

NEAR EAST UNIVESITY

Faculty of Engineering

Department of Biomedical Engineering

**DEVELOPING TUMOR CLASSIFICATION
ALGORTIHM USING SVM ON MATLAB**

**A THESIS SUBMITTED TO THE UNDERGRADUATE
SCHOOL OF BIOMEDICAL ENGINEERING OF NEAR
EAST UNIVERSITY**

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ABSTRACT

Brain tumor is a disease that threatens every person's life. It begins with an abnormal growth of cells that begins their division and multiplication in an uncontrolled manner which will increase the pressure inside the crane. When cells get old they either die or repair themselves. The main cause of death of the people with brain tumor is that they couldn't diagnose the type of tumor detected. Medical images like ECG, MRI and CT-scan images are important way to find the disease of human in an efficient way. To the errors made manually, an automated intelligent classification technique is proposed which helps us to classify the images. In our project, classification techniques based on Support Vector Machines (SVM) and image segmentation are proposed and applied to brain image classification using Matlab algorithms. Our Matlab code uses Graphical User Interface (GUI) provides an easy for user interface software by eliminating the need to learn a language or type commands in order to run the application. The system determines the type of the tumor which is benign or malignant using the Magnetic Resonance Imaging (MRI) images. The system is assessed based on a series of brain tumor images.

Keywords: *Support Vector Machine (SVM), Segmentation, Magnetic Resonance Image (MRI), Brain Tumor, Matlab, Graphical User Interface (GUI)*

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CHAPTER 1

INTRODUCTION PURPOSE

1.1 Introduction

A brain tumor is a disease in which cells divide in an uncontrollable way in the brain. Brain tumors have mainly two types. First is Benign tumors which is a type of tumor that the disease can't go out of the brain. It is possible to leave it without treatment and it doesn't exceed in a fast way. Sometimes problems are found because of their positions and surgery or radiation can be used. Second is Malignant and it is what called brain cancer. These type of tumors can affect cells near it and reach organs outside the brain. If they are not treated malignant tumor can make many problems in the brain. Also the brain malignancies is divided to two types. Primary brain cancer starts in the brain. Secondary the tumor comes to the brain from other organs. Generally, cells divide in a specific way. The main cause of the cancer is when cells, and in our case the brain cells, begin to divide uncontrollably. If cells keep dividing randomly the new not needed cells will form a tissue which is also not needed. This tissue is called cancer.

Computer and Information Technology are very much helpful in medical image processing, medical analysis and classification. Most used methods are X-ray and MR. Magnetic Resonance Imaging (MRI) is used as a valuable tool in the clinical and surgical environment because of its characteristics like superior soft tissue differentiation, high spatial resolution and contrast. It does not use harmful ionizing radiation to patients. Magnetic (Walker, et al, 1995).

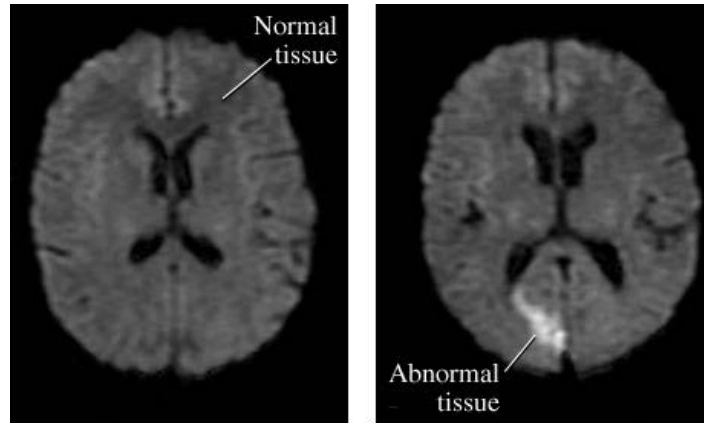


Figure 1: Normal and Abnormal MRI Brain Image

The MRI (figure 1) mainly used for brain tumor diagnosing and detection. The MRI images visual evaluation and examination by radiologists takes a lot of time and can have some errors because of the many details that the MRI image contain. Therefore an algorithmic image processing can help radiologists in brain tumor diagnosis in these types of images, especially since brain tumor detection and segmentation needs to take into account large variations in appearance and shape of structures. Hence there is a need for automated systems for analysis and classification of such medical images. An intelligent classification technique is proposed to recognize normal and abnormal MRI brain image. Here classification techniques based on Support Vector Machines (SVM) are proposed and applied to brain image classification. Support vector machines can be a help on classifying complicated images because the only features it uses is high dimensional histograms. This system for tumor detection and segmentation consists of several stages:

- i. Input MRI Brain images.
- ii. Image preprocessing is used to improve the quality of images.
- iii. The obtained image with the removed noise is segmented in order to extract the brain tumor.
- iv. Features will be extracted from the segmented images.
- v. The reduced features are submitted to a support vector machine classifier to identify tumor and to detect the edge of the tumor part in the brain.

