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# A Mini-Review: Medical Imaging and Automated Brain Tumor Detection using MRI Images

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***Abstract* – Nowadays diagnostic process is an important part of medical treatments. Doctors in all medical centers are using various techniques for diagnosing the diseases and making correct decisions for treatment of patients. In this regards, since cancers and tumors are one of the main disease in the life of people in this decade, therefore recognizing tumors in the first steps of its creation and making correct treatment can be help for increasing the life of people in all around of the world. In this regard, Medical imaging has become one of the important techniques which can be helping the doctors for detecting tumors easily. This paper is a comprehensive investigation about medical imaging with main focus on the conceptual overview of the principles of MRI and its usages for diagnosing brain tumors.**

***Keywords* – Magnetic Resonance Imaging (MRI), Medical Imaging, Brain Tumors, Diagnosing Techniques, Tumor Treatment.**

## I. INTRODUCTION

During the past few decades, the number of patients with tumor or cancer disease is increased in all around of the world. Some of these tumors if in the first steps of occurring diagnose and the process of treatment start can be help for saving life of those patients. For diagnosing tumors or cancers in all locations of body, doctors are using different techniques. Medical imaging is one of these techniques which are used by medical communities for detecting diseases and it is useful for their decision making steps or recognizing diseases.

However, Medical imaging has various imaging tool such as X-ray, MRI, Ultrasound, computed tomography (CT), PET (Positron Emission Tomography) and etc. Each one of these tools has special capabilities and provides valuable knowledge for doctors for identifying diseases. This paper provides some information about these tools and their performance, advantages or disadvantages. The main focus in this paper is related to discussing MRI principles, various usages or applications specially the use of MRI for detecting brain tumors.

This paper is organized in five sections. Section 2, introduces the basic concepts of Medical Image processing. Section 3 presents medical imaging techniques. Section 4, discusses about the various applications of MRI specially for detecting tumors. Finally section 5 summarizes the paper.

## II. IMAGE PROCESSING

Image processing is a method to convert an image from natural form into digital form and perform some operations on it. The main purpose of image processing is extracting some useful information from that image or producing an enhanced image [1]. Image processing systems functionalities are shown in Figure 1.

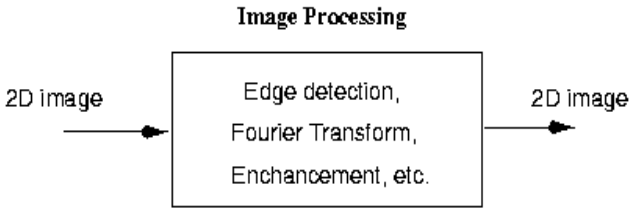


Fig.1. Image Processing Functionalities [1]

The complete steps of image processing are mentioned in Figure 2.

