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3- DPGR (3-Level Daubechies wavelet, PCA, GLCM, and RBF Kernal) method used for brain MRI categorization

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ABSTRACT

Today image processing assumes a critical part in the restorative field and medicinal imaging is a developing and testing field. Therapeutic imaging is invaluable in the determination of the illness. Numerous individuals experience the ill effects of cerebrum tumor, it is a genuine and perilous infection. Restorative imaging gives a legitimate finding of cerebrum tumor. There are numerous procedures to identify mind tumor from MRI pictures. These techniques confront challenges like finding the area and size of the tumor. To identify the tumor from the mind is the most critical and troublesome part, picture division is utilized for this. Effectively, different calculations are produced for picture division. This audit paper covers the essential wordings of mind tumor, a survey of different cerebrum tumor division procedures.

Keywords— *Image Processing, Medical imaging, Brain tumor, Segmentation techniques*

1. INTRODUCTION

Innovation in the medical field and advancements in technology for treating patients towards healthy living and cure for their ailment is possible through successful researches by efficient researchers. Invent of every new medicine and treatment involves a great number of people who gather together for a health study. In the past, in the absence of advanced technology, treatments were often given to patients based on guesses by the doctors which turned out to be a failure in most of the cases. Good research has removed such guess works from the medical field in recent days. Research in medical science evolves many methods of good treatment, care and cure for the patients.

The brain is a soft spongy mass of tissue. It is protected by the bones of the skull and three thin membranes called meninges. A watery fluid called cerebro spinal fluid cushions the brain. This fluid flows through spaces between the meninges and through spaces within the brain called ventricles. The mass of cells that results from this uncontrolled growth is called a tumor. While some of these tumors do not spread beyond their point of origin, others are capable of spreading large distances, often to other organs and tissues. This process is called metastasis, and tumors that metastasize are called cancers. Brain tumors can either originate from within the brain (primary brain tumors) or from cancer cells that have metastasized from other organs or tissues (secondary brain tumors). Primary brain tumors can be derived from over twenty different cell types that make up the brain. They are named and categorized by the type of cells that produce them. The most common forms of cancer that produce secondary brain tumors include lung, breast, kidney, and skin (melanoma) cancer. While primary brain tumors rarely metastasize outside of the central nervous system (CNS), they all have the propensity to spread within the normal brain and are all, therefore, cancerous. However, primary brain tumors do vary significantly in terms of how rapidly they grow and spread. Thus, most primary brain tumors are described in terms of grade. Low-grade tumors tend to grow slowly and frequently remain dormant for long periods of time, while high-grade tumors grow and spread rapidly.

Brain tumor plays the main role in medical imaging. The tumor is a rapid differentiation growth of abnormal cells in the human brain. Brain tumors are often challenging for doctors to diagnose and then give treatment. Diagnosing a brain tumor usually involves several steps. First, Doctor will perform a neurological examination, which among other things includes checking human vision, hearing, balance, coordination and reflexes. Depending on the results of the examination, the doctor may suggest one of the following tests: Computerized tomography (CT) scan, Magnetic resonance imaging (MRI) scan, Angiogram, X-rays, and single-photon emission computerized tomography (SPECT). MRI provides much greater contrast between the different soft tissues of the body than computed tomography (CT) does making it especially useful in neurological, musculoskeletal, cardiovascular, and oncological imaging.

2. EXISTING TECHNIQUES FOR DIAGNOSIS AND TREATMENT OF BRAIN TUMOR

The current technological development in Digital image processing and analysis has found many applications in various fields like satellite image analysis, medical image analysis and other industrial applications related to process automation.

Recently, researchers have developed automated computer-based analysis systems for tissue classification and analysis, but none of them provides precise morphological information for the cancerous tumors.

2.1 Detection of brain tumor

Till today, there are no blood tests or other screening tests recommended by the medical experts for the detection of brain tumors. Therefore, the early detection and immediate treatment can definitely improve the survival rate of the patient.

After reviewing the physical symptoms of the suspected patient of brain tumor, a diagnosis of brain tumor usually involves following several steps:

2.1.1 Neurological examination: A neurological examination is a series of tests to measure the function of the patient's nervous system and physical and mental alertness. A typical test involves testing of reflexes, sensation, muscle strength, eye and mouth movement, coordination, and alertness [1, 2]. If responses to these tests are not normal, the physician may recommend scanning of the brain and then refers the patient to a neurologist or neurosurgeon.