In this thesis we propose an intelligent classification technique to recognize normal and abnormal MRI brain image. This has a high accuracy and low error rate of MRI brain tumor classification using SVM. The classification techniques based on Support Vector Machines (SVM) and image segmentation are proposed and applied to brain

image classification. The remaining thesis is organized as follows: Section 2 talks generally about the anatomy and physiology of the brain. In Section 3, the proposed system has been described. Section 4 describes the architecture of proposed automatic intelligent classification technique. Section 5 summarizes the contents of this paper (Wang. et al., 2009).

1.2 Literature Review

There have been other works from people on how to accomplish the image analysis of brain tumor; our work has been only a development of many ideas proposed before by many scientists and biomedical engineers. The development of science, all over the years, has come to this level by scientists developing precedent ideas proposed by precedent scientists. The idea of using image segmentation and SVM for brain tumor detection by MRI image. At first, the idea began by doing image segmentation of the brain by IEEE students. Segmenting an image is decomposing it to parts in order to make it understandable by computer systems. After segmenting the image the results was in black and white image where the tumor cells in the brain can be detected easier.

After that three scientists worked on a paper by the name of International Journal of Research in Engineering and Technology developing the idea of segmentation by adding edge detection to it. So for the users it would be easier to detect which part is really a tumor tissue or cells by highlighting its edges. The results weren't at first so accurate so the algorithms has passed to many modifications by many other scientists and many papers were written in this domain. In 2013 the idea of using the SVM to classify the tumor as benign or malignant was proposed and using many studies and papers we did make writing an algorithm using the cited method to make it easier for radiologists to detect the tumor and its type.

CHAPTER 2

CLINICAL BACKGROUND

2.1 Anatomy and Physiology of the Brain

The brain is viewed as an organ contained tissue and neurons, situated in the head and secured by a hard cover named the skull. The brain is the center that control the body and is linked with the spinal cord. Together, The brain and the spinal cord form What is known as the Center Nervous System (CNS). The spinal-cord is the part that attaches the brain to the body mailing and obtaining information from also to it, to hook up the brain to the body ,the CNS works together with (PNS) Which is peripheral nervous system, also is made of neurons that branch out of the spinal-cord to body parts to convey either engine message (prompting strolling, talking,...) to these parts, or tactile messages from these parts (prompting vibe of torment, touch,...) (Saladin. et al.,1992).

2.2 Structure and Function of the Brain

The brain is the control center in the body . it gets the signals from the PNS and translate them . From then on, it responds predicated on the information it received. The brain is manufactured out of several parts, each charge of different function . Some parts control {motion, movements, activity}, others control {conversation, talk}, {feelings, thoughts}, balance, or even interior bodily functions. The elements of the brain will be the pursuing: cerebrum, cerebellum and brain stem. (Saladin,et al,1992)

The Central Nervous System

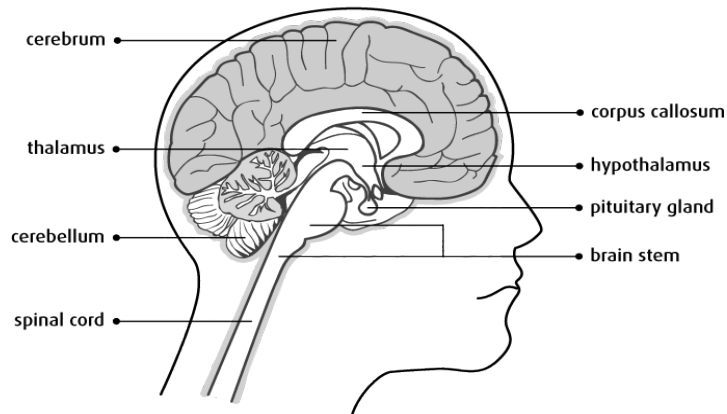


Figure 2: The Central Nervous System

2.3 Cerebrum

The cerebrum is the largest part of the brain and it is partitioned into two sections: the left and right cerebral sides of the cerebrum . The 2 sides of the cerebrum are associated by a scaffold of nerve filaments called the corpus callosum. The right side of the hemispheres controls the left side of the body and left side of the body controls the right side of the body it is inverse relationship. The space that located outer of the cerebrum is called cerebral cortex. This area of the brain (cerebral cortex) which the nerve cells make connections which is called synapses, This part controls the brain activity . The internal part of the cerebrum contained axons which is the isolated bodies of the nerve cells which transfer signals between the spinal-cord and brain . The cerebrum consist of 4 main parts called lobes. frontal lobe(front),parietal lobe(top), occipital lobe (back), temporal lobe(side) (Saladin. et al.,1992).