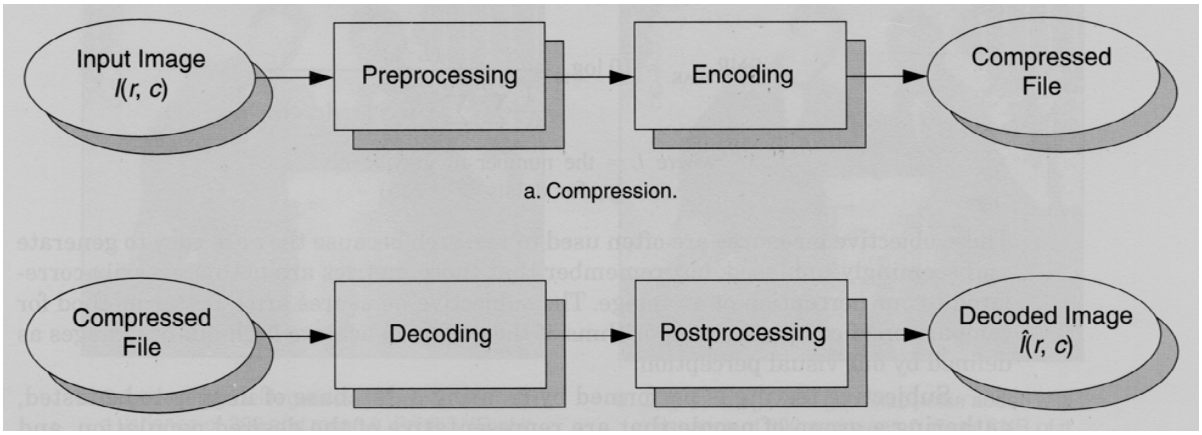


Fig.2. Image Processing Steps [1]

For the first time, digital image processing is used for transferring the pictures through the submarine cable between New York and London.

Some of applications of digital image processing are:

- Medical Imaging
- Astronomy
- Security, Biometrics
- Observation of Remote Earth Resources
- High-Energy electron and plasmas microscopy

In the remaining of this section we will be discuss about Medical imaging and its various applications.

### *A. Medical Imaging*

Medical imaging is a technique for creating visual images or representations of the inside of a body for medical treatment or clinical analysis [2] which is facilitate diagnosis or diseases detection and help to doctors to make correct decisions during treatment of diseases.

Before introducing medical imaging, diseases diagnosing and patients treatments process started without being to see the patients' inside of the body directly. In that case, the only way for see the inside of the body of patients was through exploratory surgery and this way was not simple and sometimes it created so many other problems for patients.

For the first time, medical imaging is introduced by William Rontgen on Nov. 8, 1895 with discovering X-Rays. Researchers used X-Rays for creating "shadowgrams" of the body. The use of X-Rays for creating images of internal organs of people progressed until 1960s [3]. In starting 1970s, Ultrasound, Magnetic Resonance Imaging (MRI), and Nuclear Medicine: SPECT and PET have been investigated. In these years several other modalities for medical imaging have been proposed such as Microwave imaging, Visible Light Imaging, Resistive Imaging, Thermal Imaging and Doppler ultrasound. But for the commercial or reliability issues these modalities have not been used commonly. The complete history of Medical Imaging is shown in Figure 3.

From Figure 3, it is evident that, the creation of medical imaging techniques or tools has been started from 1896 and the first technique was Radiography which is proposed by J.Hall-Edwards. MRI tomography is proposed by P.Lauterbur and P.Mansfield on 1973. And in 2010 the complete set of medical imaging techniques including CT+MRI, PET+MRI are developed for helping doctors for detecting patients' diseases.

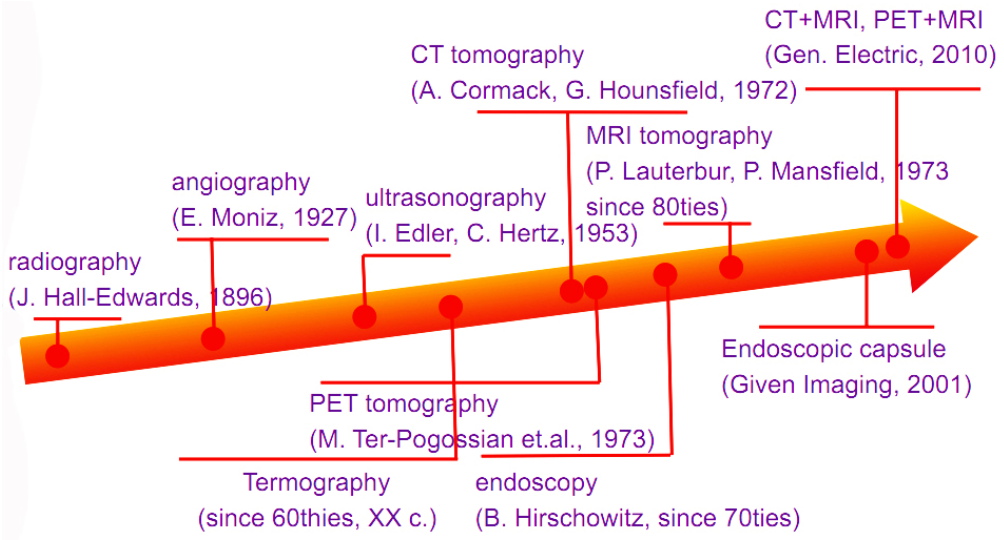


Fig.3. The History of Medical Imaging [4]

