CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Medical imaging is the general name given to the group of techniques and processes developed for creating anatomical or functional images of human body (partially or as a whole), which are used for both clinical and scientific purposes. Medical image analysis is one of the most critical studies in the field of medicine, since results gained by the analysis lead field professionals for diagnosis, treatment planning, and verification of administered treatment. Moreover, recent developments in medical imaging methods and medical image processing techniques provided a significant reduction in the requirement for invasive intervention in treatment of various diseases or abnormalities.

Segmentation of medical imaginary is a difficult task due to the complexity of the images to the absence of copy of the anatomy which completely captures the possible contortion in each structure. Brain tissue is particularly complicated in structure, and its segmentation is an important step for acquiring computerized study atlases, pre and intra operative guidance for therapeutic intervention.

In the field of scientific fact finding, medical imaging comprises a sub-control of biomedical engineering, medical physics or medicine depending on the context research and development in the area of
instrumentation, image acquisition, modeling and accounting are usually the
tottle of biomedical engineering, medical physics and computer science.
Research into the function and perception of medical images are usually to
preserve the radiology and the medical sub-discipline relevant to the area of
medical science under investigation. Many of the techniques matured for
medical imaging also have scientific and industrial applications.

Medical image segmentation has been proposed for a number of
clinical inspections of varying complexity. In the clinical background,
medical image processing is generally related to radiology or medical imaging
and the medical practitioner responsible for interpreting the image is a
radiologist. Diagnostic radiography nominates the methodological conditions
of medical imaging and it appropriates the learning of medical images. The
radiographer is normally answerable for acquiring medical images of
diagnostic aspect, although some radiological intervention is performed by
radiologists.

1.2 HUMAN BRAIN

The brain is a soft, delicate, non-replaceable and spongy mass of
tissue. It is a stable place for patterns to enter and stabilize among each other.
It is the source of all human behavior, thoughts, feelings and experience. The
brain produces many hormones and regulates its processing, recognition,
cognition and integration related to emotion. It is supported and protected by
the surrounding skin, bones of the skull and the meninges. It also contains
watery fluid called cerebro-spinal fluid. This fluid flows through spaces
between the meninges and within the brain [2] [Alexis Roche et al.].
The meninges are three connective membranes enclosing the brain and the spinal cord. Their functions are to protect the Central Nervous System (CNS), blood vessels, encloses the venous sinuses, cerebro-spinal fluid. The brain is made of three main parts: the forebrain, midbrain and hindbrain [Alexis Roche et al.] [2].

The forebrain is made up of the cerebrum, thalamus and hypothalamus. The cerebrum is divided into two cerebral hemispheres connected by a mass of white matter known as the callous. Each hemisphere is divided into four lobes frontal, parietal, occipital and temporal. The surface of each hemisphere is made up of gray matter known as the cerebral cortex and is highly folded to increase the cortical surface area available within the confines of the skull. The cortex controls perception, memory, and all higher cognitive functions, including the ability to concentrate and think in abstract form. The cerebral hemispheres are located in the most superior part of the brain. It makes up approximately eighty three percentage of total brain mass.
This area contains two levels: the cerebral cortex and the basal ganglia. They are collectively known as the cerebrum. This is involved in perceptual, cognitive, and higher motor functions.

The midbrain sits between the forebrain and the hindbrain and is approximately 2 cm long. It forms a major part of the brain brainstem. It helps to connect the spinal cord and the forebrain. It includes tectum and tegmentum. These Structures form important connections between the cerebral cortex and the brainstem and the spinal cord to control sensory processes such as vision, movement and auditory reflexes.

The hindbrain includes the cerebellum, the pones and the medulla oblongata, which function collectively to support vital body processes. The medulla is joined to the spinal cord and controls unconscious, body functions such as breathing, swallowing, blood circulation and muscle tone. The abnormal growth of cells within the brain or inside the skull may be cancerous or non-cancerous. The tumor is a type of cancer. Cancer begins in cells, the building blocks that make up tissues. Tissues make up the organs of the body. Normally, cells grow and divide to form new cells as the body needs them. When cells grow old, they die, and new cells take their place. Sometimes this orderly process goes wrong. New cells form when the body does not need them, and old cells do not die when they should.

These extra cells can form a mass of tissue called a growth or tumor. Many tumor or cancer types can spread to the brain, the most common being lung cancer, breast cancer, melanoma, kidney cancer, bladder cancer, certain sarcomas, testicular and germ cell tumors, and a number of others. Some types of cancers only spread to the brain infrequently, such as colon cancer, or very rarely, such as prostate cancer. Brain tumors can directly destroy brain cells, or they may indirectly damage cells by producing
inflammation, compressing other parts of the brain as the tumor grows, inducing brain swelling, and causing increased pressure within the skull.