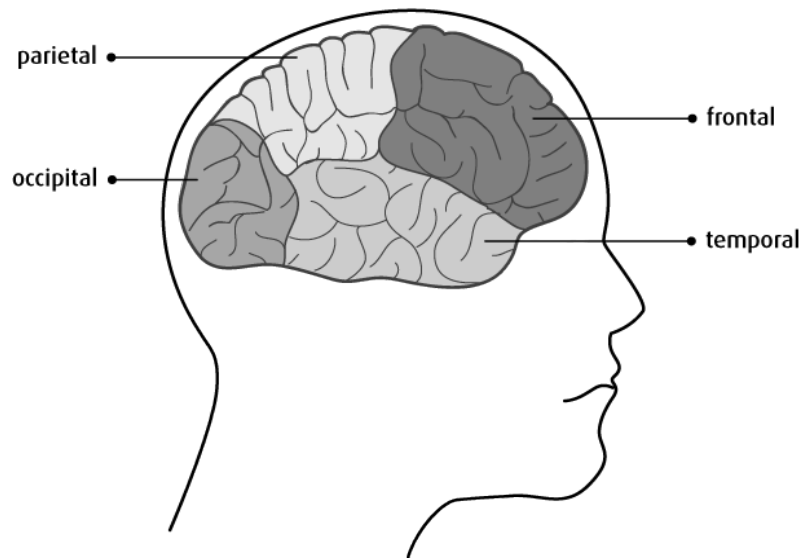


Figure 3: Lobes of the Brain

Each side has different function :

- The frontal lobe (front): is the center for voluntary movement and also called motor area, The pre frontal area controls intelligence, ideas,creativity,memory, discourse, conduct, feelings and scholarly working.
- The parietal lobe (top): this part of the cerebrum collects, organizes and recognizes sensations for example position, pain, touch, temperature, movement.
- The temporal lobe (side):this part of the cerebrum processes auditory information and stores auditory and visual memories and also controls emotions, memory, hearing.
- The occipital lobe (back):this part of the cerebrum controls vision, visual memory, eye movement(Saladin. et al.,1992).

2.4 Cerebellum

The cerebellum is located at the back of the brain and it is second largest part, it is consist of three main parts vermis, right cerebellar hemisphere, left cerebellar hemisphere

- position

- memory
- vision
- balance
- walking, talking
- receives the sensory information from the body (Saladin, et al, 1992)

2.5 Brain stem

The brain stem is located between cerebrum and cerebellum and it is at base of the brain and it connects the cerebrum to spinal-cord, the brain stem made of nerve tissue and is used to send signals between the brain and to different parts of the body.

The brain consist of three main parts:

- medulla oblongata
- midbrain
- pons

The brain stem controls:

- muscles of the face, alertness
- respiration, heart action
- blood pressure (Saladin. et al., 1992)

2.6 Other important parts of the brain

2.6.1 CerebroSpinal Fluid (CSF)

The cerebrospinal fluid is a watery liquid that found inside the brain, spinal-cord, subarachnoid space and it is supports weight of the brain and protect them. CSF gives the nutrients to the brain from blood. (Saladin. et al., 1992)

2.6.2 Meninges

The meninges is a tissue that cover and protect the brain and spinal-cord by 3 thin layers:

- Dura matter: The outer side, toughest, hardest

- Arachnoid layer: The middle side, thin membrane
- Pia matter: The inner side, thinner membrane
- Cerebrospinal fluid is a liquid that flows between the arachnoid layer and pia matter in the space, this space called subarachnoid space (Saladin. et al., 1992)

2.6.3 Corpus callosum.

The corpus callosum is a pack of nerve tissue and it is located between the two hemisphere (halves) of the cerebrum and it make connection between them (Saladin. et al., 1992).

2.6.4 Thalamus

The thalamus is located in the middle of the brain and it contained two lobes, receives sensory information and send it to the cerebral cortex

2.6.5 Hypothalamus

The hypothalamus is located in the middle of the brain beside the thalamus. it is responsible for controlling some body functions like appetite, blood pressure, automatic nervous system, emotions, carbohydrate.

2.6.6 Pituitary gland

The pituitary gland is located in the center of the brain. it is connected to the hypothalamus it is responsible for secretion some hormones in order to control other glands of the body.

2.6.7 Ventricles

The ventricles are cavities inside the brain and it has four types :

- First and second (Lateral ventricles) are located in cerebral hemisphere.
- Third ventricle is located in the center of the brains and covered by thalamus and hypothalamus.
- The fourth ventricle is located in the back of the brain which is between brain stem and cerebellum.

- All ventricles are connected to the each other, The cerebrospinal fluid (CSF); is the fluid flows in the ventricles around the brain and to the spinal-cord

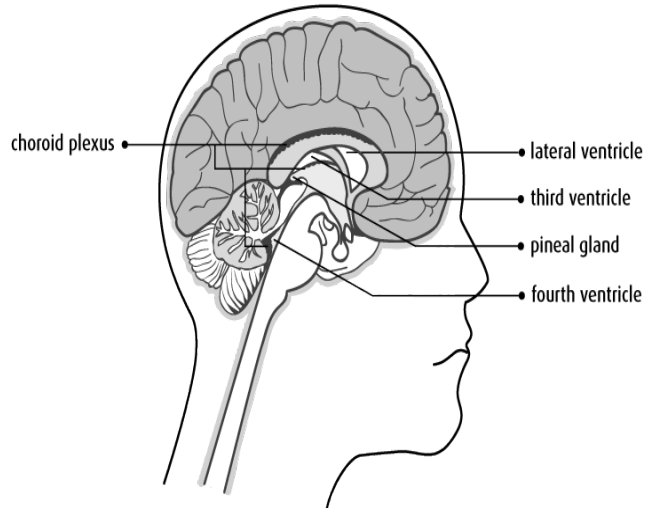


Figure 4: Ventricles of the Brain(Saladin. et al.,1992)

2.6.8 Pineal gland

The pineal gland is located in third ventricle in the brain and it is very small gland and it is responsible of secretion some hormones for sleeping, walking and sexual development.