Medical imaging systems are using physical interaction between human body and some energy sources for doing their responsibilities and creating images from different organs of the human body. Some other medical imagining systems (such as thermography and phonocardiography) are using human body's internal energy sources for creating images [5]. The typical Modern Electronic Medical Imaging System diagram is shown in Figure 4.

The imaging process does not use the ionizing radiation therefore it does not have harmful effects on human body. The signals which are used for creating images in medical imaging process, directly come from the human organs (objects) itself.

The complete discussion regarding these tools including usages, advantages, disadvantages are mentioned in the next section.

## III. Methods and Techniques for Medical Imaging

Various methods for medical imaging are proposed (as we discussed on Section 2). Some of the popular methods [6] are mentioned in this section.

### *A. X-Ray*

X-Rays is very important tool for diagnosis of diseases and treatment of injuries. R-Ray is very excellent tools for detecting metal objects or any foreign objects. It is a form of electromagnetic radiation. Since it has higher level of energy, it can pass through the body and make images from various oranges. Patients are placed between x-ray source and radiography film [7].

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X-Ray is cheap and easy for use but its radiation effects are harmful for tissues and in some case it can damage biological tissues. The other disadvantage of using X-Rays is, it has no anatomical structure.

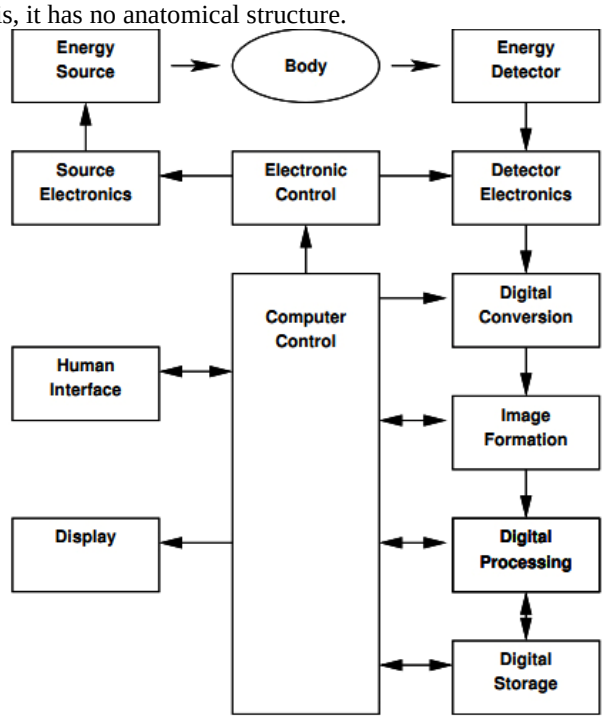


Fig.4. Modern Electronic Medical Imaging System [5]

### *B. CT or CAT (Computed Tomography)*

CT or CAT is a sophisticated way of using X-Rays. Patients are locating on a narrow table and it is passes in the middle of the scanner through a circular hole. It makes slices of the body and creates images of each slice [8].

Some advantages of CT are simplicity of its usages. Further it is quick and reliable for diagnosis of brain abnormalities. Disadvantages of CT usage is, its increases the risk of cancer, increase kidney failure and etc.