The brain is a permanent place for patterns to enter and maintain among each other. It is the origin of all human behavior, thoughts, feelings and understanding. It also integrates and controls relating to balance and autonomic functions in the body. The brain produces many hormones and regulates its processing, awareness, attention and integration related to emotion. It is supported and protected by the surrounding skin, bones of the skull and the meninges. It also holds watery fluid called cerebrospinal fluid. This fluid flows through spaces between the meninges and within the brain spaces called ventricles. The skin constitutes a protective barrier against physical injury of underlying tissues, invasion of chemical, bacterial substances, activity of its sweat glands and blood vessels. It also helps to maintain the body at a constant temperature.

The skull is another special protector of brain. It is a highly complicated structure and has compact and elastic types of bones. It provides the structure of the face and protects the brain. The brain is shaped of three major parts: the forebrain, midbrain and Hindbrain. The forebrain is shaped up of cerebrum, thalamus and hypothalamus. The midbrain has tectum and tegmentum. The hindbrain is formed of cerebellum, pons and medulla. Brain is the supervisor for the displacement, dream, hunger, thirst and essentially every other vital activity necessary to survive.

It controls main five functions which are receiving or taking the information by the senses, storing and recalling the information, Analyzing and thinking about the information, Force the Controlling, Process the functions simultaneously or one by one and assigning all internal and external functions of the body. The brain encloses amazing number of neurons for
computational process in particular unit. These neurons are attached within the brain and those makes direct connections to other neurons.

**BRAIN TUMOR**

Brain tumors are a dissimilar group of central nervous system neoplasm that arise within or adjacent to the brain. Some are curable by surgical resection, but many cannot be wiped out by current treatments, and, when they are, disabling neurological injury often occur. Brain tumor is one of the major elements for the increase in Mortality among children and adults. A tumor is a mass of tissue that grows out of control of the normal forces that regulate growth.

The terrible brain tumors can be distributed into two generic categories depending on the tumors root, their growth pattern and malignancy. Primary brain tumors are tumors that begin from cells in the brain or from the covering of the brain. A secondary or metastatic brain tumor arises when cancer cells spreading to the brain from a primary cancer in parts inside the body. The speculative brain tumors may be of any size, may have a array of shapes, may appear at any location and may appear in different image intensities [Marcel et al. 2004][80].

**Classification of Brain Tumor**

The brain tumor is classified into two types

**Primary brain tumor**

A Primary malignant brain tumor is one that arises in the brain. This type of primary brain tumors generally emits cancerous cells to other sites in the central nervous system and they infrequently spread to other parts
of the body. Primary brain tumors are signed due to the cell types, from which they are originated.

**Secondary brain tumor**

A secondary or metastatic brain tumor begins when cancer cells spreading to the brain from a primary cancer in numerous parts of the body. Secondary tumors are about three times familiar than primary tumors of the brain. Secondary or metastatic brain tumors take their root from tumor cells which spread to the brain from another spot in the body. They are more periodic than primary brain tumors.

**BRAIN TUMOR SURVEY**

Most Research in developed countries show that the quantity of people who establish brain tumors and die from them has increased perhaps as much as 300 over past three decades. In the year 2007, The National Brain Tumor Foundation (NBTF) for research in United States rates that 29,000 people in the U.S are investigated with primary brain tumors several year, and nearly 13,000 people die. In children, brain tumors are the cause of one fourth of all cancer deaths. The long term annual incidence of primary brain tumors in the United States is 11 to 12 per 100,000 people for primary malignant brain tumors, and the estimate is 6 to 7 per 1,00,000. In the United Kingdom, over 4,200 people are distinguished with a brain tumor every year.

There are about 200 other types of tumors interpreted in UK each year. About 16 out of every 1,000 cancers determined in the UK are in the brain tumor (or 1.6%). In India, totally 80,271 people are impressed by several types of tumor. In the year 2013, National Brain Tumor Society reports each year over 40,000 people are diagnosed with a primary brain
tumor and an additional 180,000 people are investigated to be diagnosed with a metastatic or secondary brain tumor.

