Palestine Polytechnic University

College of Engineering &Technology

Electrical &Computer Engineering Department

Graduation Project

Brain Tumor Detection by Using Image Processing Techniques

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Jan, 2009

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Graduation Project Report

Submitted to the Department of Electrical and Computer Engineering in the College of Engineering and Technology

Palestine Polytechnic University

Approved by _____
Chairperson of Supervisory Committee

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Date _____

جامعة بوليتكنك فلسطين
الخليل-فلسطين
كلية الهندسة و التكنولوجيا
دائرة الهندسة الكهربائية والحاسوب

اسم المشروع

Brain Tumor Detection by Using Image Techniques

أسماء الطلبة

أشجان الهريـــني ..... عبدالرحمن سلمان العرجا

بناءً على نظام كلية الهندسة والتكنولوجيا وإشراف ومتابعة المشرف المباشر على المشروع وموافقة أعضاء اللجنة الممتحنة تم تقديم هذا المشروع إلى دائرة الهندسة الكهربائية والحاسوب، وذلك للوفاء بمتطلبات درجة البكالوريوس في الهندسة تخصص هندسة الأجهزة الطبية.

توقيع المشرف

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توقيع اللجنة الممتحنة

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توقيع رئيس الدائرة

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ABSTRACT

Brain cancer is one of the most common form of cancer. It is a disease in which cancer (malignant) cells are found in the tissues of the brain. Cancer can be treated when it is detected at early stages .But people go to the doctor in its peak stages. To detect and monitor tumors we typically image the whole brain using CT or MRI scanners as prescribed by the doctor. Even after the patient has gone to the doctor, it might take a day or more before the image is being analyzed by the radiologist. If the radiologist finds a suspected lesion the patient could return for another scan. However, such re-imaging is cost prohibitive and, if the initial scan was done a month ago, the lesion may have already changed. We want to replace this scenario with an imaging modality in which the machine can be programmed to detect edges in the brain so the image will be more clearly for doctors and radiologist. This could improve diagnosis, and reduce the time and cost involved in trials of new treatments. Also the time required to analyze each MRI ,or CT image by the radiologist can reduce drastically. The primary objective of this project is to use image enhancement methods in MATLAB to detect edges in the brain by using DCT and sobel method. Which is economically viable and help an ordinary person in diagnosing the disease.

الإهـــداء

إلى من تجسدت السعادة في أحضانها، وارتسمت الفرحة في عينيها، إلى ينبوع الحياة الدافئ،
إلى الحياة وبدونها لا حياة:

إلى أمي

إلى الذي وعدته أن أكون فكنت، إلى الذي مد ذراعيه جسراً فعبرت، إلى رمز العطاء الدائم:

إلى أبي

إلى باقات الأمل، إلى من سكنوا مكان الروح من الجسد.....إخوتي و أخواتي

إلى مشاعل الوطن الكبير.....شهداء الحق والحرية

إلى رفاق دربي.....أصدقائي

إليكم جميعا أحبتنا نهدي هذا الجهد المتواضع

ACKNOWLEDGMENT

We would like to express our gratitude to our project advisor, Dr. Ghandi F.Manasra, whose expertise and understanding added considerably to our graduate experience. We appreciate his vast knowledge and skill in the areas of mathematics ,signal and system and optimization. We would to thank him for his words of wisdom and professional guidance ,also his patience in helping us during the completion of our project

We would like to thank our families for the love and support they provided during graduate school, and always. I must also acknowledge Jamal Hleqawee and Amy Oliver, without whom I could not have nished this thesis, much less my Master's coursework.

We would like to express my appreciation to ALYA and AL_AHLEE hospitals for all their work behind the scenes.

Finally, We must recognize that our graduate experience and this research would not have been possible without the assistance of the Engineering Department at Palestine Polytechnic University in the form of a generous Teaching Assistantship.

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Introduction

Chapter one
Introduction

1.1Overview:

Detection of tumors in different medical images is motivated by the necessity of high accuracy when we dealing with a human life. Also, the computer assistance is demanded in medical institutions due to the fact that it could improve the results of humans in such a domain where the false negative cases must be at a very low rate. It has been proven that double reading of medical images could lead to better tumor detection. But the cost implied in double reading is very high, that's why good software to assist humans in medical institutions is of great interest nowadays. Different approaches are needed as function of the medical images that must be studied. Also, the technique that produced those images is very important in order to know what to apply to a certain medical image in order to get better results. A lot of methods have been proposed in the literature for CT (Computed Tomography) scans and other radiological techniques. With all this effort done in the research field there is a lot of place for improvements and the medical image processing is a domain in continuous expansion. Why this domain is in continuo expansion and there are no good accepted methods? This is due to the fact that in such an important domain, the accuracy must be very high and the false negative rate must be low. The problem is that is not very easy to obtain such results. Anyway, the idea is to reduce as much as possible the human errors by assisting the physicians and the radiologists with some software that could lead to better results. This is important for human life. What we shall propose in our project is the enhancement and segmentation of brain CT images by using some prior knowledge like pixel intensity, discrete cosine Fourier transform DCT and some anatomical features to enhance medical images.

1.2Project objectives:

In this project we aim to:

1- To assist human with good software that save a lot of time, money and efforts. This software can include the a acquisition, enhancement, segmentation and analysis of images.
2- In this project we are looking to enhance the image which is generated from the CT device by using mathematical equations such as Fourier transform in order to detect edges in the brain as an output from the program.
3- If we have time and the ability we will try with another outputs for differentiate between the different kinds of abnormalities.

1.3 Literature Review:

There are many researches that discussed detection of tumor in the brain by using image enhancement techniques but in different methods than (DCT and sobel) which are used in our project ,for example detection of tumor using wavelet and morphological operation".

1.4 Scheduling Table:

The timing management will divide the system hierarchy according to the actions:

T1: ***Preparing to the project***: this stage of the project primarily aims to identify the contents of it, discuss the initial information, and evaluate the project tasks and levels.

T2: ***The project analysis***: the analysis process includes extensive study for all possible design options of the project.

T3**:** ***Conceptual Design***: project objectives, design block diagram will be done and we will show how our system will work.

T4: ***Studying project component and schematic analysis*****:** it is necessary to study the specifications of project components to meet the requirements of the project.

T5: ***Writing the documentation***: writing the documentation of project which will continue all project's time.

Table (1.1): The Task Duration

Task	Duration(weeks)	Dependencies
T1	3	-----
T2	3	-----
T3	4	T1,T2
T4	2	T3
T5	15	T4

Table 1.2: Timing plane

Task / Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
T1															
T2															
T3															
T4															
T5															

1.5 Estimated Cost:

This section lists the overall cost of the components that are considered in implementing the system.

Table 1.3: Hardware Cost

Component	Cost
Matlab program	100$
PC Computer	900$

1.6 Report Contents:

Our project is divided into six chapters; these chapters could be described as follow:

Chapter 1: Introduction

This chapter presents overview, literature review, project objectives, project scheduling, estimated cost, and report contents.

Chapter 2: Theoretical Background.

This chapter discusses the brain physiology and types of tumor affecting the brain.

Chapter 3: **Image enhancement and feature extraction**

This chapter will talk about the methods that we can apply to medical Images, it will present a system overview of the method that we will implement and we'll talk about the way that it works. Also this chapter gives some theoretical explanations about the methods and techniques used.

Chapter 4: Detection of Brain Tuomer Algorithm Using DCT and Sobel Method

This chapter includes project phases, and subsystem detailed design. Includes software of the project (block).

Chapter 5: Brain Image Processing Using MATLAB

This chapter includes processing images using image processing tool box in MATLAB

Chapter 6: Conclusion and Future work

This chapter includes conclusion and future work.

2

Brain physiology

Chapter two
Brain Physiology

2.1 Introduction

Cancer is one of the most mutable diseases known, exhibiting a superfluity and heterogeneity of molecular pathways that impart an almost chimerical nature to it. Exploiting these pathways for patient therapy demands an understanding of the physiology of tumors from the molecular to the systemic level. To this end, multi parametric functional and molecular imaging play a vital role in not only tracking delivery and efficacy of therapy, but also in discovering novel therapeutic targets.

This chapter will discuss a description of the physiology of the brain and the tumors, including a description of tumor angio-genesis and how CT scan affords us a window into such processes.

2.2 Brain parts

The human brain consists of roughly three separate parts, the first segment in the lower section, sometimes called the brain stem, consisting of structures such as the medulla (controlling breathing, heart rate and digestion) and the cerebellum (coordinating senses and muscle movement). Much of these features are inherited "as is" from the reptilian brain. [1][2]

The second segment appears as a slight swelling in lower vertebrates and enlarges in the higher primates and ourselves into the midbrain. The structures contained here link the lower brain stem to the thalamus (for information relay) and to the hypothalamus (which is instrumental in regulating drives and actions). The latter is part of the limbic system. [1][2]

Finally, the third section, the forebrain appears as a mere bump in the brain of the frog but balloons into the cerebrum of higher life forms and covers the brain stem like the head of a mushroom. It has further evolved in humans into the walnut-like configuration of left and right hemispheres. The highly convoluted surface of the hemispheres - the cortex - is about two millimeters thick and has a total surface area of about 1.5 square-meters (the size of a desktop). [1][2]

The structure of the cortex is extremely complicated. It is here that most of the "high-level" functions associated to the mind are implemented. Some of its regions are highly specialized - for example, the occipital lobes located near the rear of the brain are associated with the visual system. The motor cortex helps coordinate all voluntary muscle movements. [1][2]

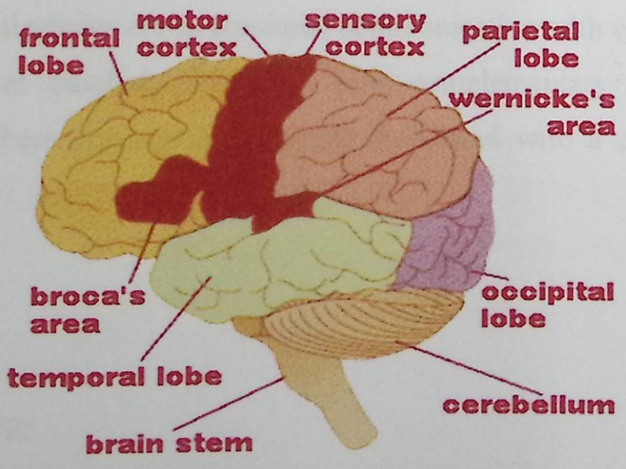

Figure 2.1: Brain Structure

There is an approximate symmetry between left and right hemispheres for example, there are two occipital lobes, two parietal lobes and there are two frontal lobes. However this symmetry is not exact - for example, the area associated with language appears only on the left hemisphere. [1][2]

The frontal lobes occupy the front part of the brain behind the forehead and compose the portion of the brain most closely associated with "control" of responses to input from the rest of the system. They are most closely linked with making decisions and judgments.