### *C. MRI (Magnetic Resonance Imaging) or NMR (Nuclear Magnetic Resonance)*

MRI (Magnetic Resonance Imaging) also is referred as NMR (Nuclear Magnetic Resonance). In this technique, patients are located inside of strong magnetic fields which are created by a large bore superconducting magnet. NMR obtains images such as a proton spin density function and relaxation times. Principles of NMR imagining introduced by Mansfield on 1982.

MRI is one of the medical diagnostic techniques which use unclear magnetic resources for creating thin-section images of different organs of the body (such as veins, heart) from any direction or angle in a short period of time without surgical invasion

Figure 5 shows the components of an MRI machine. From Figure 5 it is evident that, the components of MRI machine are [9]:

- Bore is a tunnel that patient is placed inside of it.
- The Static Magnetic Field encompasses the bore and surrounds the patient which is located inside of scanner.
- Several types of Coils including radiofrequency coils, gradient coils and etc.
  - *Radiofrequency coils* distribute a radiofrequency signal and after a few seconds collect the magnetic resonance signals.
  - *Gradient coils* for getting spatial information, it change intentionally the strength of the static magnetic field. This coil producing a sound which is hear by patient during scan, the reason for creating this sound is due to its rapidly switch on and off during MRI scanning.
- *A powerful Computer System*
- Some equipment for transmitting Radio Frequency (RF) pulses into the patients' body during scan.
- *Many secondary components*

Some important clinical applications of MRI are [10]:

- Cardiology
- Detecting cancer or tumors in different organs of body including
  - Brain, colorectal, Breast, prostate and liver.
- Damaging the Soft tissues
  - Ligaments, Cartilage
- Clinical neurology

Measuring or controlling brain structure

  - Classification or segmentation
  - Detecting sclerosis, stroke, neuron-degeneracy and etc.
  - Detecting brain tumors by MRI briefly is discussed in forth section of this paper.

There are several advantages for using MRI such as [9]:

- It has no radiation effects. Therefore, it can be used for people who is sensitive about radiation effects or for pregnant women.
- MRI is very useful for detecting problems in soft tissues
- It can be detect the problems related to blood moving problems such as moving blood from blood vessels to other organs in body.

However, there are some disadvantages for using MIR such as:

- Cost of MIR machine is high. Therefore scanning body with this machine also is expensive.
- Some people may be feeling discomfort during scan since they placed inside of tunnel and some loudly sound came because of moving magnetics
- Patients have not permission to move during scanning because any movement during scanning can be making less clear scanning results.

### *D. PET or SPECT*

PET (Positron Emission Tomography) or SPECT (Single Photon Emission Computerized Tomography) [11 and 12] produce images that can help for diagnosis problems in neurodegenerative or effects of drugs on disease improvement.

There are several advantages in using PET or SPECT such as:

- It creates excellent image with high quality.
- It shows structure and also the functionalities of these structures.

However, there are some disadvantages in using PET and SPECT such as:

- Making images with these tools are expensive.
- Making image with these tools need a lot of preparation.

- Since maintenance cost of PET and SPECT machine is so high, therefore all hospitals have not this machine.
- PET and SPECT have radioactive isotopes and these are harmful for body of technicians.