2.6.9 Choroid plexus

The choroid plexus it is responsible for producing (CSF)and it is very small organ in the ventricles.

2.6.10 Cranial nerves

The cranial nerves indicated by there numbers or names which contained 12 pairs which has specific functions. The first pairs begins in the cerebrum and the other begins in brainstem.

Function of cranial nerves;

NUMBER	NAME	FUNCTION
1	Olfactory	Smell
2	Optic	Vision and light detection by pupil
3	Oculomotor	Eye movement

		Narrowing and wending
4	Trochlear	Eye movement
5	Trigeminal	Facial sensations Chewing
6	Abducens	Eye movement outward
7	Facial	Facial expression Closing of the eyelid Taste of the front of the tongue
8	Acoustic	Balance Hearing
9	Glossopharyngeal	Speech Swallowing Gag reflex
10	Vagus	Control of the muscles in internal organs Speech Swallowing Gag reflex
11	Assessory	Neck turning Shoulder shrugging
12	Hypoglossal	Tongue movement

Table 1 Cranial nerves and their functions

2.6.11 Blood brain barrier

The blood brain barrier is a system of blood vessels and enzymes that provide a protection from the chemicals, toxins and microbes that enter the brain.

2.6.12 Types of cells in the brain

The brain consists of neurons and glial cells.

- Glial cells (neuroglial cells)
 - These cells are responsible for the support, feed and protect the neurons .
 - There are four different types :
 - Microglial cells.
 - Oligodendrocytes.
 - Astrocytes.
 - Ependymal cells.
- Neurons:
 - Neurons are nerve cells.
 - Responsible for carrying signals that allows nerve system to work.
 - If they are damage we cannot be able to replace it

CHAPTER 3

METHODOLOGY

This section presents the material, the source of brain MR image dataset, and the algorithm used to perform brain MR tissue segmentation. For our project, we will use an MRI image database and an algorithm done on MATLAB. The following image shows the steps in our proposed algorithm.

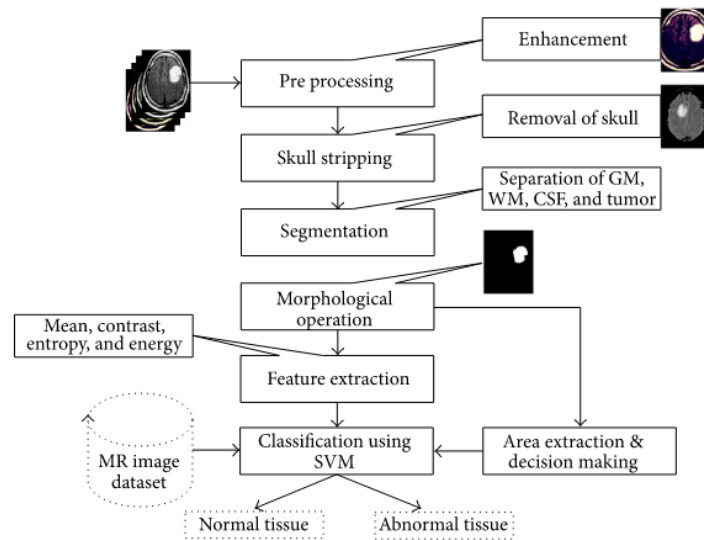


Figure 5 : Steps in the Proposed Algorithm

The proposed methodology is applied to real dataset including brain MR images of 512×512 pixel size, which were converted into 200×200 and grayscale before any processing. The following sections discuss the part of the algorithm.

3.1 Preprocessing

The main goal of the preprocessing part is to improve the quality of the image to make it more suitable for use by human and machine vision system. Preprocessing improves many parameters for MR images such as the signal to noise ratio and the visual appearance of MR images, in addition to removing unwanted parts and noise from the image so we can focus on the wanted parts and edges (Furey et al., 2000).

3.2 Skull Stripping

According to the book *Morphology Based Enhancement and Skull Stripping of MRI Brain Images* written by the researchers C. C. Benson and V. L. Lajish, skull stripping is an important process in biomedical image analysis, and it is required for the effective examination of brain tumors from the MR images.

Skull stripping is the step of removing all non-brain tissues in the brain images. Skull stripping gets rid of tissues such as fat, skin, and skull in the images. Many methods can be used for skull stripping. We have used what is known as skull stripping based on threshold value to remove skull tissues(Furey. et al.,2000).