2.1.2 Brain scan techniques: A brain scan is a picture of the internal structures in the brain. Using computer technology, a scan compiles an image of the brain by photographing it from various angles. Nowadays, with the advancement of computer technology, all the images are readily available in digital form [3,4]. The various scanning or imaging techniques are available as listed below:

(i) Magnetic resonance imaging (MRI)
(ii) Computed tomography (CT)
(iii) Positron emission tomography (PET)
(iv) X-Ray
(v) Angiogram

2.1.3 Biopsy: Biopsy is a surgical procedure in which a sample of tissue is taken from the tumor site and examined under a microscope. The biopsy will provide information about the types of abnormal cells present in the tumor. The purpose of a biopsy is to discover the type and grade of a tumor. A biopsy is the most accurate method of obtaining a diagnosis [2,3,5]. Once a sample is obtained, a pathologist examines the tissue under a microscope and analyses the brain tissue. Sometimes the pathologist may not be able to make an exact diagnosis. This may be because more than one grade of tumor cells exist within the same tumor.

2.2 Post-biopsy treatment of brain tumor

After analyzing the sample brain tissue by Biopsy and confirming the presence of cancer, the following post Biopsy treatment of Brain tumor is recommended by the Neurologists depending on the diagnosis:

(i) Surgery
(ii) Radiation Therapy
(iii) Chemotherapy.

A brief review of post biopsy treatments is presented below.

2.2.1 Surgery: Surgery is the first line of therapy for patients with primary brain tumors. For some tumors, complete surgical removal is often possible. Grade I Tumors like astrocytomas and ependymomas can be removed entirely [2, 6]. However, if the tumors cannot be completely removed safely without affecting adjacent normal brain tissue, partial removal of tumor can have a major beneficial effect on the effectiveness of other supporting treatments, such as radiation therapy and chemotherapy.

2.2.2 Radiation therapy: The term 'radiation therapy' actually denotes a variety of treatments that utilize subatomic particles or the radiation that these particles release to treat cancer. Radiation therapy (also known as 'radiotherapy') comes in a variety of forms and it can kill cancer cells by a variety of mechanisms. External beam, fractionated radiotherapy is one of the important types of radiation therapy. This form of therapy uses high-energy radiation, which is generated from a source that is located outside of the body to damage the DNA of tumor cells. Tumor cells are not as efficient as normal cells in repairing the damage caused by radiation [2,5]. Thus, giving this form of radiation in small doses at regular intervals, allows the normal cells to recover from damage while tumor cells are unable to recover.

2.2.3 Chemotherapy: Chemotherapy may be defined as any medication, administered by mouth, intravenously, or directly into the brain, which prevents further tumor growth. There has been a veritable explosion of new drugs and new methods of administering these drugs that were not available ten years ago. Classical chemotherapy is the most commonly performed chemotherapy for treatment of tumor [7]. Most of the drugs, used for chemotherapy, damage important cellular machinery and thereby induce the cells to undergo a process called 'apoptosis'. Apoptosis occurs in normal cells when their DNA is severely damaged or mutated. Under these conditions, cells activate a series of processes and do not pass on their damaged DNA to their progeny cells and do not interfere with normal bodily function. In other words, apoptosis is a form of 'cellular suicide' designed to protect our bodies from the dangerous effects of cancer affected DNA. By damaging DNA or interfering with the duplication of DNA that occurs when cells multiply, these chemotherapeutic drugs induce the tumor cells to undergo apoptosis—leading ultimately to the death of the tumor [4]. Thus, depending on the type or grade of the tumor and its intrusion in the neighbouring normal brain tissue, the physician recommends one of the treatments to the patient.

3. BACKGROUND

El-Dahshan et al. [8] suggested a hybrid technique, in which feedforward pulse-coupled neural network is applied for the segmentation of the brain images. For feature extraction, they consider the approximation component of DWT. For feature reduction they used PCA and for the classification, they used back propagation neural network and achieved 99% accuracy.

Chaplot et al. [9] have introduced a scheme for feature extraction and classification. To validate the introduced system they are taken a standard dataset of 52 brain MRI images. For feature extraction, they consider coefficient of level-2 approximation sub-band of 2D DWT. Daubechies-4 (DAUB4) filter is used as the decomposition filter. After getting the features they employed self-organizing map (SOM) and support vector machine (SVM) as a classifier and they achieved higher classification rate for SVM with radial basis function (RBF) classifier i.e. 98% compared to the self-organizing map i.e. 94%.