In most people, the left hemisphere is dominant over the right in deciding which response to make. Since the frontal lobes occupy 29 percent of the cortex in our species (as opposed to 3.5 percent in rats and 17 percent in chimpanzees), they are often regarded as an index of our evolutionary development. In individuals with normal hemispheric dominance, the left hemisphere, which manages the right side of the body, controls language and general cognitive functions. The right hemisphere, controlling the left half of the body, manages nonverbal processes, such as attention, pattern recognition, line orientation and the detection of complex auditory tones. Although the two hemispheres are in continual communication with each other, each acting as independent parallel processors with complementary functions, the dominant left-hemisphere appears most closely associated with a conscious self.. [1][2]

2.3 Brain tumor

2.3.1 Tumor physiology

Technology provides useful tools for researching the brain and helping patients with brain disorders. One of the most dangerous disorders that technology helps to detect is brain tumors.

A brain tumor is a group of abnormal cells that grows in or around the brain. Tumors can directly destroy healthy brain cells. They can also indirectly damage healthy cells by crowding other parts of the brain and causing inflammation, brain swelling and pressure within the skull. [1][2]

Brain tumors are either malignant or benign. A malignant tumor, also called brain cancer, grows rapidly and often invades or crowds healthy areas of the brain. Benign brain tumors do not contain cancer cells. They look normal under a microscope and are usually slow growing. Brain tumors fall into two different categories: primary or metastatic. Primary brain tumors begin within the brain. A metastatic tumor is formed when cancer cells located elsewhere in the body break away and travel to the brain. For this reason, metastatic brain tumors are always malignant, while primary brain tumors may be benign or malignant. [1][2]

Brain tumors are classified based on where the tumor is located, the type of tissue involved, whether the tumor is benign or malignant, and other factors. If a tumor is determined malignant, the tumor cells are examined under a microscope to determine how malignant they are. Based on this analysis, tumors are rated, or graded, by their level of malignancy from least to most malignant. Factors that determine the tumor grade include how fast the cells are growing, how much blood is supplying the cells, the presence of dead cells in the middle of the tumor, if the cells are confined to a specific area, and how similar the cancerous cells are to normal cells. [1][2]

2.3.2 Brain Tumor classifications

There are many different types of brain tumors. They are usually categorized by the type of cell where the tumor begins, or they are also categorized by the area of

the brain where they occur. The most common types of brain tumors include the following: [2]

Gliomas

The most common type of primary brain tumor is a glioma. Gliomas begin from glial cells, which are the supportive tissue of the brain. There are several types of gliomas, categorized by where they are found, and the type of cells that originated the tumor. The following are the different types of gliomas.

Astrocytomas

Astrocytomas are glial cell tumors that are derived from connective tissue cells called astrocytes. These cells can be found anywhere in the brain or spinal cord. Astrocytomas are the most common type of childhood brain tumor, and the most common type of primary brain tumor in adults. Astrocytomas are generally subdivided into high-grade, medium-grade or low-grade tumors. High-grade astrocytomas are the most malignant of all brain tumors. Astrocytomas are further classified for presenting signs, symptoms, treatment, and prognosis, based on the location of the tumor. The most common location of these tumors in children is in the cerebellum, where they are called cerebellar astrocytomas. These persons usually have symptoms of increased intracranial pressure, headache, and vomiting. There can also be problems with walking and coordination, as well as double vision. In adults, astrocytomas are more common in the cerebral hemispheres (cerebrum), where they commonly cause increased intracranial pressure (ICP), seizures, or changes in behavior.

Brain Stem Gliomas

Brain stem gliomas are tumors found in the brain stem. Most brain stem tumors cannot be surgically removed because of the remote location and delicate and complex function this area controls. Brain stem gliomas occur almost exclusively in children; the group most often affected is the school-age child. The child usually does not have increased intracranial pressure (ICP), but may have problems with double vision, movement of the face or one side of the body, or difficulty with walking and coordination.

Ependymomas

Ependymomas are also glial cell tumors. They usually develop in the lining of the ventricles or in the spinal cord. The most common place they are found in children is near the cerebellum. The tumor often blocks the flow of the CSF (cerebral spinal fluid, which bathes the brain and spinal cord), causing increased intracranial pressure. This type of tumor mostly occurs in children younger than 10 years of age. Ependymomas can be slow growing, compared to other brain tumors, but may recur after treatment is completed. Recurrence of ependymomas results in a more invasive tumor with more resistance to treatment. Two percent of brain tumors are ependymomas.

Optic Nerve Gliomas

Optic nerve gliomas are found in or around the nerves that send messages from the eyes to the brain. They are frequently found in persons who have neurofibromatosis, a condition a child is born with that makes him/her more likely to develop tumors in the brain. Persons usually experience loss of vision, as well as hormone problems, since these tumors are usually located at the base of the brain

where hormonal control is located. These are typically difficult to treat due to the surrounding sensitive brain structures.

Oligodendrogliomas

This type of tumor also arises from the supporting cells of the brain. They are found commonly in the cerebral hemispheres (cerebrum). Seizures are a very common symptom of these tumors, as well as headache, weakness, or changes in behavior or sleepiness. This tumor is more common in persons in their 40s and 50s. These tumors have a better prognosis than most other gliomas, but they can become more malignant with time.

Metastatic Tumors

In adults, metastatic brain tumors are the most common type of brain tumors. These are tumors that begin to grow in another part of the body, and then spread to the brain through the bloodstream. When the tumors spread to the brain, they commonly go to the part of the brain called the cerebral hemispheres, or to the cerebellum. Often, a patient may have multiple metastatic tumors in several different areas of the brain. Lung, breast, and colon cancers frequently travel to the brain, as do certain skin cancers. Metastatic brain tumors may be quite aggressive and may return even after surgery, radiation therapy, and chemotherapy.

Meningiomas

Meningiomas are usually benign tumors that come from the meninges or dura, which is the tough outer covering of the brain just under the skull. This type of tumor accounts for about 25 percent of brain tumors. They are slow growing and may exist for years before being detected. Meningiomas are most common in

patients in their 40s and 50s. They are commonly found in the cerebral hemispheres just under the skull. They usually are separate from the brain and can sometimes be removed entirely during surgery. They can, however, recur after surgery and certain types can be malignant.

Schwannomas

Schwannomas are benign tumors, similar to meningiomas. They arise from the supporting cells of the nerves leaving the brain, and are most common on the nerves that control hearing and balance. When schwannomas involve these nerves, they are called vestibular schwannomas or acoustic neuromas. Commonly, they present with loss of hearing, and occasionally loss of balance, or problems with weakness on one side of the face. Surgery can be difficult because of the area of the brain in which they occur, and the vital structures around the tumor. Occasionally, radiation (or a combination of surgery and radiation) is used to treat these tumors.

Pituitary Tumors

The pituitary gland is a gland located at the base of the brain. It produces hormones that control many other glands in the body. These glands include the thyroid gland, the adrenal glands, the ovaries and testes, as well as milk production by pregnant women, and fluid balance by the kidney. Tumors that occur in or around the area of the pituitary gland can affect the functioning of the gland, or overproduce hormones that are sent to the other glands. This can lead to problems with thyroid functioning, impotence, milk production from the breasts, irregular menstrual periods, or problems regulating the fluid balance in the body. In addition, due to the closeness of the pituitary to the nerves to the eyes, patients may have decreased vision. Tumors in the pituitary are frequently benign, and total removal makes the tumors less likely to recur. Since the pituitary is at the base of the skull, approaches

for removal of a pituitary tumor may involve entry through the nose or the upper gum. Certain types of tumors may be treated with medication, which, in some cases, can shrink the tumor or stop the growth of the tumor.

Primitive Neuroectodermal Tumors (PNET)

PNET can occur anywhere in the brain, although the most common place is in the back of the brain near the cerebellum. When they occur here, they are called medulloblastomas. The symptoms depend on their location in the brain, but typically the patient experiences increased intracranial pressure. These tumors are fast growing and often malignant, with occasional spreading throughout the brain or spinal cord.

Medulloblastomas

Medulloblastomas are one type of PNET that are found near the midline of the cerebellum. This tumor is rapidly growing and often blocks drainage of the CSF (cerebral spinal fluid, which bathes the brain and spinal cord), causing symptoms associated with increased ICP. Medulloblastoma cells can spread (metastasize) to other areas of the central nervous system, especially around the spinal cord. A combination of surgery, radiation, and chemotherapy is usually necessary to control these tumors.

Craniopharyngioma

Craniopharyngioma are benign tumors that occur at the base of the brain near the nerves from the eyes to the brain, and the hormone centers. Sixty percent of craniopharyngioma occur in patients older than sixteen years of age. Symptoms

include headaches, as well as problems with vision. Hormonal imbalances are common, including poor growth and short stature. Symptoms of increased intracranial pressure may also be seen. Although these tumors are benign, they are hard to remove due to the sensitive brain structures that surround them.