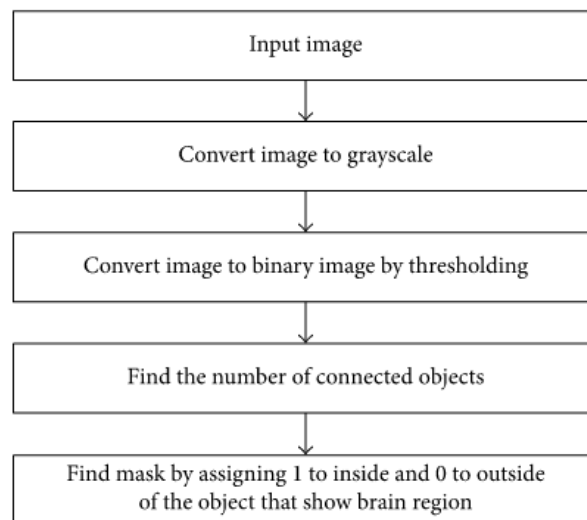


Figure 6: Steps Used in Skull Stripping Algorithm

3.3 Segmentation and Morphological Operation

Segmentation of the MR image is done by many steps. At first the preprocessed MR image is converted into a binary image using a threshold value. Every pixel value greater than our threshold value will be transformed to white, while the others are transformed to black. We will have 2 different parts around the infected tumor tissues which will be extracted for information. Secondly, we remove the white pixels using erosion operation of morphology. At the end the eroded region the image at the beginning and the eroded image are both divided into two equal regions and the black

pixel region extracted from the erode operation is counted as a brain MR image mask. In this study, Berkeley wavelet transformation is employed for effective segmentation of brain MR image. A wavelet is a function that is defined over a finite interval of time and has an average value of zero. The wavelet transformation technique is employed to develop functions, operators, data, or information into components of different frequency, which enables studying each component separately. The Berkeley wavelet transform (BWT) is described as a two-dimensional triadic wavelet transform and can be used to process the signal or image. The BWT algorithm will also perform data conversion from a spatial form into temporal domain frequency. The BWT shows a very useful method to show image transformation and it is totally orthonormal. The morphological operation is used for the removal of the boundaries of the brain images. Basically the morphological operation will only rearrange the order of the pixel by their values, not by their mathematical values, and so is suitable to process only binary images. Dilation and erosion are the most fundamental operations of morphology. Dilation operations are used to add pixels to the boundaries of the object, but erosion operations are used to eliminate the pixels from their boundaries. The method of adding and removing pixels to or from boundaries of the objects is depending on the forming element of the selected image. (Jensen., 1996).

2.3.4 Feature Extraction

It is the process of collecting higher-level information of an image such as shape, texture, color, and contrast. In fact, texture analysis is an important parameter of human visual perception and machine learning system. It is used effectively to improve the accuracy of diagnosis system by selecting prominent features.

Haralick et al. introduced one of the most widely used image analysis applications of Gray Level Co-occurrence Matrix (GLCM) and texture feature. This technique follows two steps for feature extraction from the medical images. In the first step, the GLCM is computed, and in the other step, the texture features based on the GLCM are calculated. Due to the intricate structure of diversified tissues such as WM, GM, and CSF in the brain MR images, extraction of relevant features is an essential task. Textural findings and analysis could improve the diagnosis, different stages of the tumor (tumor staging), and therapy response assessment. The statistics feature formula for some of the useful features is listed below:

1. Mean (M): The mean of an image is calculated by adding all the pixel values of an image divided by the total number of pixels in an image.

$$M = \left(\frac{1}{m \times n} \right) \sum_{x=0}^{m-1} \sum_{y=0}^{n-1} f(x, y).$$

2. Standard Deviation (SD): The standard deviation is the second central moment describing probability distribution of an observed population and can serve as a measure of inhomogeneity. A higher value indicates better intensity level and high contrast of edges of an image.

$$SD(\sigma) = \sqrt{\left(\frac{1}{m \times n} \right) \sum_{x=0}^{m-1} \sum_{y=0}^{n-1} (f(x, y) - M)^2}.$$

3. Entropy (E): Entropy is calculated to characterize the randomness of the textural image and is defined as

$$E = - \sum_{x=0}^{m-1} \sum_{y=0}^{n-1} f(x, y) \log_2 f(x, y).$$

4. Skewness (Sk): Skewness is a measure of symmetry or the lack of symmetry. The skewness of a random variable X is denoted as Sk(X) and it is defined as

$$S_k(X) = \left(\frac{1}{m \times n} \right) \frac{\sum (f(x, y) - M)^3}{SD^3}.$$

5. Kurtosis (Kurt): The shape of a random variable's probability distribution is described by the parameter called Kurtosis. For the random variable X, the Kurtosis is denoted as Kurt(X) and it is defined as

$$K_{urt}(X) = \left(\frac{1}{m \times n} \right) \frac{\sum (f(x, y) - M)^4}{SD^4}.$$

6. Contrast (Con): Contrast is a measure of intensity of a pixel and its neighbor over the image, and it is defined as

$$C_{on} = \sum_{x=0}^{m-1} \sum_{y=0}^{n-1} (x - y)^2 f(x, y).$$

7. Inverse Different Moment (IDM) or Homogeneity: Inverse Difference Moment is a measure of the local homogeneity of an image. IDM may have a single or a range of values so as to determine whether the image is textured or non-textured.

