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Review of Brain Tumor Detection using Pattern Recognition Techniques

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***Abstract* – Malignant Brain Tumor is one of the most lethal diseases on the Earth. Identifying such a tumor at an early stage is highly necessary in order to treat it properly. Medical imaging plays an important role to detect brain tumors. Although, MRI (Magnetic Resonance Imaging) is often considered to be the most suitable technique to diagnose such a tumor, it has its own limitations. On the other hand, PET (Positron Emission Tomography) has emerged as a more efficient technique to detect a brain tumor both in its pre and post treatment stages. The present work has been carried out with an objective to plan a strategy to identify brain tumors using Artificial Neural Network (ANN) and segmented PET images.**

***Keywords* - Malignant Brain Tumor, (Magnetic Resonance Imaging), PET (Positron Emission Tomography), Artificial Neural Network** (ANN)

I. INTRODUCTION

Human brain is probably the most knotty organ which controls all our physical and mental activities. Any abnormal growth of cells in or around brain is called brain tumor. The main challenge is the diagnosis of the brain tumor. Doctor's take different types of images of human brain like MRI, PET, etc. and analyze images to diagnose the tumor. It is very difficult to differentiate between tumor and other objects appearing like tumor inside the human brain. So, challenging task is to identify the tumor. The idea behind writing this paper is to plan some research work to identify the brain tumor using Artificial Neural Network (ANN). So, a detailed review work of the brain tumor detection has been performed here using image processing segmentation and other methods.

II. TYPES OF BRAIN TUMORS

Brain tumors are mainly of two types: benign or non-cancerous and malignant or cancerous [3]. Malignant brain tumors are considered as one of the most lethal diseases. Treatment of such a tumor is very complicated and unlike benign tumors, they spread at a very rapid pace. A brain tumor may increase pressure in the brain and may damage our Central Nervous System [1]. A few major symptoms of this disease are headache, blurred vision, nausea, dizziness, partial or full amnesia, etc. Possible ways of treatment include surgery, radiation and chemotherapy. Brain tumors have been graded ranging from grade I (less aggressive) to grade IV (more aggressive) [7]. Primary brain tumors are the tumors that originated in the brain and named after the cell types from which they originated. Secondary brain tumors consist of cancer cells somewhere else in the body that have spread to the brain. However, depending upon the location and cell type, the World Health Organization (WHO) has classified brain tumors into 120 types. The most common primary tumors found in adults are Gliomas, Meningiomas, Schwannomas, Pituitary Tumors and CNS Lymphoma [6].

III. BRAIN TUMOR DETECTION TECHNIQUES

In order to properly treat a malignant brain tumor, it is highly necessary to detect the tumor at an early stage and also to find out its exact location and size. The most accurate way to detect a brain tumor is biopsy [1] in which patients need to undergo a surgery. Medical imaging plays the pivotal role to diagnose such a tumor without any surgery and helps radiologists to find minute details of a tumor and also helps them in planning the treatment. Some of the prime medical imaging techniques are MRI (Magnetic Resonance Imaging), CT (Computed Tomography) scan, PET (Positron Emission Tomography), etc. [2], [5]. CT scan is a series of X-rays pass through the body, which are then analyzed by a computer, and an image constructed from the data. It can show the precise location of a tumor, its shape, and whether it is solid or hollow. However, it can only give clues as to whether or not a tumor is cancerous. It is also not very reliable if the tumor is smaller in size [1]. MRI scans use the strength of the magnetic field which causes the atoms of the body to respond, and the emissions are detected by the scanner, which are analyzed, and an image is produced. MRI provides greater contrast between different soft tissues of human body [10], [19]. PET scan uses radioactive positrons

to detect differences in metabolic and chemical activity in the body. An area with increased activity will show on a colored image [25], [26], [27]. CT and MRI scans look at structures in the body, a PET scan looks at function [11]. Since cancer cell division is very rapid, they will generally show as having more metabolic activity. PETs can pick up very small areas of activity - much smaller than either of the CT or MRI [11]. As of now, majority of the research works have considered MRI to be the source of imaging data set [12], [13], [14]. On the other hand PET has an edge over MRI when the tumor size is smaller. PET also performs well in case of recurrence of tumors or post treatment stage of the tumor. Problem arises with MRI if there are leakages in the boundary region of tumor. Thus, PET may be considered as an alternative to MRI for the detection of brain tumors at an early stage [25], [26].