NBTF announced maximum rate of primary malignant brain tumor occurred in Northern Europe, United States and Israel. Minimum rate arises in India and Philippines. The following figure shows that the rate of brain tumor in different countries [Selvanayaki and Karnan 2010] [109]. Brain tumor cannot be prevented yet, because causes are being detected only recently. Brain tumor significant differs from patient to patient, and most of these significance can also be originated in people who do not have brain tumors. The following table shows brain tumor affected rate in different countries from the year of 2007 to 2013. The source for the survival information was reported by the Central Brain Tumor Registry of the United States (CBTRUS), National Brain Tumor Foundation (NBTF), American Brain Tumor Association and Indian council of medical research-New Delhi.

**Table 1.1 Brain Tumor Affected Rate**

<table>
<thead>
<tr>
<th>Country</th>
<th>Year</th>
<th>Total Affected Rate</th>
<th>Men Affected Rate</th>
<th>Women Affected Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>2009</td>
<td>1596</td>
<td>928</td>
<td>667</td>
</tr>
<tr>
<td></td>
<td>2010</td>
<td>1247</td>
<td>735</td>
<td>512</td>
</tr>
<tr>
<td></td>
<td>2013</td>
<td>1349</td>
<td>727</td>
<td>622</td>
</tr>
<tr>
<td>United States</td>
<td>2004</td>
<td>14080</td>
<td>7930</td>
<td>6150</td>
</tr>
<tr>
<td></td>
<td>2007</td>
<td>10900</td>
<td>7300</td>
<td>3600</td>
</tr>
<tr>
<td></td>
<td>2010</td>
<td>141,553</td>
<td>74353</td>
<td>67200</td>
</tr>
<tr>
<td></td>
<td>2013</td>
<td>13130</td>
<td>12770</td>
<td>10360</td>
</tr>
<tr>
<td>India</td>
<td>2007</td>
<td>9300</td>
<td>5700</td>
<td>2800</td>
</tr>
<tr>
<td></td>
<td>2010</td>
<td>8700</td>
<td>5880</td>
<td>2820</td>
</tr>
<tr>
<td></td>
<td>2013</td>
<td>9370</td>
<td>5320</td>
<td>4050</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>2007</td>
<td>13200</td>
<td>8100</td>
<td>5100</td>
</tr>
<tr>
<td></td>
<td>2013</td>
<td>10990</td>
<td>7890</td>
<td>3100</td>
</tr>
</tbody>
</table>
Figure 1.2 Brain Tumor - Report

The following table shows the general statistical report about brain tumor types by World Health Organization (WHO) in 2010-2013.

Table 1.2 Brain Tumor Types and Affected Rates

<table>
<thead>
<tr>
<th>Types of Tumor</th>
<th>Description</th>
<th>Affected Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acoustic Neurinoma</td>
<td>Benign tumor occurring in the acoustic nerve between the pons and the cerebellum</td>
<td>2.31%</td>
</tr>
<tr>
<td>Astrocytoma</td>
<td>A type of brain tumor that begins in the brain or spinal chord in small, star shaped cells called Astrocytes</td>
<td>10.04%</td>
</tr>
<tr>
<td>Ependymoma</td>
<td>Tumor arising from the Ependymal cells found along the ventricles and central canal of the spinal cord</td>
<td>5.02%</td>
</tr>
<tr>
<td>Glioblastoma Multiforme(GBM)</td>
<td>A type of brain tumor that forms from glial (supportive) tissue of the brain. It grows very quickly and it has cells that look very different from normal cells. Also called Grade IV Astrocytoma</td>
<td>25.37%</td>
</tr>
<tr>
<td>Types of Tumor</td>
<td>Description</td>
<td>Affected Rate</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>----------------</td>
</tr>
<tr>
<td>Meningioma</td>
<td>A type of tumor that occurs in the meninges, the membranes that cover and protect the brain and spinal cord. Meningiomas usually grow slowly</td>
<td>7.06%</td>
</tr>
<tr>
<td>Metastatic Tumor</td>
<td>Tumor formed by cancer cells that spread (metastasize) to the brain from elsewhere in the body</td>
<td>16.55%</td>
</tr>
<tr>
<td>Mixed Glioma</td>
<td>Tumor containing astrocytic and neuronal elements as well as oligodendroglial cells</td>
<td>3.80%</td>
</tr>
<tr>
<td>Oligodendroglioma</td>
<td>Tumor arising from oligodendrocytes, a type of supportive brain tissue</td>
<td>8.28%</td>
</tr>
<tr>
<td>Pineal Region Tumor</td>
<td>Tumor occurring in the area of the pineal gland. Germinomas, teratomas, pineocytomas, pineoblastomas, mixed tumors and astrocytomas can occur in the pineal region</td>
<td>2.08%</td>
</tr>
<tr>
<td>Other type of Benign Brain Tumor</td>
<td>This type of tumors is not cancerous. These occur from cells in the brain</td>
<td>12.08%</td>
</tr>
<tr>
<td>Other type of Malignant Brain Tumor</td>
<td>The tumor that invades and destroys the tissue where it originates from and which can spread to other sites in the body</td>
<td>9.50%</td>
</tr>
</tbody>
</table>
Brain Tumor Symptoms

