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DETECTION AND EXTRACTION OF BRAIN TUMOR FROM MAGNETIC RESONANCE (MR) IMAGE: REVIEW AND ANALYSIS

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ABSTRACT

Image processing plays an important role in the field of medicine. Medical imaging is a growing and challenging Field and is advantageous in diagnosing the disease. As Brain tumor is a serious and dangerous disease, medical imaging provides a proper diagnosis of brain tumor. Many techniques are available to detect brain tumor from MRI images. These methods face challenges like finding the location and size of the tumor from the brain. Reliable algorithms are required for the exact position of anatomical structures and other regions of interest through image segmentation. Already, various algorithms are developed for image segmentation. In this review paper, the basic terminologies of brain tumor and MRI images, review of various brain tumor segmentation techniques are analyzed. With increasing use of Magnetic resonance imaging for diagnosis, treatment planning and clinical studies, it has become almost compulsory to use computers to assist radiological experts in clinical diagnosis and in treatment planning.

KEYWORDS: Brain Tumor, Human Brain, Image Segmentation, Magnetic Resonance Image, Medical Imaging, Support Vector Machine, Threshold Segmentation

INTRODUCTION

A noninvasive medical test, Magnetic resonance imaging (MRI) uses a powerful magnetic field, radio waves and a computer to produce detailed pictures of the organs inside our body which is used to diagnose and treat medical conditions for determining the presence of abnormalities. Radio waves will redirect alignment of naturally existing hydrogen atoms in our body without causing any chemical changes in the tissues. When the hydrogen atoms return to their usual alignment, they will emit energy that varies according to the type of body tissue. This energy is captured by MRI scanner which creates a picture of the tissues scanned based on this information. The computer processes the signals and a series of images are generated, each of them shows a thin slice of the body. Then images are stored in the computer for detail study. A brain tumor [1] [2] [3] is an abnormal growth of cells in the brain that multiplies in uncontrollable way and it can either be malignant (cancerous) or benign (non-cancerous).Brain tumors are life threatening because the skull has limited space inside, the intracranial pressure increases as tumor grow, and cause blood flow reduction and displacement of the degeneration of healthy tissue. Since MRI provides detailed information about the structure of cell, vascular supply and anatomy, it is used as an important and efficient tool for the effective diagnosis of the disease as well as the treatment and monitoring of the disease.

OVERVIEW OF HUMAN BRAIN AND BRAIN TUMOR

The brain is one of the most complex organs in the human body. It controls internal temperature, muscle movements, secretions of glands, and breathing. Brain is a central nervous system which is made up of hundred billion nerves and each nerve consist of 'n' number of neurons. *Neurons*, or nerve cells can perform all the communication and processing within the brain. The condition of the body and its surroundings information are delivered by sensory neurons entering the brain from the peripheral nervous system. The tissue of the brain contains gray matter and white matter. The brain is composed of the cerebrum, cerebellum, and brainstem. The brain is composed of three parts namely the brainstem, cerebellum, and cerebrum. The cerebrum is divided into four lobes: frontal, parietal, temporal, and occipital as shown in figure 1.

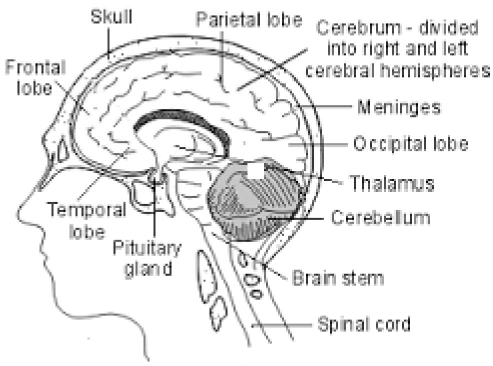

Figure 1: Structure of Human Brain

The largest part of the brain, cerebrum is composed of right hemisphere and left hemisphere. The functions performed are touch sensing, speech, reasoning, vision and hearing, emotions, movement control, and learning. The motor function, problem solving and judgment are the responsibilities of frontal lobe. The sensation, handwriting, and body position are managed by parietal lobe. The memory and hearing are involved with temporary lobe. The brain's visual processing system is contained in occipital lobe. The location of cerebellum is below the cerebrum. The functions performed by cerebellum are coordination of muscle movements, maintenance of posture, and balance. The relay center, brain stem connects the cerebrum and cerebellum into the spinal cord. Breathing, wake and sleep cycles, heart rate, digestion, sneezing, body temperature, coughing, vomiting, and swallowing functions are taken care by brain stem. Origination of ten of the twelve cranial nerves is from the brainstem. The brain is surrounded by a layer of tissue called the meninges. The skull helps in protecting the brain from injury.

