Brain Tumor Detection And Recognition From MRI Scan

Hrizi Olfa

Abstract: This paper focuses on the medical image processing which is considered nowadays a challenging field. It is an emerging domain which presents processing of Magnetic Resonance Images (MRI) as one of important part. This work proposes a fast and robust practical strategy to extract a brain tumour using patient's MRI scan images of the brain. For this purpose, some tools are used which include the basic concepts of image processing such as noise removal functions, segmentation and morphological operations. To detect and extract a tumour from MRI scan, a MATLAB software code is implemented.

Index Terms: Brain tumor, Filtering, Image processing, Magnetic Resonance Image (MRI), Matlab (Computer software), morphological operation, Segmentation

1. INTRODUCTION

Due to irregular development of cells inside the brain, people are influenced by brain tumors severely. This bug can be dangerous because it can disturb legitimate mind work. Two types of cerebrum tumors have been distinguished as benign tumors and malignant tumors [1]. Generous tumors are more secure than threatening tumors. This is explained by the fact that dangerous tumors are quick creating and destructive while favorable are moderate developing and less harmful. Medical imaging system is used to make visual portrayal of inside of the human body for restorative purposes and noninvasive potential outcomes can be analyzed by this innovation. Magnetic Resonance Imagine [2,3](MRI) is significantly utilized and it gives more prominent differentiation pictures of the mind and dangerous tissues. On the other hand, image processing is a process where the image gets analyzed and processed intensively [4]. Image processing is one of the branches of computer sciences [5]. It is interested in performing operations on images in order to improve them according to specific criteria or extract some information from them .There are some steps that need to be taken into account to assure image processing. The idea developed in this work can make MRI image processing and tumour detection process faster and cheaper presenting an optimal solution of the tumour detection. To avoid the different kinds of noises presenting in the first part, we will compare between some types of filter [6] and then select the best to continue using the morphological operators [7] to extract tumor.

The rest of this paper is organized as follow: firstly the context of this work is presented by developing its area, problematic and objectives. Then, the main solution is proposed. The next section is devoted to simulation results to illustrate the effectiveness of the proposed contribution. Finally, this manuscript is ended by concluding remarks and a discussion of future works.

2 RELATED WORK

This section deals with the works related to the use of medical image processing in the brain tumor detection. Generally, many researches and studies were done in the area of image processing by using different techniques. And depending on the problem posed, the researcher chose the right method. A number of approaches have been used to extract the brain tumor based on MRI technique, segment and predict its grade and volume. Nerurkar in his work [24] proposed a segmentation study to extract the brain abnormalities in MRI images. The results of the two efficient image segmentation algorithms presented in [23] i.e. K-means and region growing techniques let the author to select the best one. Carlos, Khan and Robert, in their work [25] suggested an ameliorated artificial neural network algorithm to perform segmentation of brain MRI and to be used for segmentation. Their result suggests excellent brain tissue segmentation. Some of other related works discussed the idea of MRI medical Image denoising by fundamental filters such as Median filter (MF), Adaptive Median filter (AMF) and Adaptive Wiener filter (AWF). Then, the performance of these filters will be compared in [25]. In our work, as first part, an improved comparative study between three types of filter is implemented to remove diverse kind of noise. This make us to continue the next part which is detection of brain tumor based on the morphological operation by using the best filter.

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3 AREA AND PROBLEMATIC

As known that the brain is the most important part of central nervous system. Otherwise, a brain tumour is a collection, or mass, of abnormal cells in the brain. So, to avoid this problem, it must extract this tumour which is considered as challenging task in Medical image processing because of the high complexity of the image brain. That's why; MRI (Magnetic Resonance Imaging) has become a useful medical diagnostic tool for the brain diagnosis and other medical images. In this context, the most optimal solution of the tumour detection is the use of the best Filter after comparison between some ones and the morphological operators which are very important and challenging process of image processing.

4 SYSTEM DESCRIPTIONS

Usually, benign tumors can be removed, and rarely grow back. Cells from benign tumors infrequently attack tissues around them. They don't spread to different parts of the body. However, benign tumors can press on sensitive areas of the brain and cause serious health problems. Unlike benign tumors in most different parts of the body, benign brain tumors are here and there life threatening. To avoid the risk of brain tumour, this work proposes a technique based on some steps:

1. Extract an MRI scan from a database given containing noisy images
2. Filtering the image using gaussian, median and an Anisotropic diffusion Filter
3. Select the best filter to continue
4. Applying the morphological operation for the hole image
5. Confirmation of tumor existence based on density and area.
6. Detect whether patient's brain has tumor or not from MRI image using MATLAB simulation.