- **Headaches**

  This is the most prevalent symptom with 46% of the patients who report that they have headache. They distinguish the headache in many distinct ways; with no one peculiar which reveals a sign of brain tumor.

- **Seizures**

  This is the second most routine symptom which is making by diseases like epilepsy, high fever, stroke, trauma and other disorders.

- **Drowsiness**

  It is a subsequent symptom of a brain tumor. If tumor grows, pressure inside the head increases. Patient may sleep more than normal and finding our self dropping off during the day. If it is not treated, the patient could eventually find more difficult to wake up and then become unconscious.

- **Nausea and vomiting**

  Like headache, these are wide ranging which process that most people who have nausea and vomiting do not have a brain tumor. 22% of the people in the survey reported that they had nausea and vomiting as a symptom.

- **Vision or Hearing Problem**

  According to the survey 25% reported perceiving problems this is a symptom which can be easily knocked off and if there are any problems related to vision or hearing, it must be checked. The following table shows the
brain tumor symptoms and affected rate. Table 1.3 Brain Tumor Symptoms and Affected Rates

**Table 1.3 Brain Tumor: Basic Symptoms**

<table>
<thead>
<tr>
<th>Basic Symptoms</th>
<th>Affected Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headaches</td>
<td>59.24%</td>
</tr>
<tr>
<td>Strange feeling in head</td>
<td>49.15%</td>
</tr>
<tr>
<td>Seizures</td>
<td>41.00%</td>
</tr>
<tr>
<td>Problems finding the right words</td>
<td>42.49%</td>
</tr>
<tr>
<td>Weakness of the arm(s) or leg(s)</td>
<td>43.59%</td>
</tr>
<tr>
<td>Nausea / Vomiting</td>
<td>40.76%</td>
</tr>
<tr>
<td>Problems with vision</td>
<td>43.78%</td>
</tr>
<tr>
<td>Problems with sensation in your hands</td>
<td>35.24%</td>
</tr>
<tr>
<td>Strange smell felt</td>
<td>32.43%</td>
</tr>
</tbody>
</table>

Earlier detection has not been an area of interest in neurooncology. Because early treatment for many types of brain tumors does not boost quality or make longer length of life, early detection approach has not been a seniority and their use may not be proper. In this respect, brain tumors are different from cancers of the breast, prostate, and colorectum, for which obstructing strategies are now widely used in healthy populations. Moreover, because the causes of brain tumors are not known, it is not yet possible to classify special populations that are at increased risk due to provisional or vocational exposure.

Brain tumors are a different group of central nervous system neoplasm’s that arise within or adjoining to the brain. Some types of tumors are not hopeless by surgical incision, but many cannot be waived by current treatments, and, when they are, disabling neurological injury often ensues.
Moreover, the location of the tumor within the brain has a wide effect on the patient's symptoms, surgical therapeutic options, and the likelihood of obtaining a definitive spot. The location of the tumor in the brain also greatly alters the risk of neurological toxicities that alter the patient's kind of life.

At present, brain tumors are recognized by imaging only after the onset of neurological significant. No early ascertain planning is in use, even in individuals known to be at risk for specific types of brain tumors by ethic of their genetic makeup. Present histopathological classification structure, which are stationed on the tumors conclude cell of origin, have been in place for virtually a century and were renewed by the World Health Organization in 1999. Although good in many respects, they do not allow strict guess of tumor behavior in the individual patient, nor do they guide therapeutic decision-making as absolutely as patients and physicians would hope and need.

**Magnetic Resonance Image**

MRI is a non interfering medical scan test that helps physicians to determine and treat medical conditions. MR imaging uses a powerful magnetic field, radio frequency pulses and a computer to generate informative pictures of organs, soft tissues, bone and virtually all other internal body structures. The images can then be tested on a computer monitor, transmitted electronically, printed or copied to a CD. MRI does not use ionizing radiation. Accurate MR images allow physicians to filter evaluation of various parts of the body. It describes the latency of positive defects that may not be determined adequately with other imaging methods such as x-ray, ultrasound or Computed Tomography (CT). MRI scans have terrific tissue contrast resolution than CT scans and it allows visualization of not only very small
lesions, but it also lesions in the temporal tip, in the inferior frontal lobe and at the base of the skull [Alexandra et al 2000] [9].