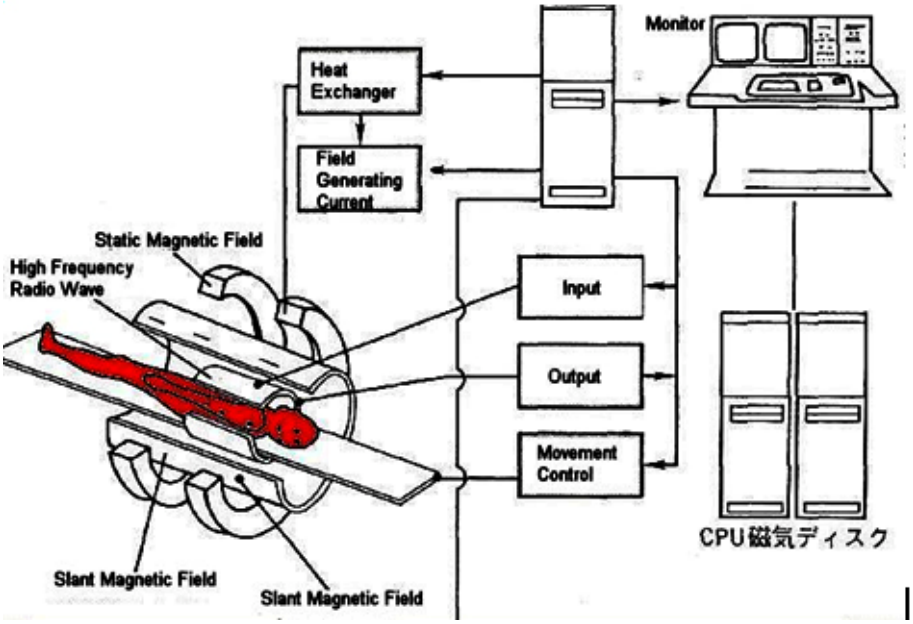


Fig.5. Components of MRI Machine [9]

### *E. Ultrasound*

Ultrasound creates images of structures into the human body by using high-frequency sound waves. The position and size of the tissue inside of the human body determines by calculating the delay of signal reflection and its amplitude. Ultrasound commonly is used for determining position, abnormalities of fetuses in utero. Ultrasound is very safe method for controlling the growth of fetuses during pregnancy [13].

Some important advantages of Ultrasound usages are:

- It does not have radiation effects.
- There is no discomfort feeling for patients in this method.
- It can be improve diagnosis skills of doctors.

However, there are some disadvantages of using Ultrasound such as:

- Making scan with Ultrasound is little expensive.

## IV. Application of MRI for Detecting Brain Tumors

A tumor is an abnormal growth of the cells in any part of the body. In the other words, a tumor is created whenever an uncontrolled or abnormal division of cells happening. All tumors classified in two types:

- Cancerous
- Non-cancerous

Brain tumors are one of the important tumors, since brain is important part of body and has various responsibilities for controls different functionalities of human body. Therefore, in this section we will discuss about the types of brain tumors, their effects on human life and the techniques which are proposed for detecting brain tumors. Brain tumors based on their locations are two types [14]:

- Tumors located in the brain itself or located in other part of brain such as skull, cranial nerves, pineal gland or brain envelopers.
- Tumors that are spread from other parts or organs of the body.

Brain tumors are 2 types:

- Benign: These types of tumors have a boundary or edge around themselves. If these types of tumor remove from the brain, very seldom another once will be grow and create tumor for second times. The other properties of these tumors are related to their spread. They do not grow and spread to other parts or organs of the body.
- Malignant: these types of tumors are very danger for people life. These tumors grow fast and spread to other tissues [15].

Any brain tumor is danger for life because of its invasive characteristic. The treatment success is depend of various characters such as: type of tumor, its size and location and its state of spread. However, the main problem related to brain tumors is, detection of tumors. Since brain located inside of skull, therefore detecting tumors usually is not occur in the first stage of growing tumor and mostly whenever symptoms are happening in the advanced stage of growing tumor, using some diagnostic tools such as MRI cause to detect tumors. Therefore, doctors for classifying tumors into benign or malignant use diagnosis information or tools. This classification can be done by location of tumor or the type of tumors' cells and etc. However, identifying this classification can be help to doctors to start correct treatments.

Medical imaging introduces powerful techniques for clinical diagnosis. One of the main applications of these techniques is related to detection of edge or border of

brain tumors in images provided by MRI or CT [16].

There are several research efforts which are focused on detecting boarder of brain tumors with applying various techniques. In the remaining of this section, we will be discussing some of these techniques.

Doctors generally following three steps for identifying brain tumors [17].