$$\text{IDM} = \sum_{x=0}^{m-1} \sum_{y=0}^{n-1} \frac{1}{1 + (x - y)^2} f(x, y).$$

8. Directional Moment (DM): Directional moment is a textural property of the image calculated by considering the alignment of the image as a measure in terms of the angle and it is defined as

$$\text{DM} = \sum_{x=0}^{m-1} \sum_{y=0}^{n-1} f(x, y) |x - y|.$$

9. Energy (En): Energy can be defined as the quantifiable amount of the extent of pixel pair repetitions. Energy is a parameter to measure the similarity of an image. If energy is defined by Haralicks GLCM feature, then it is also referred to as angular second moment, and it is defined as

$$\text{En} = \sqrt{\sum_{x=0}^{m-1} \sum_{y=0}^{n-1} f^2(x, y)}.$$

10. Correlation (Corr): Correlation feature describes the spatial dependencies between pixels and it is defined as

$$C_{\text{orr}} = \frac{\sum_{x=0}^{m-1} \sum_{y=0}^{n-1} (x, y) f(x, y) - M_x M_y}{\sigma_x \sigma_y},$$

11. Coarseness (Cness): Coarseness is a measure of roughness in the textural analysis of an image. For a fixed window size a texture with a smaller number of texture elements is said to be more coarse than the one with a larger number. The rougher texture means higher coarseness value. Fine textures have smaller values of coarseness. It is defined as

$$C_{\text{ness}} = \frac{1}{2^{m+n}} \sum_{x=0}^{m-1} \sum_{y=0}^{n-1} f(x, y).$$

12. Variance: The standard deviation (σ) is simply the (positive) square root of the variance. It is used to find how each pixel varies from the neighboring pixel (or center pixel) and is used in classify into different regions.

$$\sigma^2 = \frac{\sum (X - \mu)^2}{N}$$

13. Smoothness: In smoothing, the data points of a signal are modified so individual points (presumably because of noise) are reduced, and points that are lower than the adjacent points are increased leading to a smoother signal.(Furey, et al,2000)

3.5 Support Vector Machine (SVM)

Support vector machines are supervised learning models with associated learning algorithms that analyze data and recognize patterns, used for classification. The basic SVM takes a set of input data and for each given input, predicts, which of two classes forms the input, making it a non-probabilistic binary linear classifier. From given set of training examples, each marked as belonging to one of two categories, an SVM training algorithm builds a model that assigns new examples into one category or the other. In the proposed method we are using linear classifier. Best hyper plane is the one that represents the largest separation or margin between the two classes. So we choose the hyperplane so that the distance from it to the nearest data point on each side is maximized. If such a hyper plane exists, it is known as the maximum margin hyperplane and the linear classifier it defines is known as a maximum classifier, which is shown in the figure below(Wang. et al.,2009).

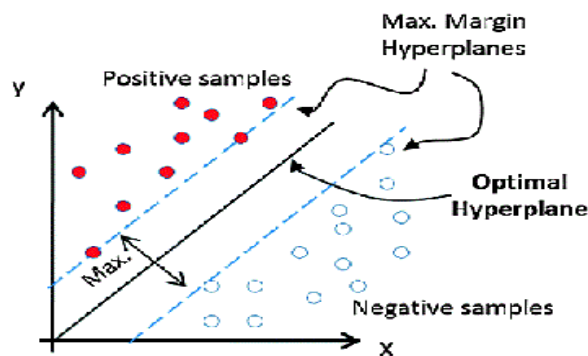


Figure 7: SVM Classifier

3.6. Edge Detection

In the last part of the project we have added an edge detection part for the program to AutoDetect the tumor in the MRI image.

We use at the beginning the same gray image we have used in the classification and apply the Sobel operator on it.

3.6.1 Sobel Operator

Sobel operator or Sobel filter is widely used in image processing and computer vision. It was co-developed with Gary Feldman at SAIL. Sobel and Feldman presented the idea of an "Isotropic 3x3 Image Gradient Operator" at a talk at SAIL in 1968. Technically, it is a discrete differentiation operator, computing an approximation of the gradient of the image intensity function. At each point in the image, the result of the Sobel–Feldman operator is either the corresponding gradient vector or the norm of this vector. The Sobel–Feldman operator is based on decomposing the image with a small, separable, and integer-valued filter in the horizontal and vertical directions for a specific task (Jensen.,1996).

3.6.2 Sobel Operator on Matlab

The Sobel operator on Matlab is already found, so by writing the correct algorithm we can have the output directly without implementing the arrays. The Sobel operator uses complicated formulas that are done for a 2-D image on the x-axis and y-axis and these formulas were converted into an array that can be applied to every pixel of the image vertically and horizontally in order to get the wanted output. And since we are applying the mask on x and y axis we should get the norm to get the output from the following formula

$$\mathbf{G} = \sqrt{\mathbf{G}_x^2 + \mathbf{G}_y^2}$$

Where G is the desired output and Gx and Gy are the output in the horizontal and vertical vector.

3.6.3 Image fusion

Image fusion refers to the combination of all important images to form one image with desired characteristics without producing image. In this case show the edge of the skin tumor(Jensen., 1996).