A large rate of the human body is built up of fat and water, both of which consist of lots of hydrogen atoms. Magnetic Resonance Imaging (MRI) is done entirely by measuring the way that these hydrogen atoms absorb and then give off electromagnetic energy. At present MRI is the most precise imaging test for human brain. MRI scans are frequently used to calculate the domestic structures of the brain. Brain MRIs are not only used to discover tumors, infection and deep routed diseases but also are now increasingly used in acute settings to look for bleeds and stroke. Brain MRIs are typically ordered for many different symptoms to ignore a tumor, aneurysm or unusual infection and as a follow up for stroke, surgery, etc. Brain activity wishes energy and a good supply of oxygen-rich blood. The scanner can see the increase in blood flow to the most active parts of the brain because it can detect the difference between hydrogen nuclei in oxygenated blood and those in de-oxygenated blood. In this way the scanner builds-up a 3D map of parts of the brain which are working particularly hard.

1.3 BREAST CANCER

Breast cancer is one of the major causes for the increase in mortality among women, especially in developed countries. Breast cancer is the second most common cancer in women. The World Health Organization’s International Agency for Research on Cancer in Lyon, France, estimates that more than 1,50,000 women worldwide die of breast cancer each year.
In India, breast cancer accounts for 23% of all the female cancers followed by cervical cancer (17.5%) in major cities such as Mumbai, Calcutta and Bangalore. Although the incidence is lower in India than in the developed countries, the burden of diagnosing and treating of breast cancer in India is alarming.

According to the International Agency for Research on Cancer, which is part of the World Health Organization (WHO), there were approximately 89,000 women per year affected by breast cancer in India in the year 2004 and 92,000 women in 2005.
Figure 1.4 The mortality rate of breast cancer per 1,00,000 women in India

The incidence is more among urban than rural women. It is more prevalent in the higher socio-economic groups. Women of the Parsi community face a higher risk. The average incidence rate varies from 22-28 per 1,00,000 women per year in urban settings to 6 per 1,00,000 women per year in rural areas.

The WHO survey suggests that by 2020 there will be 10 million new cancer cases every year in the developing world, of which 6 million people will die. In India alone it is estimated that 1.5 million new cancer cases will occur yearly at the start of this century. Currently screening mammography is advocated for all Indian women.

In order to detect the onset of cancer in the breast early, it is essential to have high quality images and skilled mammography interpretation. Radiologists may be trained in the early recognition of the signs of the onset by reading mammograms, which may be subtle and may not show typical malignant features.
It is very difficult to understand the complex nature of the onset of breast cancer through the mammogram. The proposed intelligent system for mammogram image analysis is designed to help radiologists in the diagnosis of cancer at an early stage and it is shown to be effective.

Cancer involves the uncontrolled growth of abnormal cells that have mutated from normal tissues. This growth can kill when these cells prevent the normal functioning of vital organs or spread throughout the body damaging essential systems. The term benign refers to a condition, tumor or growth that is not cancerous. This means that it does not spread to other parts of the body or invade and destroy nearby tissue. Benign tumors usually grow slowly. In general, benign tumor or condition is not harmful. However, this is not always the case. If a benign tumor is big enough, its size and weight can press on nearby blood vessels, nerves, organs or otherwise cause problems. Breast cancer, also known as carcinoma, is a malignant growth that begins in the tissues of the breast.

Types of Breast Cancer

There are several types of breast cancer. Ductal carcinoma begins in the cells lining the ducts that bring milk to the nipple and accounts for more than 75% of breast cancers 20% of lobular carcinoma begins in the milk-secreting glands of the breast but otherwise fairly similar in its behavior to ductal carcinoma; 5% of other varieties of breast cancer can arise from the skin, fat, connective tissues and other cells present in the breast. Figure 1.3 shows the breast cancer types.
Figure 1.5 Breast cancer types

Causes for Breast Cancer

The cause of breast cancer is represented in the following table.