Pineal Region Tumors

Many different tumors can arise near the pineal gland, a gland that helps control sleep and wake cycles. Gliomas are common in this region, as are pineal blastomas. In addition, germ cell tumors, another form of malignant tumor, can be found in this area. Benign pineal gland cysts are also seen in this location, which makes the diagnosis difficult between what is malignant and what is benign. Biopsy or removal of the tumor is frequently necessary to tell the different types of tumors apart. Persons with tumors in this region frequently experience headaches or symptoms of increased intracranial pressure. Treatment depends on the tumor type and size.

2.4 Imaging of brain tumors

Technology provides useful tools for researching the brain and helping patients with brain disorders. Computerized tomography is a good screening method for the demonstration of supratentorial abnormalities, because it is accurate and the imaging method most often available. It is still considered as the basic radiologic study since it gives sufficiently specific information for the management of brain tumors and is only minimally invasive.

Several criteria are important for the differential diagnosis of brain tumors:

1- Signal contrast with normal brain.

2- Tumor structure.

3- Tumor margins.

4- Presence, absence, and extent of per focal edema.

5- Indirect tumor signs.

6- Relation of tumor to blood vessels, richness of tumor blood supply.

7- Degree of contrast enhancement.

2.4.1 Unique Features of Brain Tumors

Unlike any other organ in the human body, the brain has a multilayered protection and defense mechanism that keeps foreign substance away and maintains a delicate system that ensures a homeostatic milieu. The rigid skull is an obvious structural defense against physical trauma, but there are other structural and functional barriers, such as the blood-brain barrier (BBB), and auto regulation mechanisms that strive to maintain homeostasis of the brain environment. These structural and functional barriers create a uniquely challenging environment for brain tumor cells to grow and prosper.

Because brain tumors are an extraordinarily heterogeneous group of lesions, accurate diagnosis is essential to proper management. Current imaging techniques provide a sensitive means for delineating the anatomical features of brain tumors but have not provided an effective means for early detection. Early detection could also be complicated by the ethical problems created by presymptomatic diagnosis of

tumors for which there may not be effective treatment, and in an organ whose proper function is essential to quality of life.

2.4.2 Normal Cells vs. Tumor Cells

Tumor cells vary from normal cells in several basic ways. First, the division of normal cells is tightly regulated by special cell signals. With tumor cells, it's as if the signals are no longer produced or perhaps they are no longer received.

The division of normal cells is regulated by something. Normal cells in culture grow until the bottom of their dish is carpeted with the cell. The layer is only 1 cell thick. Once this density is reached, they stop dividing because there is no more space. If one cell dies, an adjacent one will divide to fill in the space. Additionally, normal cells will divide a certain number of times after which time, the division process halts. There are a certain pre-determined number of generations that may be produced and then there is no more dividing. Eventually, the entire culture will die.

With tumor cells, it's a completely different story. Tumor cells will divide over and over, time after time; forever if supplied with nutrients. With enough time, tumor cells in culture will become a piled up mess. They lack order to their growth. It is as though tumor cells lose have lost the capacity to follow the rules and they divide (proliferate) out of control.

A second major difference between normal cells and tumor cells is that normal cells perform a special function or duty for the body. Healthy cells have specialized behaviors and serve a purpose. For example, lung cells have a specialized duty to perform while cells of cardiac tissue have a very different one. Normal cells taken from different tissues even have very different appearances. Tumor cells have a

different appearance than normal cells taken from the tissue they are derived from. This is due to the fact that they have lost their specialized function.

Differentiation is the term given to describe the specialized function a given cell has. Differentiation and proliferation are closely tied together. In general, a cell that proliferates at a high rate loses some of its specialized function. The problem is, it really doesn't have time to perform a specific function since its too busy dividing. Cells that perform a highly specific function (i.e. differentiated) have a lower rate of proliferation. Researchers are studying the possibility of making tumor/cancer cells differentiated so they might lose their ability to proliferate continuously. In theory, this would cause the tumor to stop growing.

3

Image enhancement and feature extraction

3.1 Introduction

3.2 Equipment

3.3 Feature extraction

3.4 Theoretical Background

Chapter three
Image enhancement and feature extraction

This chapter focuses on the theoretical subjects related to the main idea of the object and information about image enhancement techniques used in the project.

KEYWORDS:

DCT, MATLAB , Extraction , Features

3.1Introduction

One of the steps to detect tumor in the brain is to use a microscope to analyze a tissue sample taken from the brain .the analysis is done by a pathologist, who is looking for any kind of deviation from the normal tissue .this analysis takes a lot of time, causing (intense) pains and it is very monotonous .if the analysis could be done by a computer it would save the pathologist a lot of time and help to distinguish malignant from benign changes in difficult cases.

3.2 Equipment

There are three sources to get the CT images in this project:

1. Microscope and digital camera.
2. CT scan device.
3. CT atlas in the internet.

3.2.1 Microscope and digital camera

The microscope used when collecting the images of brain tissue is a Leica DM RXE.

To create an image the tissue sample is put into the microscope and by looking through the microscope a part of the sample is chosen. The sharpness is decided. Then a program in the computer saves the image. First a part of the sample is chosen and an image created with white light. Then the fluorescent light is turned on and one more image is taken at the exact same position of the sample. These images are later on used together to make other useful images. [3][11]

Figure 3.1 Microscope

Digital Camera

The digital camera connected to the microscope is a Leica DC 200. Before creating images a background image is taken with the digital camera. The lighting from the microscope is not equal all over the surface of the samples, so this must be compensated. The background image is later on removed from the image of the tissue sample. The background image is not the same at different magnifications so this image must be created for each grade of magnification.[3][11]

3.2.2 CT imagining

The image used in this project are taken from CT scan device so this paragraph will explain how this device work. Computed Tomography (CT) was the first non-invasive radiological method allowing the generation of tomographic images of all parts of the human body without superposition of neighboring structures. The image is formed

by projecting many x-ray beams through the object using fan-beam geometry. The x-ray source is moved in a circle around the object. At fixed angles of the circle an x-ray fan-beam is emitted and recorded by an array of x-ray detectors at the opposite side of the object. When the x-ray attenuation of all projections is recorded, the tomography image is reconstructed from these projections using the Radon transform. To image a complete organ, parallel image slices of the organ is recorded. Today the planar resolution in standard CT is less than 1 mm, while the axial resolution (or slice thickness) is several mm. This is one serious disadvantage of standard CT. Another disadvantage with standard CT is that each scan lasts about 2 sec, and the scans have to be separated by about 6 sec delays to reorient the x-ray source detector assembly within the gantry to prevent entanglement of cables. This delay is so long that many organs can not be imaged during one breath hold. Thus, some lesions may be skipped. [10]

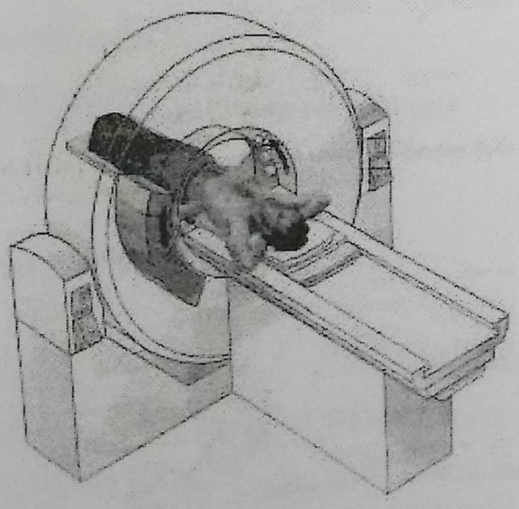

figure 3.2: CT scan system

3.2.3 CT Atlas in the internet

This Web site was the one we used to get the image
http://www.med.mun.ca/Radiology/studentprojects/ct_atlas/CTatlas-part1.htm

3.3 Feature and extraction

3.3.1Choice of features:

The choice of features was selected by observing the images. In the first we were looking foe features that clearly separate the normal images from the abnormal images, and these four features were the ones we found: - [6]

1. Total area of objects in the image.
2. Number of objects in the image.
3. Average size of holes in the objects in the image.

Total area in the image:

The area in the images of malignant has a larger total area than the other classes. The objects in the malignant have large holes, so the total area is lager than the total area in other types of images. To calculate the total area a function bwarea in Matlab will be used. [6]

Number of objects in the image

Image with normal tissue sample have in general fewer objects than images with abnormal tissue. To count the number of objects in an image the Matlab function bwlabel will be used. [6]

Average size of objects in the image:

The object in the image with abnormal tissue is in general bigger than the average size of objects in the image with abnormal tissue. To calculate the average size of objects, the total area of all objects is divided by the number of objects in the image. [6]

3.4Theoretical Background

3.4.1 Image enhancement techniques

The principal objective of enhancement is to process an image so that the result is more suitable than the original image for a specific application.

Image enhancement approaches fall into two broad categories: spatial domain methods and frequency domain methods. The term spatial domain refers to the image plane it self, and approaches in this category are based on direct manipulation of pixel in an image. Frequency domain processing techniques are based on modifying the Fourier transform of an image.

Now we will begin discussion of image process techniques that we used it in order to be suitable to our goal (detection of edge in the brain) this processing will work to modify shapes, increase contrast, remove noise, emphasize and detect edges. [9]

3.4.1.1 Edge detection using DCT

Introduction to Fourier transform and the frequency domain:

This section introduce the Fourier transform in two dimensions, the focus is mostly on a discrete formulation of the continuous transform and some of its properties.

