TEST:** Function used for reading input image from the work space & performing feature extraction & locating the region.
   - Uigetfile(user interface get file)
5. **GUI6:** The next user interface function used to create interface for processing brain fMRI and extracting the features.
6. **Q_TEST:** Implements Early Brain Cancer Detection system.
7. **BINARIZATION:** This function is used for representing the image into 6-level.
8. **THSRHLD:** For the binarization of equalized image a thresholding method is used.
9. **DEG0, DEG45, DEG90, DEG 135:** Five co-occurrence matrices are constructed in four spatial orientations horizontal, right diagonal, vertical and left diagonal (0°, 45°, 90°, and 135°). A fifth matrix is constructed as the mean of the preceding four matrices.
10. **FEATURE 0, FEATURE 45, FEATURE 90, FEATURE 135:** These functions takes the image data as input and extracts the five features such as angular Second Moment, Contrast, Entropy, Inverse difference moment, and dissimilarity at different degrees.

**10.CLASSIFY:** This
function is used for classifying the given fMRI image after feature extraction into appropriate class of tumor.

10. **GUI3**: The user interface function used to perform different morphological operations & extracting the region of tumor from the given fMRI image.

11. **RD**: This function is used for reading query image.

12. **LR**: This function is used for locating the region of interest & extracting the tumor region from the given fMRI image.

### 6.10 CONCLUSIONS

This thesis presents an automated recognition system for the fMRI image using the BSS based Neural logic. Texture features are used in the training of the neural model implementing wavelet packet method. Co-occurrence matrices at different directions are calculated and Grey Level Co-occurrence Matrix (GLCM) features are extracted from the matrices. It is observed that the system resulted in better classification during the recognition process. The considerable iteration time and the accuracy level is found to be about 50-60% improved in recognition compared to the existing prediction methods.
6.11 REFERENCES


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