In the next section, we will develop the different steps explained previously.

4.1 MRI Technique

Magnetic resonance imaging (MRI) is a test that uses powerful magnets, radio waves, and a computer to make detailed pictures inside your body. A doctor can use this test to diagnose you or to see how well you've responded to treatment. Unlike X-rays and CT scans, an MRI doesn't use radiation [8]. An MRI helps a doctor diagnose a disease or injury, and it can monitor how well you're doing with a treatment. MRIs can be done on different parts of your body.

4.2 Noise Types

Noise is unwanted information in images. It produces undesirable effects such as artifacts, unrealistic edges, unseen lines, corners, blurred objects and disturbs background scenes. Therefore, image noise is random variation of brightness or color information in images, and is usually an aspect of electronic noise. In the current investigation, we will focus on two types cited next.

4.2.1 Uniform noise

This sort of noise generates a noise sequence and follows the uniform distribution function with value ranging from a to b and is added uniformly to all the pixels of the image.

4.2.2 Salt and Pepper noise

An image comprising salt-and-pepper noise will have dark pixels in bright regions and bright pixels in dark regions [9]. It is also sometimes called Impulse Noise. This noise is usually caused by sudden and sharp disturbances in the image signal. It often presents itself as sparsely occurring black and white pixels. The term salt and pepper noise was been important for medical images and is also highlighted in recent works [10, 11].

4.3 Filtering Techniques

An image filter is a technique through which size, colors, shading and other characteristics of an image are altered. An image filter is used to transform the image using different graphical editing techniques. Image filters are usually done through graphic design and editing software [12, 19]. To reduce the undesirable effects of noise, we will propose some filters such as:

4.3.1 Gaussian Filter

A Gaussian filter is a linear filter. It's usually used to blur the image or to reduce noise. It is a filter whose impulse response is a Gaussian function (or an approximation to it, since a true Gaussian response is physically unrealizable).

4.3.2 Median Filter

Median filter is a nonlinear digital filtering technique, often used to remove noise [13]. The main idea of the median filter is to run through the signal entry by entry, replacing each entry with the median of neighboring entries.

4.3.3 Anisotropic Diffusion Filter

It is a technique aiming to reducing image noise without removing significant parts of the image content, typically edges, lines or other details that are important for the interpretation of the image. Anisotropic diffusion is a generalization of this diffusion process: it produces a family of parameterized images, but each resulting image is a combination between the original image and a filter that depends on the local content of the original image. As a consequence, anisotropic diffusion is a non-linear and space-variant transformation of the original image [14, 17].

4.4 Image Processing

Image processing is the appropriate digital coding for images. It is the creation of methods for processing such digital data so that like images or information carried by the images are usable by the machine, i.e: a computer, a robot or other machinery. Digital image processing is of great importance in the field of image recognition, for example when we try to make a computer or robot understand the image or its meaning, and it is also very important in the field of recognition of patterns or shapes. There are several techniques used in the image processing. It is worthwhile to mention some tools:

- Anisotropic diffusion: in this technique the image noise is reduced without affecting important parts of the image content.
- Image editing: image editing includes image change operations, whether digital images or analog images or illustrations. Traditional editing of analog images is called image retouching, with some tools such as airbrush, and illustrations can be edited with any other traditional art tool.
- Image restoration: it is the process of restoring degraded images that can not be taken or drawn again. Original images can be restored by prior knowledge of damage or deformation that causes deterioration of images such as cracks, scratches, dust and stains. The restoration also includes images

taken with modern cameras that have been distorted due to transport problems or the conditions in which they were taken, such as images of space missions or scanners. The process of removing a wrap is one example of how to restore the image [18].

- Linear Filtering: Filtering is a technique in which the image gets enhanced or modified. Linear Filtering is separating in which the estimation of a yield pixel is a straight blend of the estimations of the pixels in the info pixel's neighborhood.

4.5 Segmentation

Image segmentation is the process of dividing an image into multiple parts. This is typically used to identify objects or other relevant information in digital images. There are many different ways to perform image segmentation [21, 22]. For further clarification, image segmentation is to change the image representation into easier and better meaningful to analyze [15, 20]. These regions have two main properties: Heterogeneity between the regions and Homogeneity within a region.