Our interest is in discrete function, so we will deal with these equations. The discrete Fourier transform of a function (image) f(m, n) of size (m*n)is given by the equation:-

$$F(k,l) = \frac{1}{MN} \sum_{m=0}^{M-1} \sum_{n=0}^{N-1} f(m,n) e^{-j2\pi \left(km / M+Ln/N \right)}$$

This expression must be computed for values of u= 0,1,2,…,M-1; and also for v = 0,1,2,…,N -1; similarly , given F(u.v), we obtain f(x,y)via the inverse fourier transform , given by the expression .

$$f(m,n) = \sum_{k=0}^{M-1} \sum_{l=0}^{N-1} F(k,l) e^{j2\pi \left(km / M+Ln/N \right)}$$

For m=0,1,2,…,M-1and n = 0,1,2,…,N equations (1&2)comprise the two dimensional discrete Fourier transform (DFT)pair the variables u and v are the transform or frequency variable , and x and y are the spatial or image variables.
High frequencies are responsible for detail, such as edges and noise.

A filter that attenuates how frequencies while "passing" high frequencies is called a high pass filer.

A high pass filter image would have use gray level variation in smooth areas and emphasized transitional (eg-edge)edge gray level detail . Then the image will be sharper

But we used LPF since if we used HPF some noise will remains in the image as freckle

If we subtracted the LPF from the true image we will get the HPF

HPF=true image-LPF [9]

3.4.2- Increase contrast

Scaling (shift-invariant, linear): Scaling simply spreads or contracts image intensity into a new range. [9]

***Window/level*:** Window and level adjustments are piecewise-linear or nonlinear operations that can be approximated by adjusting the lookup table of a displayed image. [9]

***Histogram equalization*:** histogram equalization attempts to take advantage of unassigned output values. It is a one-to-one operation, unlike window/level operations. The lookup table simply follows the shape of the cumulative histogram. [9]

***adaptive histogram equalization**:* Adaptive histogram equalization computes an output intensity level from the histogram of a local neighborhood of each pixel. [9]

3.4.3 Thresholding and Segmentation

Thresholding is one of the most important and used techniques for image segmentation. In order to extract some objects that we are interested in from the image we have to choose a threshold in such a way that it separates those objects from the rest. One way to choose the threshold is using the histogram of the image. [9]

3.4.4. Classification

Statistical parameters:

A region having a particular texture has a wide variety in its gray levels, the question is how can we capture this texture in order to distinguish between different textures. In our case, the original brain CT image will split in small windows (15 by 15 pixels) and each one of these is characterized using statistical calculus. This area, also called window, can also be varied in its size to capture a sample of different scales to be found here.

The mean gray level and the standard deviation are known as statistical moments, and we are going to calculate this statistical parameters for more than one image in order to compare between them. [6]

4

Detection of Brain Tumor Algorithm Using DCT and Sobel Method

4.1 Introduction

4.2 System Overview

4.3 Image name

4.4 Equipment

4.5 Computer and program

4.6 Procedural Description

4.7 Edge detection

4.8 Implementation

4.9 statistical parameter

CHAPTER FOUR

Detection of Brain Tuomer Algorithm Using DCT and Sobel Method

4.1 Introduction

Simple edge detection algorithms that extract all the edges found in the area of interest as well as in the surroundings, are quite efficient under noisy measurement conditions. So this chapter focuses in a simple and fast method on DCT and sobel method, also this chapter shows we can get image brain using different equipment.

A single camera with special Projection Sensor System has been used in the project.

Transform has been used to extract 2-D brain boundaries in the images coming from CT system.

A simple and fast method based on segmentation followed by edge detection and logical operation has been suggested in this project for brain tumor.

Keywords:

Methods: pre-processing, feature extraction, classification
Modalities: computerized tomography (CT), Diagnostic Task: Detection

4.2 System Overview

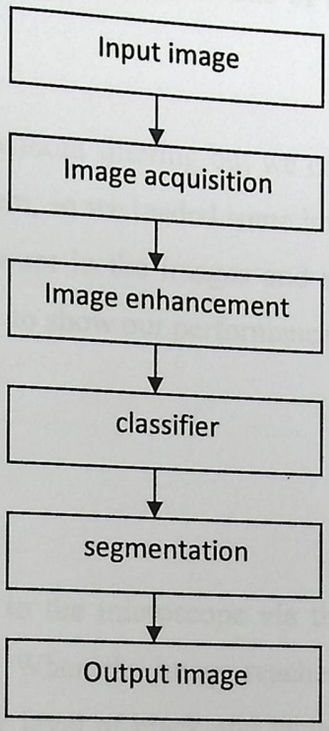

Figure 4.1 Block diagram of System Overview

4.3 Image name

The names of the images all end with a number, e.g. (brain1.jpg) the number Means sample number 1.

4.4 Equipment

When the samples have been stained they are observed through a microscope. The microscope is connected to a computer through a digital camera and this was one way to get the images.

The second source of the image was the CT scan device in AL-AHLI hospital in Palestine in which we used especial software (syngo fast View) to open this

image(we have 2 different cases for two patients one of them is malignant and the other is benign.

We tried to get the images without filtering but we can't since the CT includes special filters including in it system, so we loaded some images from atlas in internet in order to imply the noise we want in the images and supposes that there are no filtering in the CT device in order to show our performances.

4.5 Computer and programs

The computer connected to the microscope via the digital camera has two different programs that we used. When the image reaches the computer an image-processing program calculates the level of black and white in the image. MATLAB program is used. First it calculates the level of black and white in the first image, adjusts it if necessary, and saves it. Then it asks for the fluorescent image, does the same calculations and saves the image.

4.6 Procedural Description

Preprocessing:- CT images are obtained from the CT scanners and once they are obtained they have to be registered. Standard Image Enhancement techniques are applied on the images in order to remove the noise introduced during the capturing of the image or while the image is moved on the network. The image enhancement techniques that we have used for the noise removal are Histogram Equalizer and Filters (**DCT, median and sobel**) which are frequency and spatial domain enhancements. [9]

4.7 Edge detection

The block diagram representation of the algorithm is shown in Fig. 4.4 which show the processing steps that applied to the image and finally the combination of these steps which gives the output. Different stages of this algorithm are briefly explained.

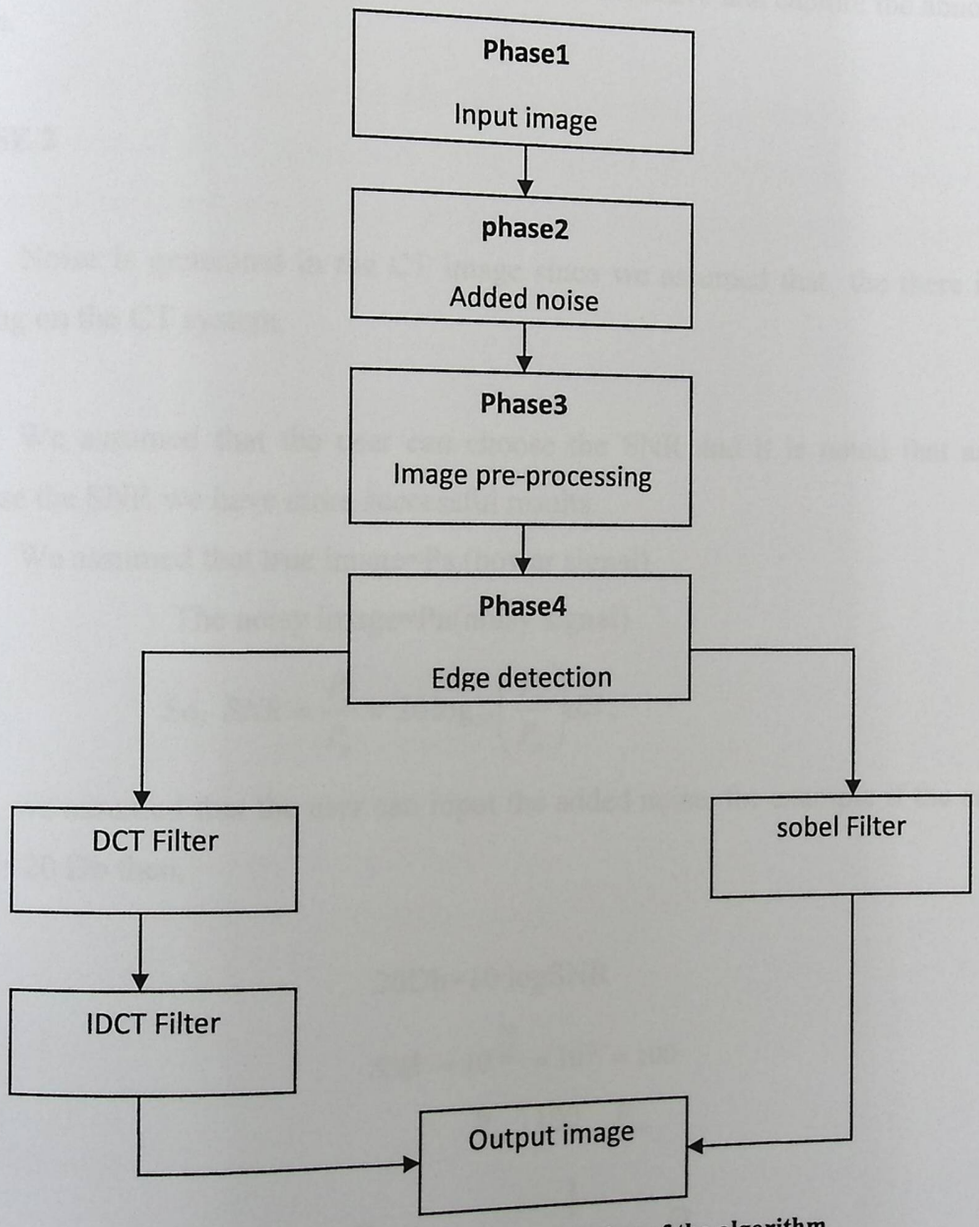

Figure 4.2 Block diagram of representation of the algorithm

PHASE 1

We loaded CT image in the MATLAB At that same location a healthy CT image is taken from the training set and used for comparison. This will be helpful to compare two similar CT images (two CT images are similar if they are sliced at the same vertical location), one healthy and the other defective and capture the abnormal region.