- *Neurological examination* is the first step of detecting brain problems. In this step, doctors using a set of tests for checking performance of patient nervous system and physical and mental alerts.
- *Brain Scan :* it is created an image from internal parts of brain with using CT, MRI, PET and etc.
- *Analysis of the brain tissue*

Leela [14] made segmentation for brain tumors with applying using k-means and fuzzy c-means clustering algorithms. In this research, the images provided by MRI from scanning brain of people with brain tumor diseases have been taken as inputs for creating or developing segmentation techniques. This author's research claimed that, with applying their proposed model, performance of segmentation has been improved and finding and detecting boundary of tumors had become more easy and fast.

James [18] attempts to prognosis the brain tumors or detects these tumors in the first stages of their creation. He used the brain tumors images which have been provided by MRI scanner. He made a model with analyzing patients' past records for predicting the occurring of brain tumors and detecting these tumors in the first stages or estimating the size of tumors.

Robert [19] proposed an 3D template matching- based method and claimed that it is an effective tool for detecting and diagnosis of brain tumors. This author mentioned 89% accuracy for detecting tumors with the use of his proposed method. In this research also input was MRI images that have been taken from 22 patients' data sets. This author developed an computer aided tools for detecting of tumor rapidly with high accuracy.

Sachin [20] has been proposed an approach that uses bilateral symmetry information of brain MRI as an extra feature for creating segmentation. This author claimed that, this proposed approach, improved automatic brain tumor segmentation performance in medical and scientific applications.

Parameshwarappa [21] made an enhanced image with normalizing the value of pixels and applying enhancement techniques. Then applied Fast Fourier Transform and some morphological operations to obtain favorite results. Author claimed that this proposed model gives our correct favorite output and tumor detection or segmentation results whenever applied on different images which have been provided by MRI.

Sahaa [22] proposed an novel automatic segmentation technique named as FBB [Fast Boundary Box]. Input which is used in this technique was a set of MRI slices and output was a subset of slices including axis boxes that have been detected tumors and eliminated the boundary of tumors. This researcher's proposed approach was an unsupervised detection method. It looked for detecting dissimilarity between regions (between right and left halves of a human brain) which are mentioned on MRI slice view. This author claimed that, their proposed approach had good performance for detecting boundary of tumors and edemas.

Kharrat [22] proposed a methodology for detecting brain tumors from MRI images. The proposed methodology had three steps including enhancement, segmentation and classification.

Researchers in this study, applied mathematical morphology for improving quality of images and contrast in MRI images. Further, authors for decomposing MRI images during segmentation process used Wavelet Transform. For detecting suspicious regions or tumors, authors used k-means algorithm.

## V. CONCLUSION

In the last decades, many researchers in all around the world have focused on study of methods for detecting or diagnosis of brain tumors. Since number of patients with this diseases is increasing day by day, so finding a treatment for this disease or proposing an approach for detecting this disease in the first stage of creation is essential for saving people life.

In this study we attempt to discuss the structure and performance of popular medical imaging tools including their advantages and disadvantages. Then we discussed about MIR and detecting brain tumors with the help of several methods proposed by researchers including methods for segmentation and detecting the boundary of tumors.

## REFERENCES

[1] DoruCioata and CristianIacob, "Digital Image Processing in Medicine", http://ace.ucv.ro/sintes11/Volume2/3%20SOFTWARE%20ENGINEERING/IS10_Cioata_Doru.PDF [Accessed on 1 May 2014]

[2] Z. H. Cho, J. P. Jones, and M. Singh.Foundations of medical imaging.Wiley, New York, 1993.

[3] S. Webb. From the watching of shadows: the origins of radiological tomography. A. Hilger, Bristol, 1990.

[4] K. K. Shung,M. B. Smith, and B. Tsui. Principles of medical imaging. Academic Press, New York, 1992.