A brain tumor is an accumulation of abnormal cells in the tissue. Normally, the cells in our body age, die, and are replaced by new cells. With cancer and other tumors, this cycle is disturbed. Tumor cells grow, even though the body does not require them, and unlike normal old cells, they will not die. As this process goes on, the tumor continues to grow as more and more cells are added to the tissue. Primary brain tumors are emerged from various cells that make up the brain. Gliomas and meningeal are the most common types of brain tumors. Glimosis tumors are formed from astrocyte. Meningeal tumors are formed in the meninges, a thin layer of tissue that covers the spinal cord and brain. Benign brain tumors are noncancerous whereas malignant primary brain tumors are cancerous and can spread to other parts of the central nervous system and brain. Benign brain tumors have clearly defined borders and are not deeply rooted in brain tissue and hence it is easier to surgically remove. Benign tumors are less likely to recover than malignant ones. Symptoms of brain tumors may vary according to the type of tumor and the location. Few tumors have no symptoms until they are quite large and cause a serious problem in health. Other tumors may have symptoms that develop slowly. A common initial symptom of a brain tumor is headaches. Other symptoms may be Seizures, Numbness or tingling in the arms or legs, small changes in speech or hearing, abnormal changes in vision, Problems with walking, Problems with memory, Personality changes, Inability to concentrate, Weakness in one part of the body, and Balance problems.

MAGNETIC RESONANCE IMAGING (MRI)

Magnetic resonance imaging (MRI) of the brain is a safe and painless test that utilizes a magnetic field and radio frequency waves to produce detailed images of the brain and the brain stem. An MRI test takes 30 to 60 minutes but in some case it takes 2 hours.MRI image generations are done with the usage of MRI scanner as shown in figure 2. The tissue disease or damage, such as infection or inflammation, or a tumor, stroke, or seizure can be measured by using MRI. These detailed information from an MRI are saved and stored in a computer for further analysis.

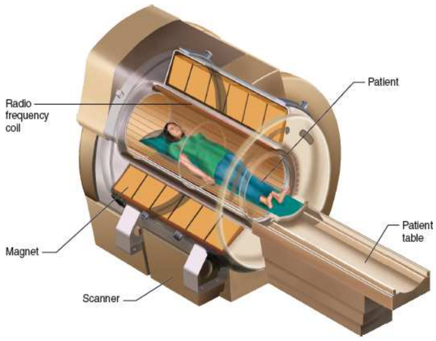

Figure 2: MRI Scanner

MRI is more valuable in the surgical treatment of brain by allowing regions with essential brain functions to be located. The doctors avoids damaging this regions while removing as much diseases or dysfunctional tissue as possible. Brain images in scanned by using MRI can be either normal or abnormal. The characteristics of normal brain were gray matter (GM), white matter (WM) and cerebrospinal fluid (CSF) tissues. Whereas the abnormal brain contains active tumor, necrosis and edema in addition to normal brain tissues. Dead cell located inside an active tumor is Necrosis, whereas edema is located near active tumor borders. Edemas is a created from local disruption of blood brain barrier, which often overlap with normal tissues and is highly difficult to differentiate from the other tissues. An axial MRI can be developed from looking at the brain from below in a series of images starting at the chin and moving up to the top of the head. A sagittal MRI are generated by looking at the brain from the side in a series of images starting at one ear and moving to the other ear. A coronal MRI can be developed by looking at the brain from behind in a series of images starting at the back of the head and moving to the face as shown in Figure 3.

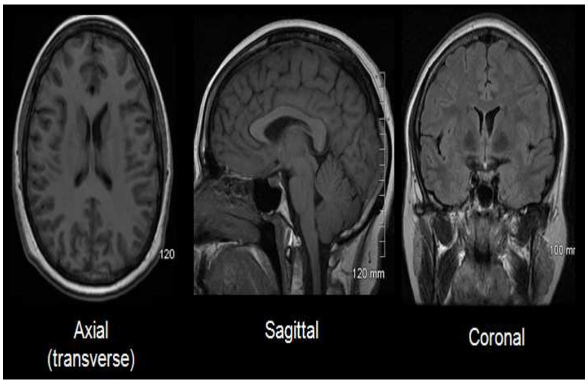

Figure 3: Brain MR Images from a) Axial Plane, b) Sagittal Plane, and c) Coronal Plane

The three different images that can be achieved from the same body: T1-weighted, T2- weighted and PD-weighted (proton density) while processing the signals as shown in Figure 4.