PHASE 2

Noise is generated in the CT image since we assumed that the there is no filtering on the CT system.

We assumed that the user can choose the SNR and it is noted that as we increase the SNR we have more successful results.

We assumed that true image=Ps (power signal)

The noisy image=Pn(noisy signal)

So, $SNR = \frac{P_s}{P_n} = 20\log_{10}\left(\frac{P_s}{P_n}\right) dB$,

we assumed that the user can input the added noise, for example if the added noise is 20 Db then,

$$20Db = 10\ \log SNR$$

$$SNR = 10^{\frac{20}{10}} = 10^2 = 100$$

$$\therefore\ P_s \rangle 100\ \ P_n$$

$$P_n = \frac{1}{100} P_s$$

PHASE 3

Image pre-processing:-Let the image be represented as, $I(m, n)$, with m and n being the two coordinate directions Median for noise elimination Median filter can be represented as v(m, n) = median { I (m- k, n - l), (k, l)€ W}. Where, W is a suitably chosen window.

Scaling is done taking the selected value of upper and lower threshold as the reference. The value of upper and lower threshold varies between '0' and '255', respectively the smallest and largest gray scale intensity values of any image pixel.

Scaling has the form:-

1.I min	if i(m,n)<=a
2. i(m, n) *Imax / (b - a)	if a< i(m, n)< b
3. I max	if i(m,n) >= b

Where, Imax = maximum possible value of intensity

Imin = minimum possible value of intensity

i(m, n) = actual value of intensity at a point (m, n)

a = lower threshold for intensity scaling

b = upper threshold for intensity scaling

PHASE 4

Edge detection

DCT filter and Sobel filter are used for boundary extraction. Performances of both the filters are not similar.

The DCT Transform Matrix

There are two ways to compute the DCT using image processing toolbox software. Use the dct2 function. dct2 uses an FFT-based algorithm for speedy computation with large inputs. use the DCT *transform matrix*, which is returned by the function dctmtx

Basic steps in DFT filtering:-

DFT filtering can be summarized in the following step by step procedure involving matlab functions. The output image after boundary extraction can be represented as:

$G(m, n) = F(m, n) \times H(m,n)$

G(m, n) is the image containing extracted edge

F(m, n) is the original image data, H(m, n) is the filter used

1. Obtain the padding parameters using function padded size.

   PQ = padded size (size (f))
2. Obtain Fourier transform with padding:-

   F = DCFT (F , PQ (1),PQ(2))
3. Generate a filter function , H of size pq(1) x pq(2).
4. Multiple the transform by the filter:-

   G = H .*F
5. obtain the real part of the inverse DCFT of G

   g= real (iDCFT (G))

The DCT Transform Matrix

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Basic steps in DFT filtering:-

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G(m, n) is the image containing extracted edge

F(m, n) is the original image data, H(m, n) is the filter used

1. Obtain the padding parameters using function padded size.

   PQ = padded size (size (f))
2. Obtain Fourier transform with padding:-

   F = DCFT (F , PQ (1),PQ(2))
3. Generate a filter function , H of size pq(1) x pq(2).
4. Multiple the transform by the filter:-

   G = H .*F
5. obtain the real part of the inverse DCFT of G

   g= real (iDCFT (G))

6. crop the top , left rectangle to the original size

   G= g(1: size (f,1), 1:size(f,2))

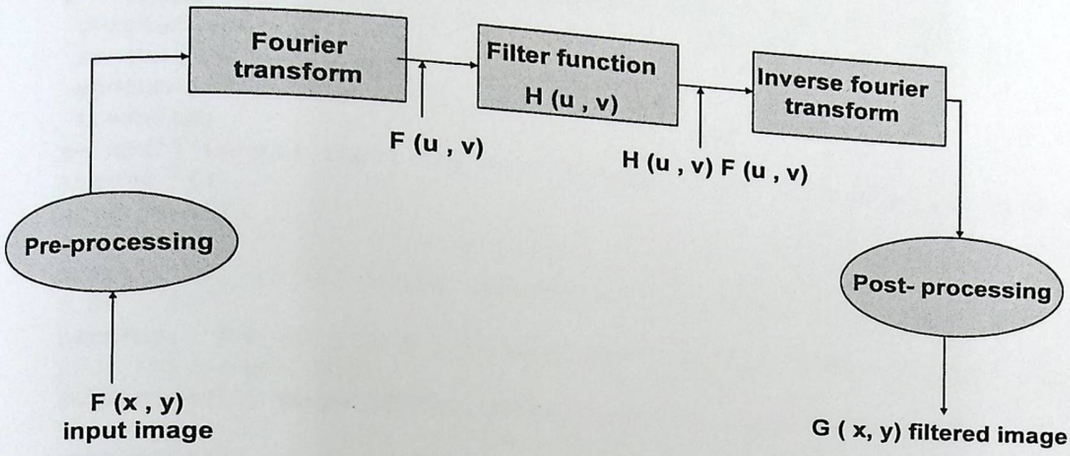


Figure 4.3: Basic steps in DFT filtering

The edge detection using the DCT filter and sobel method was completely explained in chapter3.

4.8 Implementation

In order to test the performance, an algorithm has been implemented on Matlab with varying thresholds, which depend on the gray scale intensity level.

We applied the algorithm in two different patients. Finally, we get the output processed images having clear boundaries.

This algorithm Show the result:

```
X = im2double(imread('brain1.jpg'));% load image as a double
x = rgb2gray(X);                    % convert to a 2-D image
 y=randn(size(x));
 np=sum(sum(y.^2));
 sp=sum(sum(x.^2));
 tt=sp/np;
a=input('please input the multiplying factor in db that you need to
remove ');
a=10^(a/10);
pf=tt/a;
ny=pf*y;%ny is the noise  added to the original image which have the
same size
nx=x+ny;  %nx is the noisy image which equall to the original image
plus the added noise
subplot(441),image(100*x),title('original image') %we multiply the
image by 1000 inorder to have sauitable gray level
subplot(442),image(1000*ny),title('added noise')
subplot(443),image(100*nx),title('noisy image')
%we choose ndb=10 since it is the more sauitable noise
im=100*nx;
im1=medfilt2(im,[3 3]);
BW = edge(im1,'sobel'); %finding edges
[imx,imy]=size(BW);
msk=[0 0 0 0 0;
     0 1 1 1 0;

     0 1 1 1 0;
     0 1 1 1 0;
     0 0 0 0 0;];
 B=conv2(double(BW),double(msk));
L = bwlabel(B,8);% Calculating connected components
colormap gray
 xf=dct2(x);
 [i  j]=size(x);
 for i=1:257
     for j=1:250
       r=sqrt(i^2+j^2);
     if(r<70),xf(i,j)=xf(i,j);
     else xf(i,j)=0;
     end
     end
 end
 pause
 subplot(444),image(100*xf),title('dct')
 mX=idct2(xf);
subplot(425),image(100*mX),title('idct')
 % Storing the extracted image in an array
 subplot(445),image(100*BW),title('sobel')
subplot(446),image(100*B),title('finding edge')
```