[5] J. Fessler, "Introduction to Medical Imaging Systems", August 2, 2009, http://web.eecs.umich.edu/~fessler/course/516/l/c1-intro.pdf [Accessed on 1 May 2014]

[6] A. Macovski. Medical imaging systems. Prentice-Hall, New Jersey, 1983.

[7] Medical Council, "X-Rays–Benefits and Risks", http://www.radiology.ie/wp-content/uploads/2012/01/X-Rays-Benefits-and-Risks.pdf [Accessed on 1 May 2014]

[8] Hongmei Zhu, "Medical Image Processing Overview" , University of Calgary, http://www.fields.utoronto.ca/programs/scientific/0304/mathmedicine/notes/ZHU_notes.pdf [Accessed on 1 May 2014]

[9] DG Nishimura, " Principles of Magnetic Resonance Imaging" , April 1996.

[10] Z-P Liang and PC Lauterbur, " Principles of Magnetic Resonance Imaging: a signal processing perspective", IEEE press series in biomedical engineering, 1999.

[11] David J. Brooks, "Positron Emission Tomography and Single-Photon Emission Computed Tomography in Central Nervous System Drug Development", NeuroRx. Apr 2005; 2(2): 226–236.

[12] N Bloembergen, EM Purcell, and RV Pound, “Relaxation effects in nuclear magnetic resonance absorption,” Phys. Rev. vol. 73, pp 679-712, 1948.
[13] "Ultrasound- General." Radiology Info (07-10-2007) [http://www.radiologyinfo.org/en/info.cfm?pg=genus&bhcp=1] [Accessed on 1 May 2014]
[14] Leela G A, H.M VeenaKumari, “Morphological Approach for the Detection of Brain Tumour and Cancer Cells”, Journal of Electronics and Communication Engineering Research , Volume 2 ~ Issue 1 (2014) , pp: 07-12
[15] Pratibha Sharma , ManojDiwakar , SangamChoudhary “Application of egde Detection for Brain Tumour detection” Volume 58, No 16(2012)
[16] Amarjot Singh, ShiveshBajpai, Srikrishnakaranam, Akash Choubey, ThaluruRaviteja “Malignant Brain Tumour Detection”, Volume 4, No 6(2012)
[17] M.Sadeghzadeh and F.JohariDaha, “Brain Tumors Diagnostic by Tumor Imaging Agents”, Nuclear Science & Technology Research Institute Iran, http://cdn.intechopen.com/pdfs-wm/20275.pdf [Accessed on 1 May 2014]
[18] James D. Murray, “On the Growth of Brain Tumours: enhancing imaging techniques, highlighting limitations of current imaging, quantifying therapy efficacy and estimating patient life expectancy”,
[19] Robert D. Ambrosini, Peng Wang, and Walter G. O’Dell, “Computer-Aided Detection of Metastatic Brain Tumors Using Automated Three-Dimensional Template Matching”, Journal of Magnetic Resonance Imaging 31:85–93 (2010)
[20] N.Sachin G, V. Khairnar, “ Brain Tumor Detection Based On Symmetry Information”, Int. Journal of Engineering Research and Application, Vol. 3, Issue 6, Nov-Dec 2013, pp.430-432
[21] V.Parameshwarappa and Nandish S, “A Segmented Morphological Approach to Detect Tumour in Brain Images”, International Journal of Advanced Research in Computer Science and Software Engineering, Volume 4, Issue 1, January 2014
[22] B.N. Sahaa, N. Raya, R. Greinera, A. Murthab, H. Zhanga, “Quick detection of brain tumors and edemas: A bounding box method using Symmetry”, Computerized Medical Imaging and Graphics Journal, Elsevier, 36 (2012) 95–107.
[23] A. Kharrat, M. B. Messaoud, N. Benamrane and M. Abid, “Detection of Brain Tumor in Medical Images”, 2009 International Conference on Signals, Circuits and Systems, pp.1-6.

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