Figure 8: Gray Scale / Post Processed / Fused Image

3.6. System as Whole

Our program is decomposed to three main parts. After being activated a pop-up window will be shown which is a GUI automatically generated by Matlab, and designed by us. For the first part it is just a read image part where the user can load the needed image to the program in order to be processed later.

In the second part, the image is pre-processed, skull stripped, and segmented. The results will be shown in the middle box on the GUI. After that the extraction features were used and SVM applied in order to classify the results as if the tumor is benign or malignant.

For the last part we have used another segmentation method, so at first the image is pre-processed and then using Sobel operator we have detected the edge of the tumor in the MRI image. In order to get a better image and to see the details of the MRI image we have used the image fusion filter and the results is posted at the third box.

CHAPTER 4

CONCLUSION

Brain tumor is a main cause of death. Many approaches are used to detect the tumor as early as possible because early detection is important in the cure of this disease. Medical imaging can be used for the identification of brain tumor. For MRI-based brain tumor identification, the proposed system is proved to be quite efficient. Our proposed system is a new algorithm for automatic segmentation of Brain tumor for MRI image and classification of this tumor as Benign or Malignant.

We used all the mentioned processes to make this a unique and effective program as seen from the performance of the system. Our program has one of the best accuracy with brain tumor which is the deadliest form of cancer. With 100 percent performance for segmentation accuracy, and 100 percent for classification. The system is quite useful in the context of detection and classification of brain tumors.

Besides the ability of the program to load image and segment it by click from the user is very practical and can help radiologists accomplishing their work in more accurate way.

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APPENDIX

THE CODE

```
function varargout = untitled(varargin)
% UNTITLED MATLAB code for untitled.fig
%   UNTITLED, by itself, creates a new UNTITLED or raises the existing
%   singleton*.
%
%   H = UNTITLED returns the handle to a new UNTITLED or the handle to
%   the existing singleton*.
%
%   UNTITLED('CALLBACK',hObject,eventData,handles,...) calls the local
%   function named CALLBACK in UNTITLED.M with the given input arguments.
%
%   UNTITLED('Property','Value',...) creates a new UNTITLED or raises the
%   existing singleton*. Starting from the left, property value pairs are
%   applied to the GUI before untitled_OpeningFcn gets called. An
%   unrecognized property name or invalid value makes property application
%   stop. All inputs are passed to untitled_OpeningFcn via varargin.
%
%   *See GUI Options on GUIDE's Tools menu. Choose "GUI allows only one
%   instance to run (singleton)".
%
% See also: GUIDE, GUIDATA, GUIHANDLES

% Edit the above text to modify the response to help untitled

% Last Modified by GUIDE v2.5 16-Apr-2017 01:07:00

% Begin initialization code - DO NOT EDIT
gui_Singleton = 1;
gui_State = struct('gui_Name',    mfilename, ...
                  'gui_Singleton', gui_Singleton, ...
                  'gui_OpeningFcn', @untitled_OpeningFcn, ...
                  'gui_OutputFcn', @untitled_OutputFcn, ...
                  'gui_LayoutFcn', [] , ...
```

```

        'gui_Callback', []);
if nargin && ischar(varargin{1})
    gui_State.gui_Callback = str2func(varargin{1});
end

if nargin
    [varargout{1:nargout}] = gui_mainfcn(gui_State, varargin{:});
else
    gui_mainfcn(gui_State, varargin{:});
end
% End initialization code - DO NOT EDIT

% --- Executes just before untitled is made visible.
function untitled_OpeningFcn(hObject, ~, handles, varargin)
% This function has no output args, see OutputFcn.
% hObject    handle to figure
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)
% varargin   command line arguments to untitled (see VARARGIN)

% Choose default command line output for untitled
handles.output = hObject;
ss = ones(200,200);
axes(handles.axes1);
imshow(ss);
axes(handles.axes2);
imshow(ss);
% Update handles structure
guidata(hObject, handles);

% UIWAIT makes untitled wait for user response (see UIRESUME)
% uiwait(handles.figure1);

% --- Outputs from this function are returned to the command line.
function varargout = untitled_OutputFcn(~, ~, handles)

```

```

% varargout cell array for returning output args (see VARARGOUT);
% hObject handle to figure
% eventdata reserved - to be defined in a future version of MATLAB
% handles structure with handles and user data (see GUIDATA)

% Get default command line output from handles structure
varargout{1} = handles.output;

% --- Executes on button press in pushbutton1.
function pushbutton1_Callback(hObject, ~, handles)
% hObject handle to pushbutton1 (see GCBO)
% eventdata reserved - to be defined in a future version of MATLAB
% handles structure with handles and user data (see GUIDATA)
[FileName,PathName] = uigetfile('*.jpg;*.png;*.bmp','Pick an MRI Image');
if isequal(FileName,0)||isequal(PathName,0)
    warndlg('User Press Cancel');
else
    P = imread([PathName,FileName]);
    P = imresize(P,[200,200]);
    % input =imresize(a,[512 512]);

    axes(handles.axes1)
    imshow(P);title('MRI Image');
    % helpdlg(' Multispectral Image is Selected ');

    % set(handles.edit1,'string',Filename);
    % set(handles.edit2,'string',Pathname);
    handles.ImgData = P;
    % handles.FileName = FileName;

    guidata(hObject,handles);
end

% --- Executes on button press in pushbutton2.
function pushbutton2_Callback(hObject, ~, handles)
% hObject handle to pushbutton2 (see GCBO)