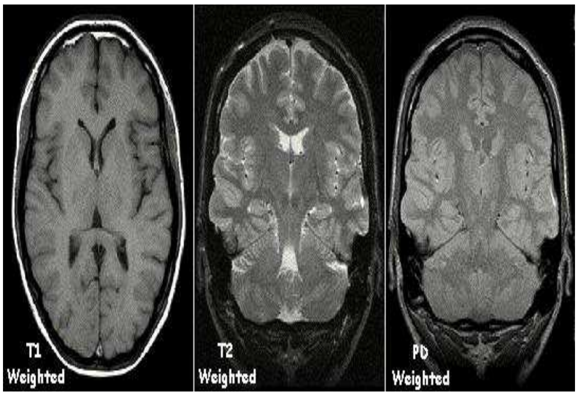

Figure 4: Brain MR Images from Axial Plane a) T1-w, b) T2-w, and c) PD-w image

The four basic parameters will decide the intensity of signal on the MR image namely Proton density, T1 relaxation time, T2 relaxation time, and Flow. The Proton density is the measured with the concentration of protons in the tissue in the form of water and macromolecules. The T1 and T2 relaxation times are defined by the way in which the protons are reverted back to their resting states after the initial RF pulse. The flow measured as an effect in loss of signal from rapidly flowing arterial blood. The pulse sequence parameters are used for calculating contrast on the MR image. The specific number, strength, and timing of the RF and gradient pulses are set by pulse sequence. The two important aspects are the repetition time (TR) and the echo time (TE). The TR is calculated to be the time between consecutive 90 degree RF pulse. The TE is determined to be the time between the initial 90 degree RF pulse and the echo. T1-weighted and T2-weighted spin-echo sequences are the two important pulse sequences. The T1-weighted sequence contains a short TR and short TE (TR < 1000msec, TE < 30msec). The T2-weighted sequence contains a long TR and long TE (TR > 2000msec, TE > 80msec). The T2-weighted sequence is normally employed as a dual echo sequence. The proton density (PD) weighted or a mixture of T1 and T2 is the first or shorter echo (TE < 30msec). This image that was generated is very useful for determining periventricular pathology, such as multiple sclerosis, due to the hyper intense plaques are contrasted against the lower signal CSF. Nowadays, the has PD image are replaced by FLAIR (Fluid Attenuated Inversion Recovery) sequence. T2-weighted with the CSF signal suppressed are termed to be FLAIR images. When analysing an MR image, the easiest way to determine the type of pulse sequence which was used, or the "weighting" of the image, is found by looking at the cerebrospinal fluid (CSF). If the CSF is high signal (bright), then it must be a T2-weighted imaged. If the CSF is dark, it reflects a T1-weighted image. Then, look at the signal intensity of the brain structures. The primary determinants of signal intensity and contrast are measure of the T1 and T2 relaxation times. The contrast is different on T1 and T2-weighted images.

REVIEW AND ANALYSIS

Segmentation

Image Segmentation [9][10] is the procedure of partition a digital image into numerous regions or sets of pixels. In image partitions different objects have the same texture or color. The results of image segmentation are a set of regions that cover the entire image together and a set of contours extracted from the image. With respect to some characteristics such as color, intensity, or texture each and every pixels in a region are similar. Neighboring regions pixels are different with respect to the some individuality. The different approaches used are (i) By limits finding between regions based on discontinuities in intensity levels (ii) Thresholds based on the distribution of various pixel properties (iii) Finding the regions directly. Region based methods are based on continuity [6]. In thresholding technique, regions can be classified on the basis range values. Methods based on finding the regions directly find for abrupt changes in the intensity value. These methods are called as Edge or Boundary based methods [8]. The flow chart Figure 5 illustrates the procedure for determining the tumor detection and segmentation. The images are obtained from radiologist and some images are acquired from the brain tumor MRI database. Every image is pre-processing and applied to various thresholding [4] [5] and morphological operations[7] for segmentation and detection of the tumor. Figure 6 represents the original MR Brain grey level image and color image. Figure 7 represents the image segmentation of MR brain image.