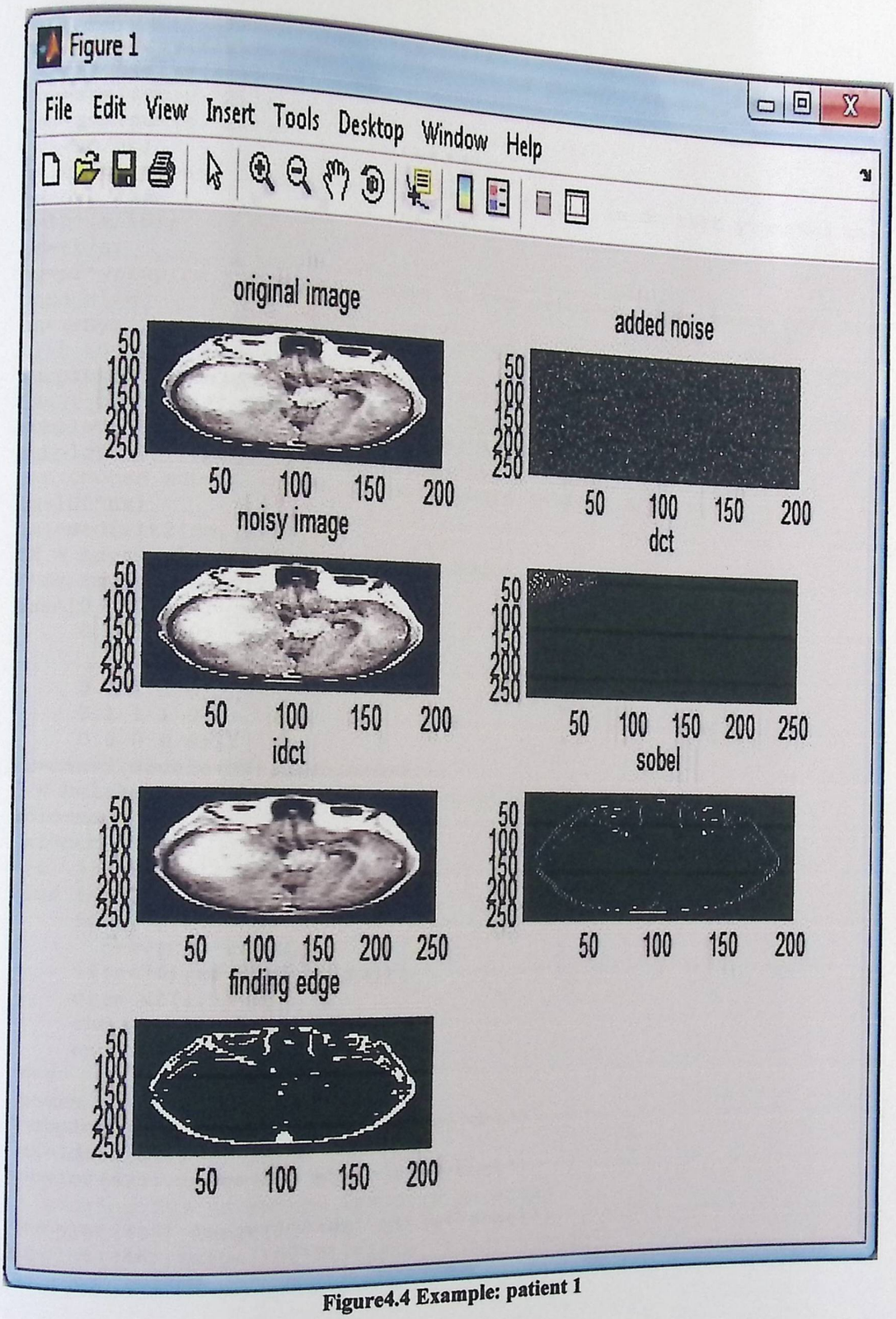


Figure4.4 Example: patient 1

```
X = im2double(imread('brain4.jpg'));% load image as a double
x = rgb2gray(X);                    % convert to a 2-D image
 y=randn(size(x));
 np=sum(sum(y.^2));
 sp=sum(sum(x.^2));
 tt=sp/np;
a=input('please input the multiplying factor in db that you need to
remove ');
a=10^(a/10);
pf=tt/a;
ny=pf*y;%ny is the noise  added to the original image which have the
same size
nx=x+ny;  %nx is the noisy image which equall to the original image
plus the added noise
subplot(441),image(100*x),title('original image') %we multiply the
image by 1000 inorder to have sauitable gray level
subplot(442),image(1000*ny),title('added noise')
subplot(443),image(100*nx),title('noisy image')
%we choose ndb=10 since it is the more sauitable noise
im=100*nx;
im1=medfilt2(im,[3 3]);
BW = edge(im1,'sobel'); %finding edges
[imx,imy]=size(BW);
msk=[0 0 0 0 0;
     0 1 1 1 0;

     0 1 1 1 0;
     0 1 1 1 0;
     0 0 0 0 0;];
 B=conv2(double(BW),double(msk));
L = bwlabel(B,8);% Calculating connected components
colormap gray
 xf=dct2(x);
 [i  j]=size(x);
 for i=1:257
     for j=1:250
       r=sqrt(i^2+j^2);
     if(r<70),xf(i,j)=xf(i,j);
     else xf(i,j)=0;
     end
     end
 end
 pause
 subplot(444),image(100*xf),title('dct')
 mX=idct2(xf);
subplot(425),image(100*mX),title('idct')
 % Storing the extracted image in an array
 subplot(445),image(100*BW),title('sobel')
subplot(446),image(100*B),title('finding edge')
```

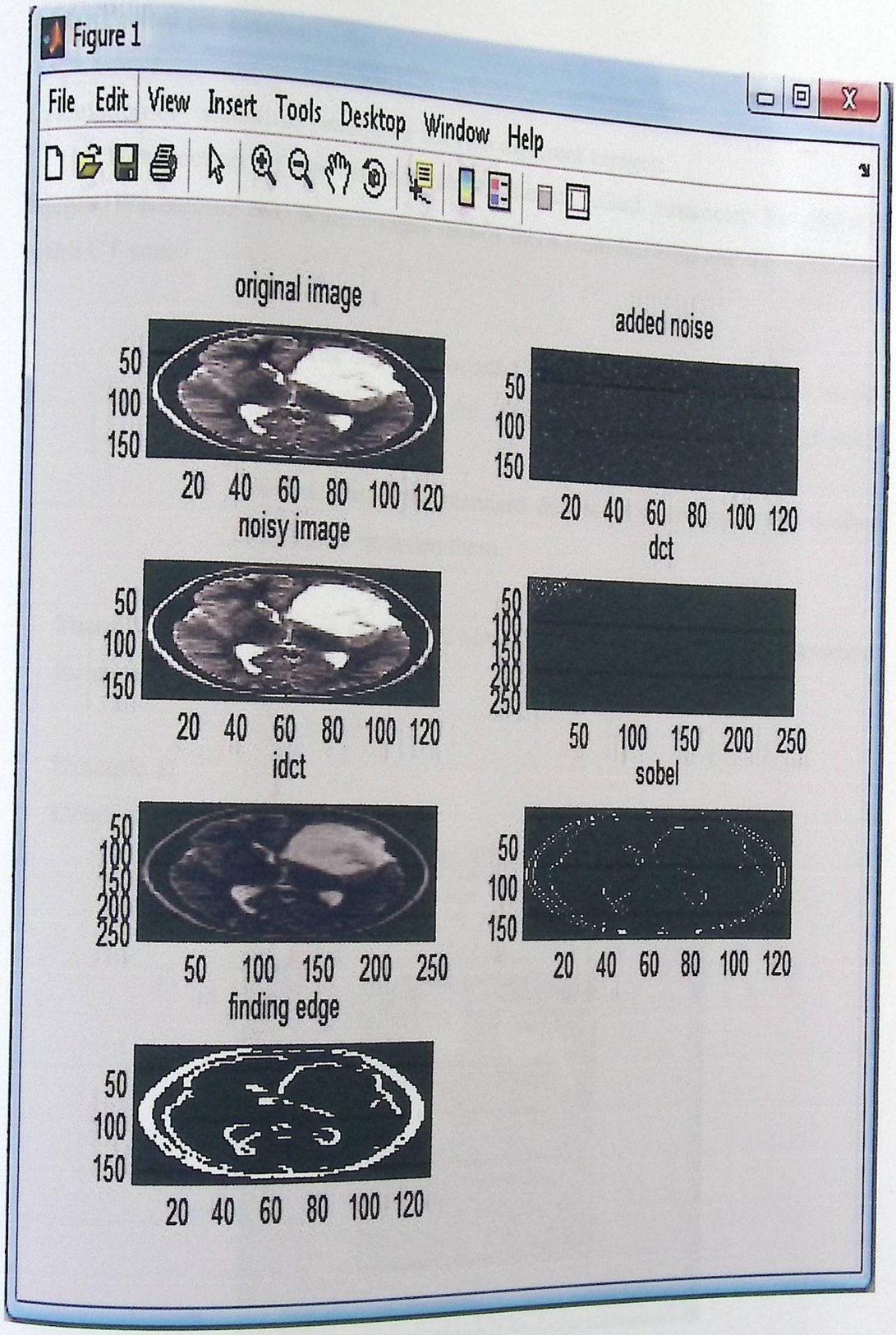


Figure4.5 Example2: patient 2

4.9 Statistical parameter

Calculation of statistical parameter for two different images:

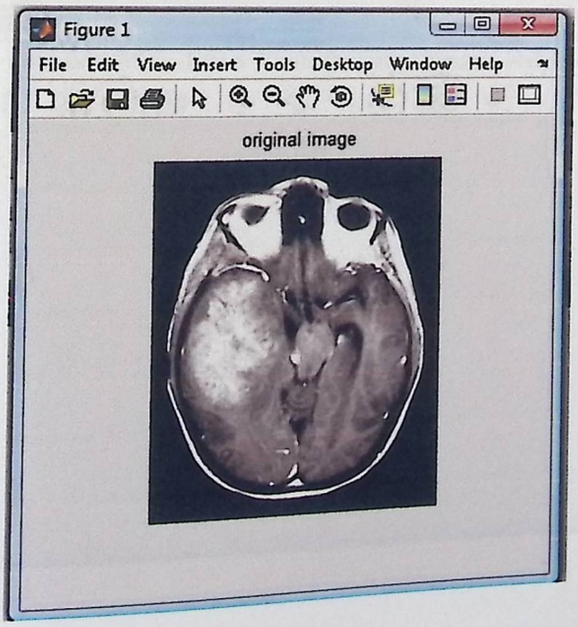
This section of the project shows the statistical parameter for different images. We entered two brain images one of them from the atlas and the other form alahli CT scan.

1. As a first step, we opened the image using the function imread then we displayed the histogram for each of the image using imhist function.
2. We calculated the standard deviation, mean value and made a correlation between them.

These two examples were applied in MATLAB to show the statistical parameter for each image.