5 SYSTEM DESIGN

The multifaceted brain tumors can be split into two common categories depending on the tumors beginning, their enlargement prototype and malignancy. Primary brain tumors are tumors that take place commencing cells in the brain or commencing the wrapper of the brain. In this paper, the morphological operations like dilation, erosion etc… was done to remove the tumor from the MRI Flowcharts.

5.1 Flowchart

The following figure explains the sequence and how methods are arranged in the algorithm proposed in this work:

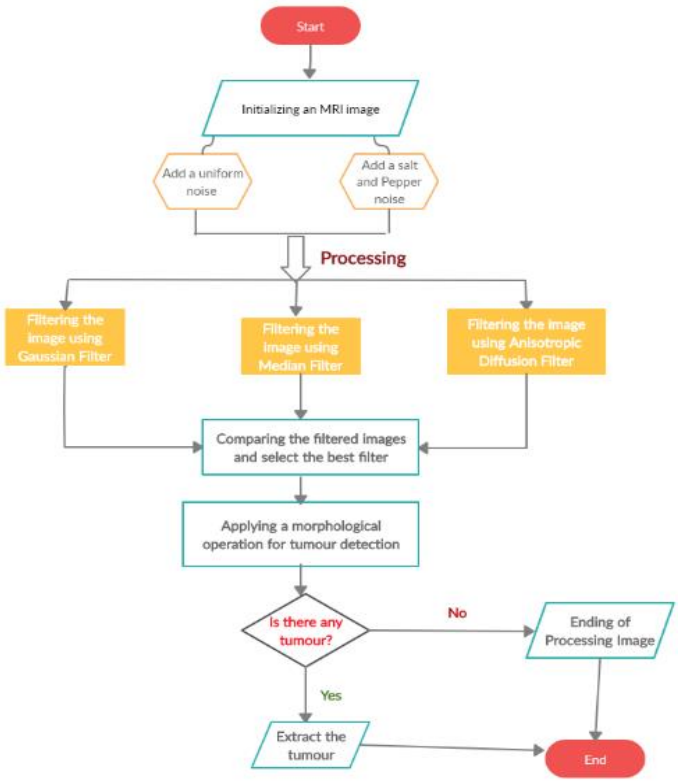

***Fig.1**. Flowchart for Brain tumor Extraction Algorithm*

Here we explain in detail the flowchart way in which the algorithm works:

1. Start : The program starts loading an image of a brain with a tumor or healthy brain from the database to verify it to work on it
2. Filtering the image using a median, Gaussian and an Anisotropic diffusion Filter
3. Compare between the proposed filter algorithm and select the anisotropic diffusion filter for many reasons:

Initialization process is the procedure by which functional and (usually) anatomical images are read in from the raw format produced by the MRI scanner, and converted into the mrVista structure.Anisotropic diffusion preserves the sharpness of edges better than Gaussian blurring. It is a technique where an image generates a parameterized family of successively more and more blurred images based on a diffusion process. Each of the resulting images in this family is given as a convolution between the image and a 2D isotropic Gaussian filter, where the width of the filter increases with the parameter. This diffusion process is a linear and space-invariant transformation of the original image [4].

4. Morphological Dilation and Erosion:

Morphology is a broad set of operations which applies a structuring element to an input image, creating an output image of the same size.

Morphological techniques for digital images rely only on the relative ordering of pixel values thus they are most suitable for binary, or gray scale images. Image enhancement using morphological approaches have been widely experimented in previous researches, to subjectively improve the appearance of an image. Meanwhile, also employed mathematical morphology operations to reduce noise existence in images.

5. Confirmation of tumour based on density and area and its estimated location

The tumor regions from MRI brain images are segmented using threshold, watershed segmentation and morphological, operators. The output image clearly shows the abnormal cells which have been separated from the normal cells

6. Ending of processing image If no tumor

The front is the first window that shows the original image of the MRI and the other on the right, the tumor is exposed after processing the image, where it appears to the user bare after passing through the stages of liquidation.

5.2 Image processing

The Image Processing Toolbox is a collection of functions that extend the capabilities of the MATLAB's numeric computing environment [16]. The toolbox supports a wide range of image processing operations, including:

- Geometric operations
- Linear filtering and filter design
- Transforms
- Image analysis and enhancement
- Binary image operations
- Region of interest operations

There is many types of images in Matlab such as: Binary images, Intensity images, RGB images, Multidimensional images...

To summarize this section "system design", we tried to explain all techniques and tools used. In the rest, we will display all results obtained by different ways.