Table 1.4 Causes of breast cancer

<table>
<thead>
<tr>
<th>Causes</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age and Gender</td>
<td>With most cancers, age is a significant factor. In fact, 77% of new cases and 84% of breast cancer deaths occur in women aged 50 and older. More than 80% of breast cancer cases occur in women over 50. Less than 1% of breast cancers occur in men.</td>
</tr>
<tr>
<td>Early Menstruation and Late Menopause</td>
<td>Women who started menstrual periods early (before age 12) or went through menopause late (after age 55) are at higher risk. Also, women who have never had children or who had them only after the age of 30 are at a higher risk.</td>
</tr>
<tr>
<td>Oral Contraceptives</td>
<td>Birth control pills may slightly increase the risk of breast cancer, depending on age, length of use and other factors.</td>
</tr>
</tbody>
</table>
Table 1.4 (Continued)

<table>
<thead>
<tr>
<th>Causes</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hormone Replacement Therapy</strong></td>
<td>Hormone Replacement Therapy may also increase the risk of breast cancer.</td>
</tr>
<tr>
<td><strong>Physical Characteristics</strong></td>
<td>Obesity is controversial as a risk factor. Some studies report obesity as a risk of breast cancer, possibly associated with higher levels of estrogen production in obese women.</td>
</tr>
<tr>
<td><strong>Alcohol Consumption</strong></td>
<td>Alcohol consumption has been associated with an increased risk of breast cancer.</td>
</tr>
<tr>
<td><strong>Exposure to Estrogen</strong></td>
<td>Some studies have pointed to exposure to estrogen like chemicals that are found in pesticides and other industrial products as a possible source of increased risk of breast cancer.</td>
</tr>
<tr>
<td><strong>Diethylstilbestrol</strong></td>
<td>Women who took diethylstilbestrol to prevent miscarriage may have an increased risk of breast cancer.</td>
</tr>
</tbody>
</table>

The choice of initial treatment is based on many factors. For stage 0, I, II, or III cancers, the main choices are to adequately treat the cancer and prevent a recurrence either at the place of the original tumor or elsewhere in the body. For stage IV cancer, the goal is to improve symptoms and prolong survival. However, in most cases, stage IV breast cancer cannot be cured.

**Stages of Breast Cancer**

The stages of breast cancer are represented in the following table.
### Table 1.5 Stages of breast cancer

<table>
<thead>
<tr>
<th>Stages</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Stage 0</strong></td>
<td>The cancerous cells are in their original location within normal breast tissue known as either ductoral carcinoma or lobular carcinoma, depending on the type of cells involved and the location. It is a pre-cancerous condition and only a small percentage of ductoral carcinoma tumors progress to become invasive cancers.</td>
</tr>
<tr>
<td><strong>Stage I</strong></td>
<td>Tumor less than 2 cm in diameter with no spread beyond the breast.</td>
</tr>
<tr>
<td><strong>Stage II A</strong></td>
<td>Tumor 2 to 5 cm in size without spread to auxiliary (armpit) lymph nodes or tumor less than 2 cm in size with spread to auxiliary lymph nodes.</td>
</tr>
<tr>
<td><strong>Stage II B</strong></td>
<td>Tumor greater than 5 cm in size without spread to auxiliary lymph nodes or tumor 2 to 5 cm in size with spread to auxiliary lymph nodes.</td>
</tr>
<tr>
<td><strong>Stage III A</strong></td>
<td>Tumor smaller than 5 cm in size with spread to auxiliary lymph nodes which are attached to each other or to other structures or tumor larger than 5 cm in size with spread to auxiliary lymph nodes.</td>
</tr>
<tr>
<td><strong>Stage III B</strong></td>
<td>The tumor has penetrated outside the breast to the skin of the breast or of the chest wall or has spread to lymph nodes inside the chest wall along the sternum.</td>
</tr>
<tr>
<td><strong>Stage IV</strong></td>
<td>A tumor of any size with spread beyond the region of the breast and chest wall such as to liver, bone or lungs.</td>
</tr>
</tbody>
</table>

### Mammography

Mammography, also known as mammogram, is an X-ray picture of the breasts. It is used to detect tumors and cysts in an advanced stage of cancer and to help distinguish benign (noncancerous) and malignant (cancerous) cases.
Screening Mammography

A screening mammography program separates normal mammograms from abnormal ones. The abnormal mammograms are then further evaluated by methods such as diagnostic mammography or biopsy to determine if a malignancy exists. A standard mammogram screening consists of four images, two views of each breast. There is a Cranio-Caudal or top-to-bottom view and a Medio-Lateral or middle-to-outside view. Each image is an X-ray image. The high or bright values in the image, by common convention, represent high absorption of X-rays. Conversely, the low or dark values represent low absorption of X-rays.