Example 1:

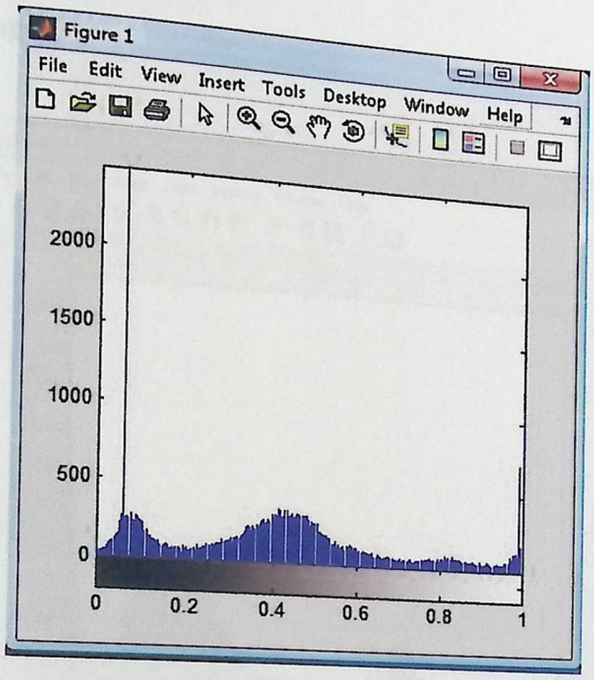
Original image1



Mean = 0.3395

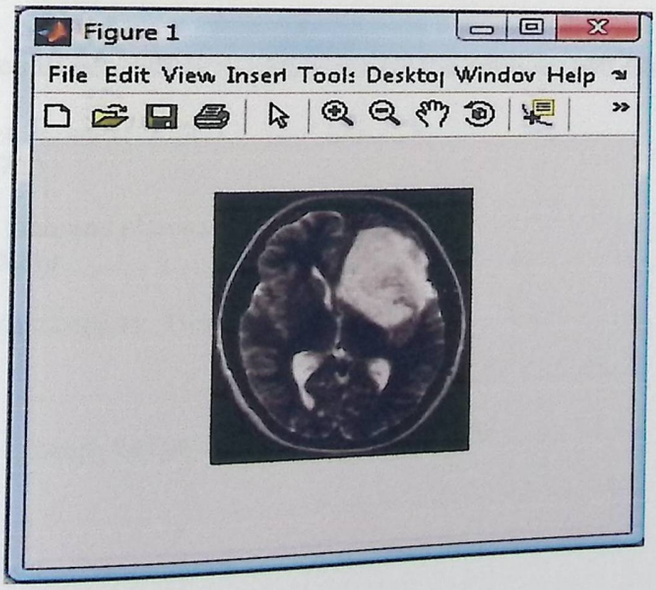
Standard deviation = 0.2909

Histogram image1



Example2:-

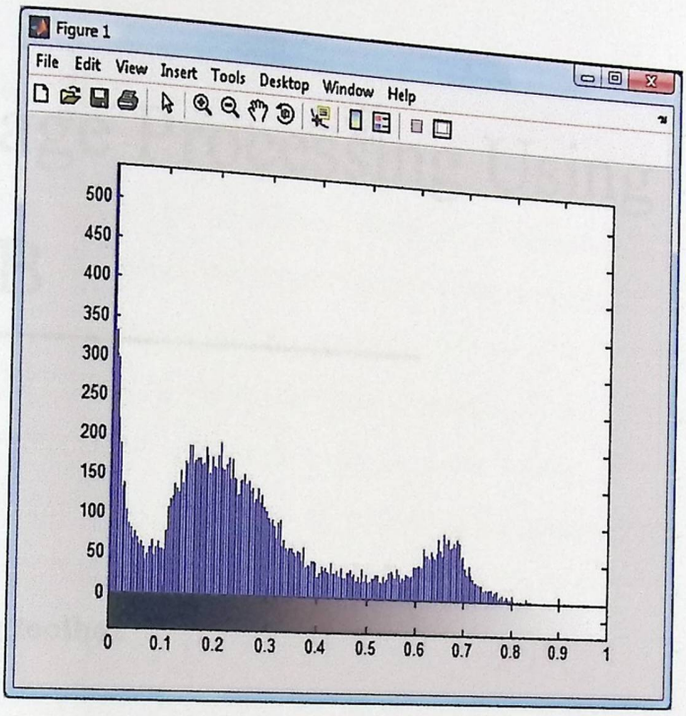
Original image2



Mean = 0.2216

Standard deviation = 0.2152

Histogram Image 2



The algorithm used to get statistical parameter for the previous two examples is:

```
X1 = im2double(imread('brain1.jpg'));
x1 = rgb2gray(X1);
imshow(x1)
X2 = im2double(imread('brain4.jpg'));
x2 = rgb2gray(X2);
imshow(x2)
%now we want to display the histogram
figure(1),
imhist(x1)
imhist(x2)
 %calculate the mean value,standard diviation,
y1=mean2(x1)
s1=std2(x1)
y2=mean2(x2)
s2=std2(x2)
 R = corrcoef(x1,x2)
imshow(R)
```

5

Brain Image Processing Using MATLAB

5.1 Image processing toolbox

5.2 Code for the program written in MatLab

Chapter Five
Brain Image Processing Using MATLAB

5.1 Image processing toolbox

In this work we will adapt an X-ray Computed Tomography (CT) image is composed of pixels, whose brightness corresponds to the absorption of X-rays in a thin rectangular slab of the cross-section, which is called a ''voxel''. In the Pixel Region tool window. We can determine the current position of the pixel region in the target image by using the pixel information given at the bottom of the tool. In this way we found the x- and y- coordinates of pixels in the target image coordinate system. The Adjust Contrast tool displays a histogram which represents the dynamic range of the X-ray CT image (Figure5.1.).[4]

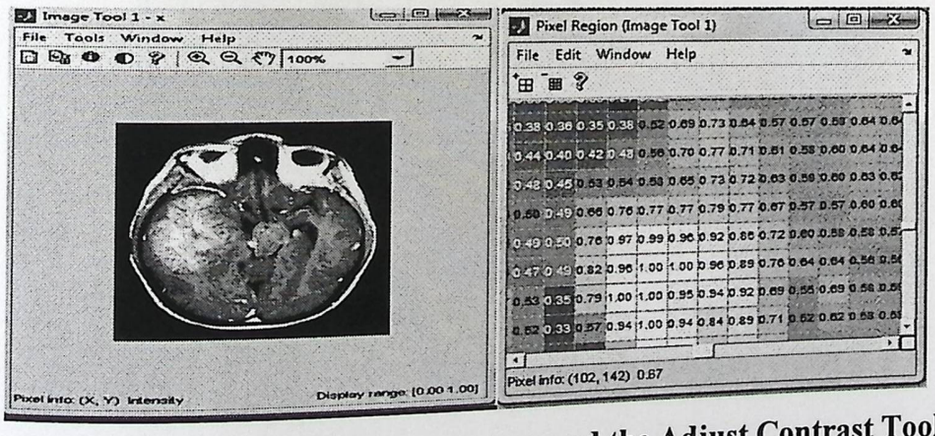


Figure 5.1 Pixel Region of an X-ray CT scan and the Adjust Contrast Tool

1. We calculate The statistical functions such as: mean, median standard deviation, range, etc., (Figure5.2)

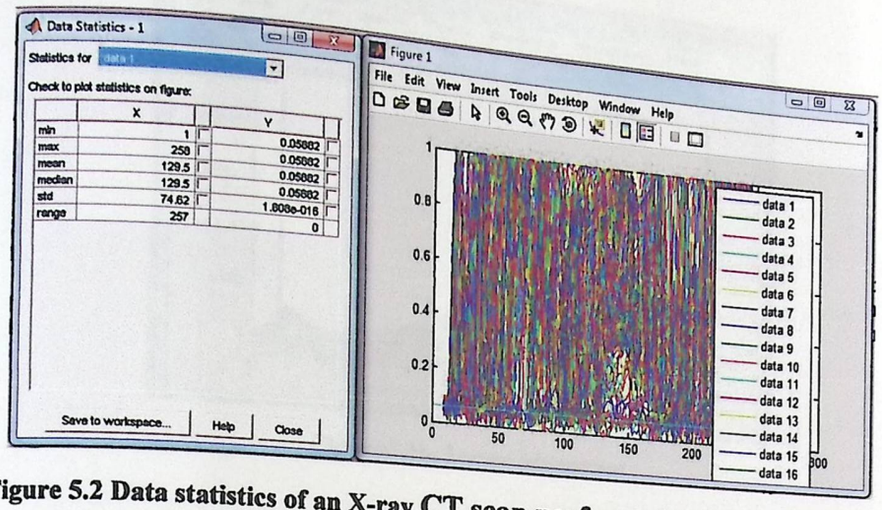


Figure 5.2 Data statistics of an X-ray CT scan performed by MATLAB 7.0.

1. We displayed the brain image histogram and plotted the profile of intensity values (Fig5.3a, b).

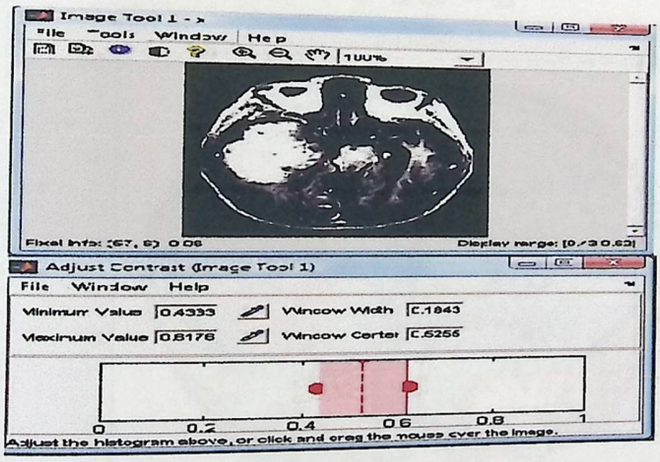


Figure5.3 a. Brain image and adjusting contrast

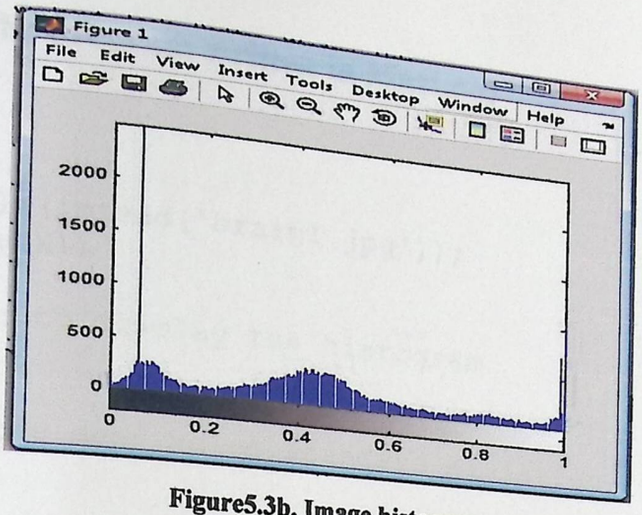


Figure5.3b. Image histogram

2. Contour Plot is used since it is useful for delineating organ boundaries in images. It displays isolines of a surface represented by a matrix (Figure 5.5).