6 RESULTS AND DISCUSSION

6.1 Graphical User Interface

At the beginning, we will propose a graphical interface in which the callback of each button translates all methods used from the programming code which contains functions Mfile.
Matlab software will be used and the interface will be shown in Figure 2. The button (Load Image) located at the top of the original image window is to upload picture from the database to be treated with the image in the next buttons after noise and filter and extract the tumor. The button Detect tumor starts processing until the image is displayed after processing. This part will be more explained in the next section. As the tumor is found, there is a message that shows the highest result picture says "Brain Tumor detected".

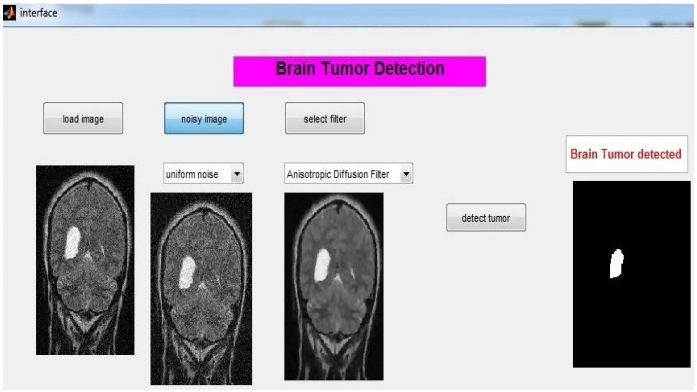

***Fig. 2**. Proposed GUI (Graphical user interface) using MATLAB*

On the other hand, in case of no tumor, a message appears showing the highest result picture says" No Tumour" as indicated in Figure 3.

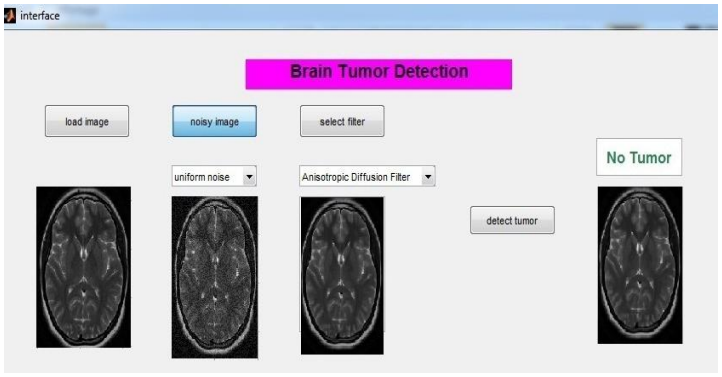

***Fig. 3**. Result of GUI in case of no tumor*

After implementation of the proposed algorithm on Matlab, we obtain the desired results. In the next section, we will explain the sequence and the output's methods which are arranged in our algorithm.

6.2 Step 1: Load image

From a database given in Figure 4 with different tumor's location and size, we will select a figure as input image. The predefined function used to load an image from a file is called "uigetfile". Then, we obtain the two following figures Figure 5 and Figure 6: the first with a uniform noise and the second with a salt and pepper noise to show the noise effect on image.

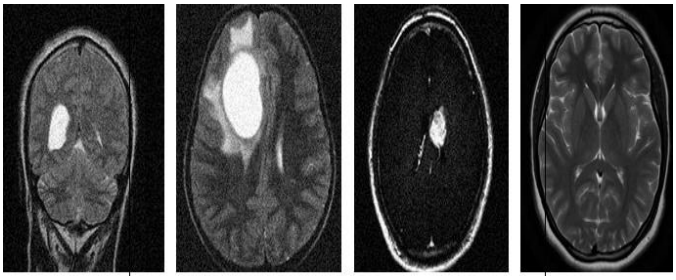

***Fig. 4**. Brain database (MRI Scan)*

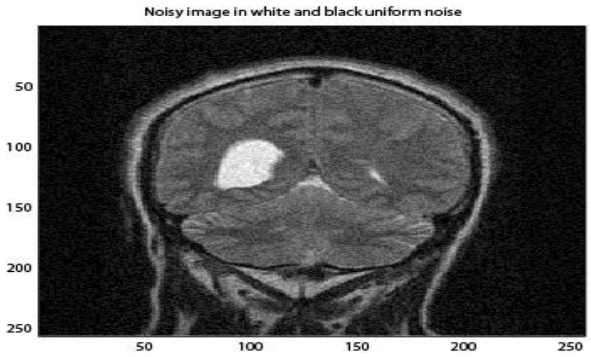

***Fig. 5**. Noisy image in white and black uniform noise*

It's clear that the noise is scattered in a uniform way in the entire image selected.