```

```

% eventdata reserved - to be defined in a future version of MATLAB
% handles structure with handles and user data (see GUIDATA)
if isfield(handles,'ImgData')
    %if isfield(handles,'imgData')
    Itumor = handles.ImgData;

gray = rgb2gray(Itumor);
% Otsu Binarization for segmentation
level = graythresh(Itumor);
% gray = gray>90;
%%converting gray scale image to binary image...BW output image with
%%replacing all pixels in the input image with luminescence greater than
%%0.65
image = im2bw(Itumor,0.65);
%removing small object from binary image fewer than 90 pixels
image = bwareaopen(image,90);

axes(handles.axes2)
imshow(image);title('Segmentation');

%image to binary image basing on threshold
image2 = im2bw(Itumor);
handles.ImgData2 = image2;
guidata(hObject,handles);

signalcollected = image2(:,:);
%Normalizing the signal component with respect to other signal components to zero mean
and unit variance.
[cA1,~,~,cD1] = dwt2(signalcollected,'db4');
[cA2,~,~,cD2] = dwt2(cA1,'db4');
[cA3,cH3,cV3,cD3] = dwt2(cA2,'db4');
%collecting signal in 1 matrix
signalzero = [cA3,cH3,cV3,cD3];
%extract important loadings from the matrix collected as signal zero
LSZ = pca(signalzero);
>List them

```

```

whos G
%9 features in the name of status
%%%gray-level spatial dependence matrix of G
g = graycomatrix(LSZ);
status = graycoprops(g,'Contrast Correlation Energy Homogeneity');
%contrast correlation energy homogeneity mean sdv entropy rms
C1 = status.Contrast;
C2 = status.Correlation;
E1 = status.Energy;
H = status.Homogeneity;
Me = mean2(LSZ);
Sdv = std2(LSZ);
E2 = entropy(LSZ);
R = mean2(rms(LSZ));
%%% variance sothess kurtosis skewness IDM
V = mean2(var(double(LSZ)));
a = sum(double(LSZ(:)));
S = 1-(1/(1+a));
ku = kurtosis(double(LSZ(:)));
Sk = skewness(double(LSZ(:)));

a = size(LSZ,1);
b = size(LSZ,2);
in_diff = 0;
for i = 1:a
    for j = 1:b
        temp = LSZ(i,j)/(1+(i-j).^2);
        in_diff = in_diff+temp;
    end
end
I = double(in_diff);
%all features in 1 array /// 13 features
allfeatures = [C1,C2,E1,H, Me, Sdv, E2, R, V, S, ku, Sk, I];

load Matrix.mat
sepinfo = meas;
group = label;

```



```

svmStructure = svmtrain(sepinfo,group,'kernel_function', 'linear');
type = svmclassify(svmStructure,allfeatures,'showplot',false);

if strmatch(type,'MALIGNANT')
else
    strmatch(type,'BENIGN')
end
set(handles.edit2,'string',type);
end

% --- Executes on button press in pushbutton3.
function pushbutton3_Callback(~, ~, handles)
% hObject    handle to pushbutton3 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)
if isfield(handles,'ImgData')
    %if isfield(handles,'imgData')
    I = handles.ImgData;
    rgb=I;
I = rgb2gray(I);
%%sobel mask
hy = fspecial('sobel');
hx = hy';
Iy = imfilter(double(I), hy, 'replicate');
Ix = imfilter(double(I), hx, 'replicate');
gradmag = sqrt(Ix.^2 + Iy.^2);
%%edge detection using Canny method
d = edge(gradmag,'canny',0.3);
%processing image and removing small objects from the image aka clearing
%noise
ds = bwareaopen(d,40);
con=imfuse(ds,rgb, 'ColorChannels',[1 2 0]);
axes(handles.axes3)
imshow(con);title('Edge');
end

```

```

function edit2_Callback(~, ~, ~)
% hObject   handle to edit2 (see GCBO)
% eventdata reserved - to be defined in a future version of MATLAB
% handles   structure with handles and user data (see GUIDATA)

% Hints: get(hObject,'String') returns contents of edit2 as text
%       str2double(get(hObject,'String')) returns contents of edit2 as a double

% --- Executes during object creation, after setting all properties.
function edit2_CreateFcn(hObject, ~, ~)
% hObject   handle to edit2 (see GCBO)
% eventdata reserved - to be defined in a future version of MATLAB
% handles   empty - handles not created until after all CreateFcns called

% Hint: edit controls usually have a white background on Windows.
%       See ISPC and COMPUTER.
if ispc && isequal(get(hObject,'BackgroundColor'),
get(0,'defaultUicontrolBackgroundColor'))
    set(hObject,'BackgroundColor','white');
end

```