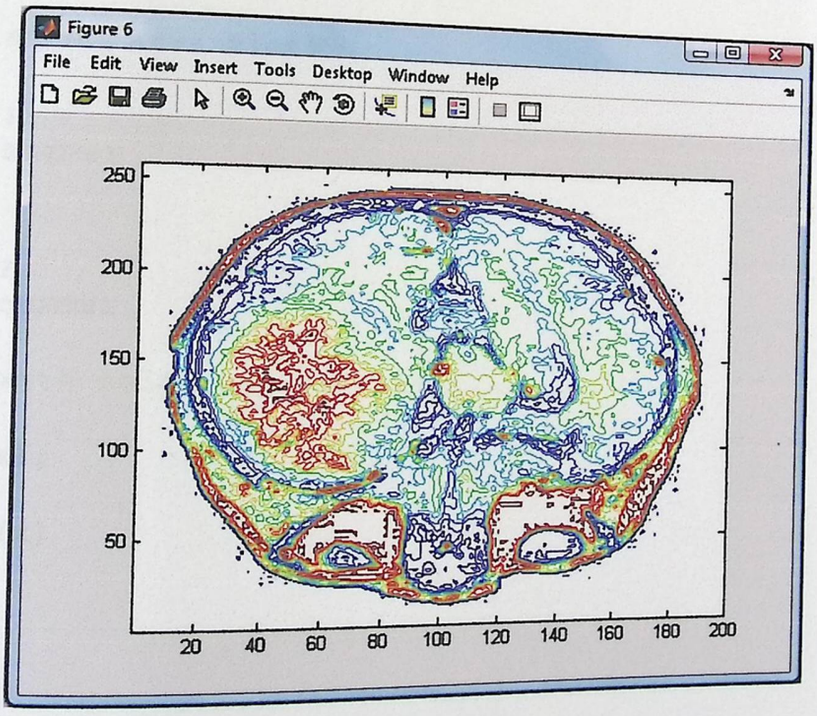


Figure5. 4 Contour plot

5.2 Code for the program written in MatLab:

The code is:

```
X = im2double(imread('brain1.jpg'));
x = rgb2gray(X);
imshow(x)
%now we want to display the histogram
figure(1),
imhist(x)
%calculate the mean value,standard diviation,
y=mean2(x)
s=std2(x)
%caculate the area
figure(2)
a=area(x)
grid on
colormap summer
colorbar
title 'Stacked Area Plot'
figure(3)
surfc (x);
colormap summer
alpha(.0)
figure(4)
surfc (x);
colormap summer
alpha(.4)
 % image with color map scalling
figure(5)
imagesc (x);
figure(6)
c=contour(x)
imshow(c)
```

6

Future Work

6.1. Results and Discussions

6.1Result and conclusion

Since, very simple linear and non- linear filters are used, this algorithm is significantly fast. As the noise is mostly impulse noise ,the use of median filter fulfills the requirement. Adaptive median filter may do in cases having the need for very high accuracy. But the size of the filter window has to be right. Larger size than the required filter size may result in smoothing out of the images, resulting in very unclear edges. Smaller sized window may result in insufficient noise removal.

This method is based on DCT. This method works well with all types of conditions and has shown its insensitivity to small disturbances. The images used here are not normal clear images. In spite of that the extraction of edges shows the reliability and accuracy of this method. This method has very high potential for being implemented in future CT systems, due to its good speed and accuracy. Also, with the development of new software day by day that support more and more parallel computation, this method can be seen as the real solution of tumor detection.

In this experiment we could test for 8 different kinds of tumors collected from online brain atlases. The results were very successful, but it is very clear that they could be improved by having a good training set(having more healthy CT images) and increasing the number of descriptors that are being used in the profiles. The system that we have implemented is used for detecting tumors in brain CT images. Although, some medical assistance would be necessary taking into account that such a project represents an interdisciplinary work and both computer knowledge and medical are needed. we had no extra information that could be very useful in detecting some patterns in developing a certain disease. In such a system, not only the images are important, but also some patient information. We intend to continue the work on this system, so in the following lines we will present some future research that we want to do. First, hopefully, we will have more images and real

ones. When the acquisition of these images will be done, we want to use both feature extracted from images(descriptors) and patient information in order to get an accurate classification of the images in normal and abnormal. In our opinion, the classification of the tumors can be performed after the segmentation method and the segmentation results to be used in classification. The results of the segmentation could also be used to detect the size or the location of the tumor in the brain. Also, this location could probably lead to interesting patterns when more images are studied.

APPENDECIES

1. Appendix A (Used Programs).

2. Appendix B (Codes).

Appendix A (Used Programs)

1. Microsoft Word: this program was used for writing the documentation of our project. It is a very easy program to deal with; also gives many opportunities for controlling the options of writing.

2. Microsoft Project: this program was used for generating the scheduling table, and also producing the timing plan. It is an important program and every body must have even little information about this program.

3. Microsoft Visio: this program was used for generating the block diagrams implemented inside this project. This program gives also excellent choices to draw and generate block diagrams.

4. Math Type: is an intelligent mathematical equation editor designed for personal computers running Microsoft Windows.

Appendix B (Codes)

1- The code is:

```
X = im2double(imread('brain1.jpg'));
x = rgb2gray(X);
imshow(x)
%now we want to display the histogram
figure(1),
imhist(x)
%calculate the mean value,standard diviation,
y=mean2(x)
s=std2(x)
%caculate the area
figure(2)
a=area(x)
grid on
colormap summer
colorbar
title 'Stacked Area Plot'
figure(3)
surfc (x);
colormap summer
alpha(.0)
figure(4)
surfc (x);
colormap summer
alpha(.4)
 % image with color map scalling
figure(5)
imagesc (x);
figure(6)
c=contour(x)
imshow(c)
```

2-

```
X1 = im2double(imread('brain1.jpg'));
x1 = rgb2gray(X1);
imshow(x1)
X2 = im2double(imread('brain4.jpg'));
x2 = rgb2gray(X2);
imshow(x2)
%now we want to display the histogram
figure(1),
imhist(x1)
imhist(x2)

%calculate the mean value,standard diviation,
y1=mean2(x1)
s1=std2(x1)
y2=mean2(x2)
s2=std2(x2)
 R = corrcoef(x1,x2)
imshow(R)
```

3-

```
X = im2double(imread('brain4.jpg'));% load image as a double
x = rgb2gray(X);                    % convert to a 2-D image
 y=randn(size(x));
 np=sum(sum(y.^2));
 sp=sum(sum(x.^2));
 tt=sp/np;
a=input('please input the multiplying factor in db that you need to
remove ');
a=10^(a/10);
pf=tt/a;
ny=pf*y;%ny is the noise  added to the original image which have the
same size
nx=x+ny;  %nx is the noisy image which equall to the original image
plus the added noise
subplot(441),image(100*x),title('original image') %we multiply the
image by 1000 inorder to have sauitable gray level
subplot(442),image(1000*ny),title('added noise')
subplot(443),image(100*nx),title('noisy image')
%we choose ndb=10 since it is the more sauitable noise
im=100*nx;
im1=medfilt2(im,[3 3]);
BW = edge(im1,'sobel'); %finding edges
[imx,imy]=size(BW);
msk=[0 0 0 0 0;
    0 1 1 1 0;
```

```
    0 1 1 1 0;
    0 1 1 1 0;
    0 0 0 0 0;];
 B=conv2(double(BW),double(msk));
L = bwlabel(B,8);% Calculating connected components
colormap gray
 xf=dct2(x);
 [i  j]=size(x);
 for i=1:257
    for j=1:250
      r=sqrt(i^2+j^2);
    if(r<70),xf(i,j)=xf(i,j);
    else xf(i,j)=0;
    end
    end
 end
 pause
 subplot(444),image(100*xf),title('dct')
 mX=idct2(xf);
subplot(425),image(100*mX),title('idct')
 % Storing the extracted image in an array
 subplot(445),image(100*BW),title('sobel')
subplot(446),image(100*B),title('finding edge')
```

4-

```
X = im2double(imread('brain1.jpg'));% load image as a double
x = rgb2gray(X);                    % convert to a 2-D image
 y=randn(size(x));
 np=sum(sum(y.^2));
 sp=sum(sum(x.^2));
 tt=sp/np;
a=input('please input the multiplying factor in db that you need to
remove ');
a=10^(a/10);
pf=tt/a;
ny=pf*y;%ny is the noise  added to the original image which have the
same size
nx=x+ny;  %nx is the noisy image which equall to the original image
plus the added noise
subplot(441),image(100*x),title('original image') %we multiply the
image by 1000 inorder to have sauitable gray level
subplot(442),image(1000*ny),title('added noise')
subplot(443),image(100*nx),title('noisy image')
%we choose ndb=10 since it is the more sauitable noise
im=100*nx;
im1=medfilt2(im,[3 3]);
BW = edge(im1,'sobel'); %finding edges
[imx,imy]=size(BW);
```

```
msk=[0 0 0 0 0;
     0 1 1 1 0;

     0 1 1 1 0;
     0 1 1 1 0;
     0 0 0 0 0;];
 B=conv2(double(BW),double(msk));
L = bwlabel(B,8);% Calculating connected components
colormap gray
 xf=dct2(x);
 [i  j]=size(x);
 for i=1:257
     for j=1:250
       r=sqrt(i^2+j^2);
     if(r<70),xf(i,j)=xf(i,j);
     else xf(i,j)=0;
     end
     end
 end
 pause
 subplot(444),image(100*xf),title('dct')
 mX=idct2(xf);
subplot(425),image(100*mX),title('idct')
 % Storing the extracted image in an array
 subplot(445),image(100*BW),title('sobel')
subplot(446),image(100*B),title('finding edge')
```

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