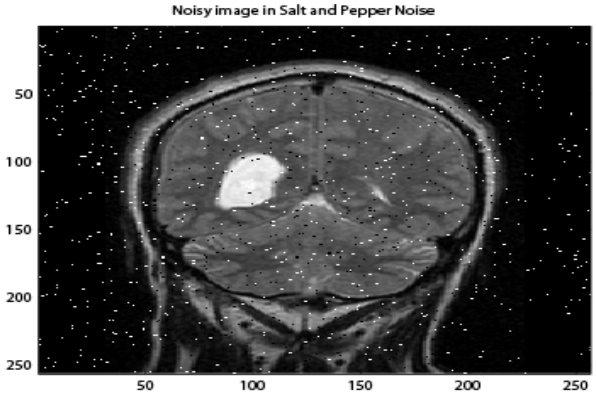

***Fig. 6**. Noisy image in Salt and Pepper Noise*

For this type of noise, we notice that half of salt and pepper noise is scattered as black pixels and the other half as white pixels.

6.3 Step 2: Filter image

As next step, filtering is a technique for modifying or enhancing an image. Using the predefined function on matlab, we begin by the median filter shown in Figure 7.

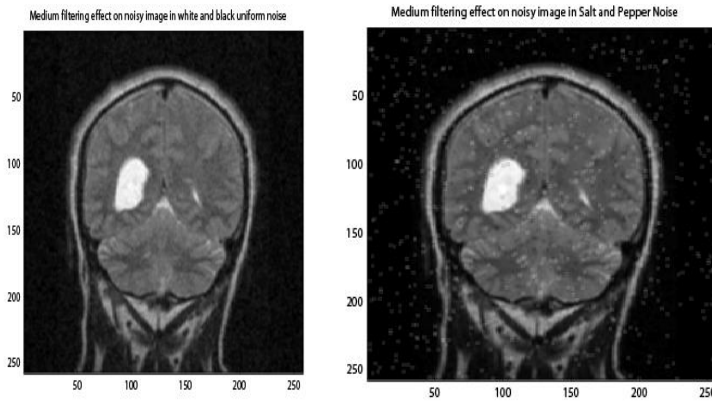

Fig. 7*. Medium filtering effect on noisy image*

For the two types of noise cited previously, even when applying the filter severely, a little part of noise will be eliminated but a blur on image cannot be removed. Then, as result of gaussian filter we obtain the Figure 8.

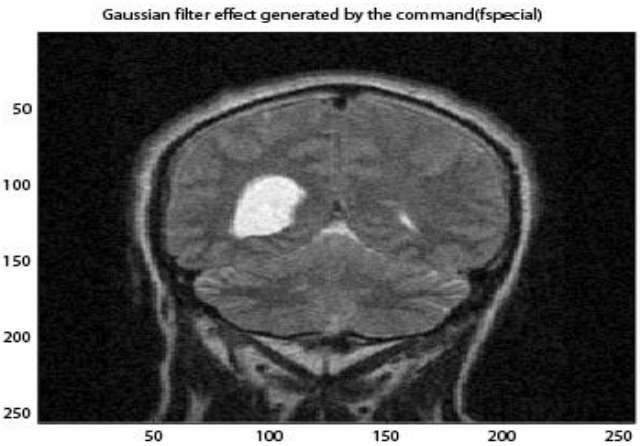

Fig. 8. *Gaussian Filter*

This filter realizes a weighted average of the values in the entire neighborhood: in the center, it is about a strong weight and low at the periphery (the weighting follows a form of Gaussian). Another function develops an anisotropic diffusion method to filter the input image to get the Figure 9 by removing all noise. We must follow some conversion when using an anisotropic diffusion Filter:

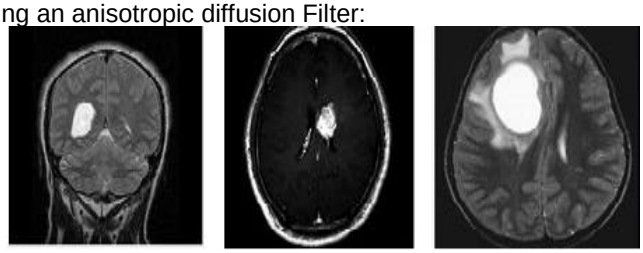

Fig. 9*. Anisotropic diffusion Filter*

In the rest of work, we will use the anisotropic diffusion filter because it is the best in terms of filtering the image and remove noise from them. Also anisotropic diffusion preserves the sharpness of edges better than Gaussian blurring. So we choose to continue with anisotropic diffusion Filter function which is written to be applied to the image and we determine the amount of filter for each image to become clearer, this will show the image after being processed with filter anisotropic diffusion.