IV. IMAGE PROCESSING METHODS

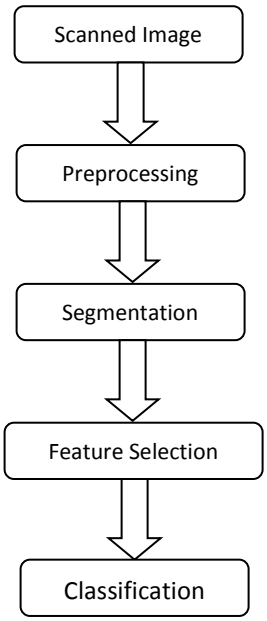


Figure 1. Steps of Digital Image Processing [14]

Figure 1, below, describes the steps to process images digitally and to extract data therein. The numeric representation of the image helps in drawing valid conclusion regarding the problem in hand.

A. Scanned Image

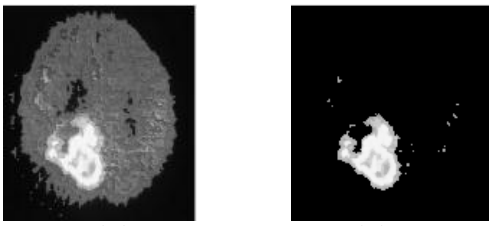
Image data is first acquired from a standard medical imaging database [17]. Scanned images with a default size are accepted as the input. Color images are converted into equivalent Gray-scale images and described by using a large two-dimensional matrix whose entries are numerical values (0-255).

B. Preprocessing

This phase is comprised of two phases: image smoothing and image registration. Image smoothing is trailed by image enhancement phase [18], [20]. Image smoothing is done by text removal, noise removal and sharpening of image. In this phase various image processing filters are applied on the input image to obtain a fine tuned standard image. Image registration is aligning two or more images properly. The end result of this phase is a distortion free clear image having high contrast and quality.

C. Segmentation

Image segmentation is the process of partitioning a digital image into sets of pixels also known as super pixels [15]. Precise aim of segmentation is to identify the region of interest. In case of brain tumor detection, image segmentation helps in identifying the tumor boundary region properly. Figure 2, below, shows a normal image and its segmented version. The segmented image groups similar pixels and helps in indentifying them from the other parts of the image.



(A) (B)

Figure 2. (A) Normal Image (B) Segmented Image

Image segmentation methods include (a) Edge Detection based, (b) Clustering, (c) Region growing, (d) Fuzzy based, (e) Thresholding based, etc. [4], [9], [21].

D. Feature Selection

The purpose of feature selection is to reduce the original data by measuring certain properties, or features, that distinguish one input pattern from another pattern. The selected feature should provide the characteristics of the input type to the classifier by considering the description of the relevant properties of the image into feature vectors [8].

E. Classification

Many research works have already been accomplished to compare advanced image classification techniques like Artificial Neural Networks, Support Vector Machines, Fuzzy Logic, Genetic Algorithms, etc. These studies help to conclude that the Neural Network approach of classification improves the accuracy and the finer information from the individual class is obtained by using textures [22], [23], [24].

V. FUTURE SCOPE

A CAD (Computer Aided Designing) system may be developed to automatically detect brain tumors through pattern recognition along with their respective shape, size, location and also to determine the stage and nature of the tumor. Figure 3, below, shows the fusion of PET with CT and MRI. Such fusions not only clearly identify the tumor but also demarcate its boundary region properly.

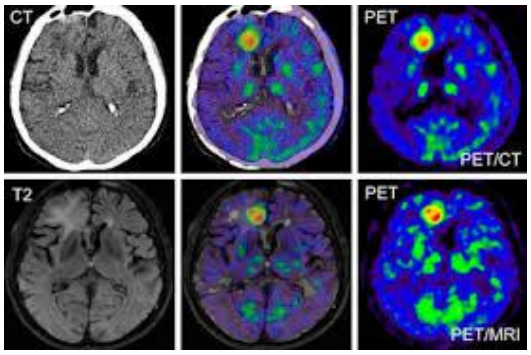


Figure 3. Fusion of PET with CT & MRI

PET imaging data may be used as input and in future the fusion methods of imaging such as PET/CT or PET/MRI may also be used as input data. ANN may be used as the image data classification technique and the algorithm may minimize the time consuming learning trail of traditional Neural Network Models. The idea behind writing this paper is to acquire PET images, preprocess the images and present to ANNs to detect and locate the tumor with accuracy.

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