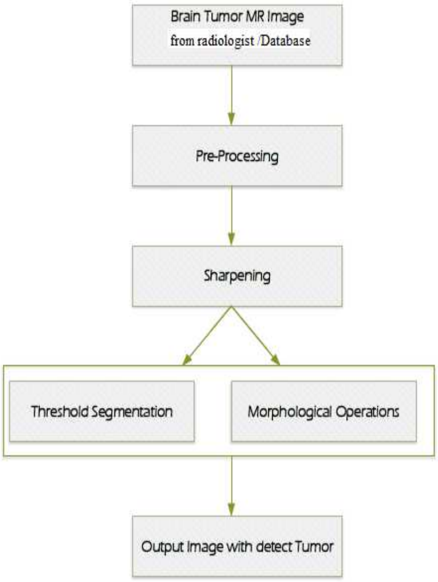

Figure 5: Procedure of Tumor Detection and Segmentation

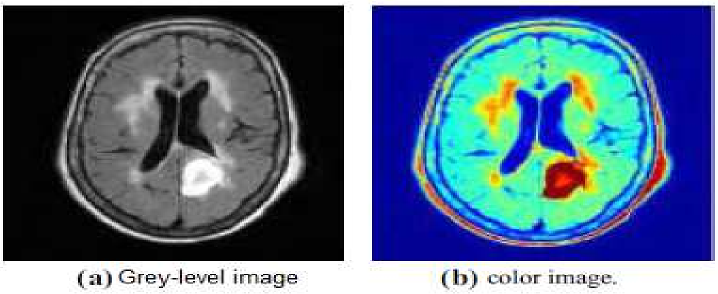

Figure 6: Original MR Brain Image

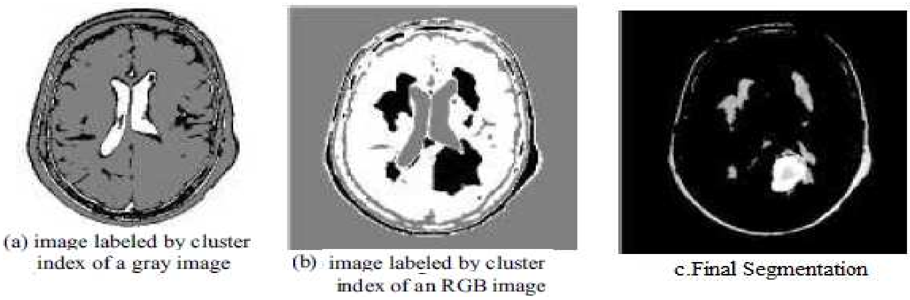

Figure 7: Image Segmentation of MR Brain Image

Support Vector Machine

The SVM is a supervised learning method. It is a good tool for data analysis and classification. SVM classifier has a fast learning speed even in large data. SVM [11] is used for two or more class classification problems. Support Vector Machine is based on the conception of decision planes. A decision plane is one that separates between a set of items having dissimilar class memberships**.** Classification is done to identify the tumor class present in the image. The use of SVM involves two basic steps of training and testing as shown in figure 8.The Classification and detection of brain tumor was done by using the Support Vector Machine technique as shown in Figure9.

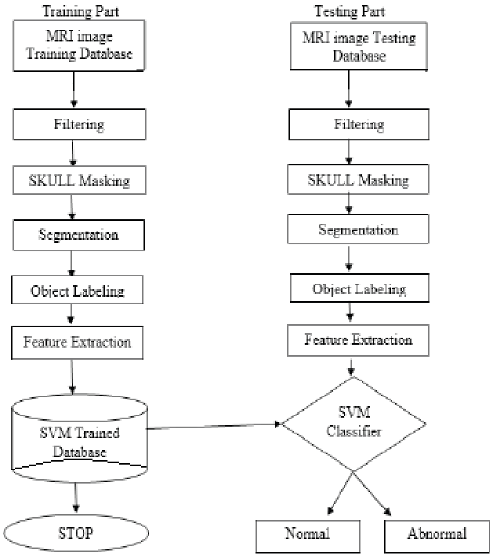

Figure 8: Basic Steps of Training and Testing

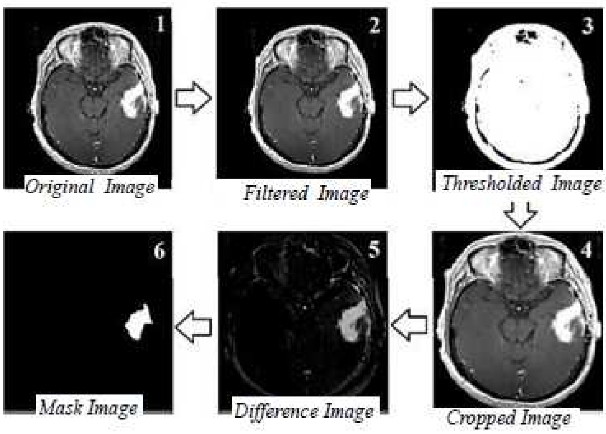

Figure 9: Classification and Detection of Brain Tumor using SVM

CONCLUSIONS

Image processing has become an important task in today's world. Applications of image processing were originated in number of areas like medical, remote sensing, electronics and so on. In medical applications, image segmentation was widely used for diagnosis purpose. In this paper, review and analysis of system was made by using segmentation of brain MR Images for Detection and identification of brain tumor. SVM was used for pattern mapping and pattern matching process.

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