6.4 Step 3: Tumor Detection

In this step and after application of the best filter selected, we refer to morphological operation which is based on segmentation technique. Morphology is a broad set of image processing operations that process images based on shapes. In a morphological operation, each pixel in the image is adjusted based on the value of other pixels in its neighborhood. The most basic morphological operations are dilation and erosion. We used the Erosion which replaces each pixel with the local minimum of the neighborhood around the pixel. The object operates on a stream of binary intensity values. This object uses a streaming pixel interface with a structure for frame control signals. In contrary, the dilation is block that replaces each pixel with the local maximum of the neighborhood around the pixel. The block operates on a stream of binary intensity values. This block uses a streaming pixel interface with a bus for frame control signals. This interface enables the block to operate independently of image size and format. In case of tumor, we must follow the steps cited next or display a message "no tumor" else. First, we will measure properties of image region using the function "regionpropos" which has as output Stats. This contains area, Bounding Box, solidity. Second, we will appear separately the tumor alone in Figure 10 We will detect the tumor using "Bounding box" knowing that Bounding boxes are imaginary boxes that are around objects as shown in Figure 11.

Fig. 10. *Tumor alone*

Third, after determining the position, density and area of tumor, there is a function called "rectangle" which surround the tumor as shown in the next figure:

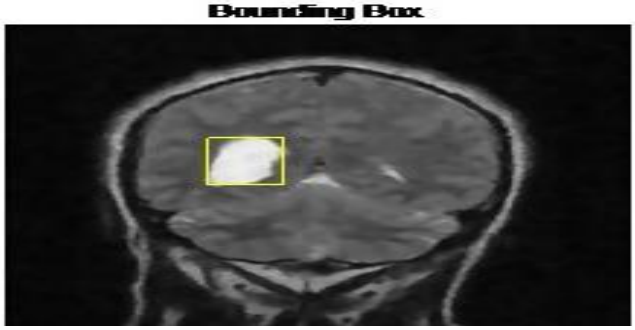

Fig. 11*. Bounding box*

Then, to complete the steps of morphological operation we obtain these figures: erosion and dilation:

Fig. 12. *Erosion step*

Fig. 13*. Dilation step*

As last part, to confirm the detection we insert the outline in filtered image in red color:

Fig. 14*. Tumor detected*

Finally, the goal is achieved. To conclude, we try to enumerate all stages followed from the beginning after selecting the right filter and continue the work with it. The Figure 15 showed this succession of steps.

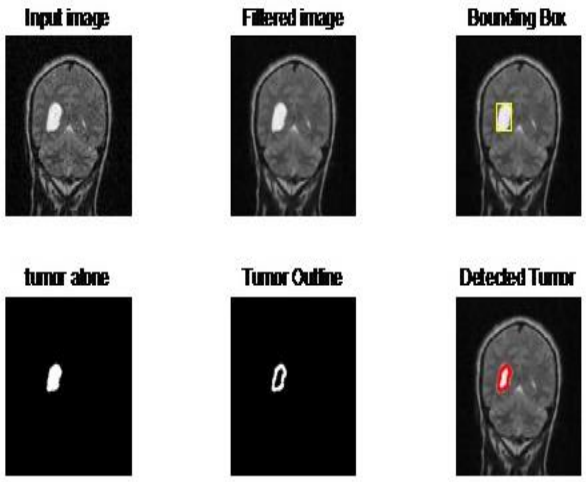

Fig. 15*. Stages of tumor detection*

7 CONCLUSION

This work has written an algorithm for the brain tumor detection from MRI using MATLAB software. A selection of the best filter and methods improves our algorithm compared to the standard algorithms. Image processing in the other hand is a process where the image gets analyzed and processed intensively and is a one of the main points in the paper. This work can make MRI image processing and tumor detection process faster and cheaper optimal solution of the tumor detection: use of anisotropic diffusion Filter and the morphological operators. As result, it can be easier on modern medicine extraction tumors. The algorithm developed can be ameliorated in the next work by giving more information about estimation of tumor before detection.

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