Figure 1.6 Normal mammogram
Characteristics of Mammograms

Mammography films are of two types, namely conventional and digital. Conventional mammography takes an X-ray image of the breast tissue. The image is developed into printed images that allow the radiologist to examine for any abnormalities. Digital mammography uses X-rays to create an image of the breast on a computer screen. In a matter of seconds, the image is analyzed from the computer picture, printed and stored for future reference.

Mammography Abnormalities

A radiologist looks for certain signs and characteristics indicative of cancer when evaluating a mammogram. A mass is a tiny calcium deposit accumulated in the tissue in the breast and it appears as a small bright spot on the mammogram.
A cluster is typically defined to be at least 3 to 5 masses within a square centimeter region. Up to 50 percent of malignant masses demonstrate clustered masses and in a number of cases, the clusters are the only sign of malignancy. The calcifications vary in size from smaller than 0.1 millimeters to 5 millimeters in diameter and a radiologist must carefully examine the mammogram with a magnifier to locate calcifications, which may be embedded in dense parenchymal (connective) tissue. Size, shape and radiographic density are the most important factors when analyzing individual calcifications. The number and distribution of calcifications within a cluster are also considered Table 1.3 shows the characteristics of calcifications.

**X-Ray Mammography Equipment**

Diagnostic criteria require that mammograms exhibit both excellent spatial resolution and contrast sensitivity. X-ray mammography is currently performed using a conventional phosphor screen-film combination as the image receptor. Properly exposed film mammograms reveal fine detail in the breast, with the capability of detecting contrast levels as low as 2 to 5%.

The size of the smallest detectable calcifications, a finding sometimes associated with malignancy, is typically 0.2mm or somewhat larger. In spite of the quality of the screen-film technique, improvements are still desirable. Ideally, an imaging system, which offers wider dynamic range, higher contrast sensitivity, higher spatial resolution and the ability to manipulate and archive the image, is desirable.

**MIAS Data Base**

Obtaining real medical images for carrying out research is highly difficult due to privacy issues, legal issues and technical hurdles. Hence, the MIAS database is used in this thesis to study the efficiency of the proposed
intelligent system since it is a benchmark database available online for research.

The MIAS, which is an organization of UK-based research groups interested in the understanding of mammograms, has produced a digital mammography database (ftp://peipa.essex.ac.uk). The X-ray films in the database have been carefully selected from the United Kingdom National Breast Screening Programme and digitized with a Joyce-Lobel scanning microdensitometer to a resolution of 50 μm × 50 μm, 8 bits representing each pixel.

1.4 THESIS OVER VIEW

Medical imaging is the general name given to the group of techniques and processes developed for creating anatomical or functional images of human body (partially or as a whole), which are used for both clinical and scientific purposes. Medical image analysis is one of the most critical studies in field of medicine, since results gained by the analysis lead field professionals for diagnosis, treatment planning, and verification of administered treatment. Moreover, recent developments in medical imaging methods and medical image processing techniques provided a significant reduction in the requirement for invasive intervention in treatment of various diseases or abnormalities.

Medical image such as CT images, X-ray and MRI is one of the best technologies currently being used for diagnosing tumour and cancer. Cancer is diagnosed at advanced stages with the help of the Medical images. In this thesis, the system is designed to diagnose brain tumour through MRI and breast cancer through mammograms, using image processing techniques and intelligent optimization tools such as Firefly optimization Algorithm
(FFA) with Fuzzy Enhanced Artificial Bee Colony Optimization (EABCO) and Artificial Neural Network (ANN).

Automated breast cancer and brain tumour detection has been studied for more than two decades. This survey has been conducted in order to establish a roadmap that is able to forecast the future developments of image processing technology in medicine and healthcare.

In this work, various steps in detection of tumors (i) the pre-processing (ii) enhancement (iii) segmentation algorithms (iv) features extraction, selection and classification (vi) receiver operating characteristics analysis and their performance have been studied and compared.

In scope of this work, a new medical image processing and statistical analysis framework has been developed based on a comprehensive review of modern image processing literature. Main motivation behind this study was performing the analysis, design, implementation, and validation of a fast and robust system, which enables application of several medical image processing routines necessary for quantification and analysis of various image features in an effective way.

The aim of this research work is to develop a method for automatic segmentation and classification of the tumour through medical images based on a soft computing approach. In this thesis, the detection of tumour is performed in two phases: preprocessing and segmentation in the first phase and feature extraction, selection and classification in the second phase.