Chatterjee et al. [10] have proposed a scheme for feature extraction and classification. For the feature extraction they have used slantlet transform (ST) and for the classification, they used a back-propagation neural network (BPNN) and archived ideal result. In [5] they introduced a scheme, they used ST for feature extraction and fuzzy c-means for classification and from the experimental result, they observed that the proposed scheme outperformed.

Table 1: Comparative analysis of various techniques

Author	Work performed	Technique used
El-Dahshan et al.	Suggested a hybrid technique, in which feedforward pulse-coupled neural network is applied for the segmentation of the brain images.	Used DWT for feature extraction and PCA for feature reduction.
Chaplot et al.	Introduced a scheme for feature extraction and classification.	Used DWT for feature extraction and Daubechies-4 (DAUB4) filter is used as decomposition filter.
Chatterjee et al.	Proposed a scheme for feature extraction and classification.	Used slantlet transform (ST) for feature extraction and back-propagation neural network (BPNN) for classification.
Selvaraj et al.	Suggested a system for brain MR image classification.	Used many classifier i.e. SVM classifier, Neural classifier, statistical classifier.
El-Dahshan et al.	Suggested a technique comprising of three stages i.e. feature extraction, feature reduction and classification.	DWT for feature extraction and PCA for feature reduction.
Zhang et al.	Proposed a scheme for classification.	Used Haar wavelet and PCA.
Saritha et al.	Suggested a scheme, in which they have used entropy of wavelet approximation component.	Used SWP for feature extraction and PNN for classification.
Yang et al.	Suggested a wavelet-energy based approach for brain MR image classification.	Used DWT for feature extraction and SVM for classification.
Nayak et al.	Proposed hybrid technique for brain MR image classification.	Used DWT for feature extraction and SVM as a classifier.

Selvaraj et al. [11] suggested a system for brain MR image classification. For classification, they have used many classifiers i.e. SVM classifier, Neural classifier, statistical classifier. Among all these classifiers LS-SVM outperformed with 98% success rate.

El-Dahshan et al. [12] suggested a technique. The suggested technique comprises three stages i.e. feature extraction, feature reduction and classification. For feature extraction, the approximation sub-band of DWT is considered. Principal component analysis (PCA) is used for feature reduction and for the classification feed forward back-propagation neural network (FP-ANN) and k-nearest neighbour (k-NN) used as a classifier and they achieved 97% and 98% accuracy, respectively.

Zhang et al. [13] have proposed a scheme for classification. They have taken 160 images (20 normal, 140 abnormal) to validate the scheme. For feature extraction, level-3 approximation component using Haar wavelet is used. After feature extraction, PCA is used for feature reduction and for the classification forward neural network is used and they achieved 98.75% classification accuracy.

Saritha et al. [14] suggested a scheme, in which they have used entropy of wavelet approximation component at level-8 computed along with SWP for feature extraction. For the classification, they used Probabilistic neural network (PNN) and their results indicate that they achieve a high success rate.

Yang et al. [15] suggested a wavelet-energy based approach for brain MR image classification. For feature extraction, they have used 2D DWT. For brain image classification SVM classifier was employed and BBO method was utilized to optimize the weights of the SVM. They noticed that their scheme was superior then KSVM, PSO-KSVM and BPNN.

Nayak et al. [16] have proposed a hybrid technique for brain MR image classification. For feature extraction, through brain MR images they utilize the approximation coefficient of level-3 of discrete wavelet transform (DWT). To reduce the large set of extracted features from brain MR images they have employed kernel principal component analysis (KPCA). After getting the reduced set of features they have employed least square support vector machine (LS-SVM) as a classifier with different kernel function and they have reported that the proposed scheme outperforms with high accuracy.

4. CONCLUSION

To precisely analyze the brain tumor, an appropriate division strategy is required to distinguish the cerebrum tumor from MRI pictures. Data given by numerous pictures from different cuts are required for the precise conclusion, arranging and treatment reason. The principle centre is around the change of data acquired from the pictures through the cut introduction and consummating the procedure of division to get a precise photo of the cerebrum tumor. In this paper, a portion of the ongoing examination work done on the cerebrum tumor location and division is evaluated.

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