The MIAS, which is an organization of UK–based research groups interested in the understanding of mammograms, has produced a digital mammography database which contains 322 images, which is available in the web site ftp://peipa.essex.ac.uk. 300 MRI images obtained from KMCH
hospital to establish its competence. The suspicious region is segmented using Markov Random Field (MRF) hybrid with FFA and EABCO algorithm for images. The BPN classifier is validated using Round Robin Method. A Free Response Receiver Operating Characteristics (FROC) curve analysis is performed to evaluate the classification performances of the proposed approaches. The area under the FROC curve is used as a measure of the classification performance and it is denoted by Az.

The new tracking algorithm is proposed to remove film artifacts such as labels and X-ray marks from the image. The weighted median filtering technique is applied to remove the high frequency components in the image. The advantage of using the median filter is that it removes the noise without disturbing the edges. Initially, a unique label is assigned to similar patterns in the images. A kernel of 3×3 matrix is selected randomly from the enhanced image. The MRF is used to compute the MAP value of each kernel. The metaheuristic algorithm FFA and EABCO is implemented to obtain the optimum labels by minimizing the MAP values. The intensity value corresponding to the central pixel of the kernel that holds the optimum label is used as the threshold value for segmentation.

The MRF based image segmentation method is a process seeking the optimal labeling of the pixels. The optimum label is that which minimizes the Maximizing a Posterior (MAP) estimate. The modified metaheuristic algorithm is implemented to compute the optimum label, which is to be treated as an optimum threshold for segmentation. The textural features are extracted from the segmented image to classify the abnormal or normal. Textural analysis methods such as Spatial Gray Level Dependency Matrix (SGLDM), Surrounding Region Dependency Matrix (SRDM), Gray Level Run-Length Matrix (GLRLM), and Gray Level Difference Matrix (GLDM)
are used to extract the fourteen Haralick features from the segmented image. The whole process of preprocessing and segmentation is shown in Figure 1.

Figure 1.8 Flow diagram for Preprocessing and Segmentation

The dominated features are selected from the extracted set of features using rough set based reduction algorithms such as Decision Relative Discernibility (DRD) based reduction, Heuristic approach, Hu’s algorithm, Quick Reduct (QR), and the metaheuristic algorithms such as GA, ABCO and ACO algorithms. The feature selection technique is applied to obtain the selected feature set in order to reduce the space and running time of the system.
Initially the reduced features are normalized between zero and one. The normalized feature values are given as input to a three-layer BPN to classify the tumour into abnormal or normal. The network is trained to produce the output value 0.9 for abnormal and 0.1 for normal images. The BPN classifier is validated using round robin Method. A Receiver Operating Characteristics (FROC) analysis is performed to evaluate the classification performances of the proposed approaches. The area under the FROC curve is...
used as a measure of the classification performance and it is denoted by $Az$. A larger value of $Az$ indicates better classification performance.

1.5 FRAME WORK OF THE THESIS

In this work, a novel method is proposed to detect the tumors in images. The thesis is organized into 7 chapters. The 1st chapter is introductory and the subsequent chapters discuss the proposed techniques in detail. The gist of each chapter is provided here.

Chapter 2: Literature Survey

Systematic overviews of the existing techniques for automatic detection of tumors in digitized medical images are summarized in this chapter. In particular, the preprocessing, enhancement, segmentation algorithms, feature extraction, selection and classification, ROC curve analysis and their performance are studied and compared.

Chapter 3: Preprocessing and Enhancement

In this chapter, tracking algorithms and median filtering is applied to enhance the images.

Chapter 4: Segmentation

This chapter presents two methods of segmentation of images to extract the suspicious regions. FFA with fuzzy and EABCO method is used to segment the suspicious region from the image.

Chapter 5: Feature Extraction, Selection and Classification

In this chapter textural analysis methods such as SRDM, SGLDM, GLRLM, and GLDM are used to extract the fourteen Haralick features from
the segmented images. The reduced features are selected using four different rough set based algorithms such as Hu’s, Heuristic, DRD, QR, and the metaheuristic algorithms such as GA, ACO and ABCO algorithms. The reduced features selected in chapter 6 are given as input to the three-layer BPN to classify the benign, malignant and normal ones.

Chapter 6: Performance Evaluation

In this chapter, FROC analysis is presented to evaluate the classification performance of the textural features extracted by texture analysis method. The area under the FROC curve Az is used as a measure of the classification performance.

Chapter 7: Conclusion

The thesis is concluded with the key findings and provides suggestions to do further study in it.