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REVIEW ARTICLE

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Transform Based Method for Classification of Various Meningioma Subtype Images

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***Abstract*:** A brain tumor is an abnormal mass of tissue in which some cells grow and multiply at a rapid speed. This growth of a tumor occupies space within the skull, interferes with normal brain activity and causes damage to the brain tissue and nerves by increasing pressure in the brain, by shifting the brain or pushing against the skull. Identification of the tumor requires a neurological examination, scanning of the brain followed by analysis of the brain tissue and biopsy. The overall process is time consuming. Once the tumor has been diagnosed the next challenge involves determining the type of brain tumor. Of these Meningioma tumor accounts for 27% of the entire brain tumor. So the next challenging task is classification between the subtypes of Meningioma tumor viz. Fibroblastic, Meningiothelial, Transactional and Psammomatous. In this paper, we present a wavelet based technique for discriminating between four different subtypes of Meningioma. Because the overall process, right from the diagnosis of the tumor to the classification of the Meningioma subtype is time consuming, may also cause error and mainly dependent on the experts convenience, hence computer based technique helps in classification of Meningioma subtypes.

Keywords: Brain tumor, Meningioma, Fibroblastic, Meningiothelial, Transactional and Psammomatous, Wavelet based technique.

I. INTRODUCTION

A brain tumor, or tumor, is an abnormal growth of cells within the brain or the central spinal canal which can be cancerous or non-cancerous (benign). They are created by an abnormal and uncontrolled cell division, usually in the brain itself, but also in lymphatic tissue, in blood vessels, in the cranial nerves, in the brain envelopes (meninges), skull, pituitary gland, or pineal gland[1] . The tumor occupies space within the skull and can interfere with normal brain activity. Due to that it causes pressure in the brain, and causes pressure against the skull, thereby damaging the nerves and healthy brain tissue. Identifying a brain tumor usually involves a neurological examination, brain scans, biopsy, and then an analysis of the brain tissue. The doctors then use the diagnostic information to classify the tumor as benign or malignant. Identifying the type of tumor helps doctors determine the most appropriate course of treatment. This neurological examination for identification of the tumor involves a series of tests which are lengthy procedure.

A brain scan which is a picture of the internal structures in the brain is suggested by the doctors for detailed examination. Once a tumor is identified in the brain, a biopsy is conducted. It 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 on 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]. Once a sample is obtained, a pathologist examines the tissue under a microscope and writes a pathology report containing an analysis of the brain tissue. The overall procedure is lengthy. Sometimes the pathologist may not be able to make an exact diagnosis. This may be because more than one grade of tumor cells exists within the same tumor.

Doctors group brain tumors by grade. This grading of a tumor is based on the way the cells look under a microscope [3]:

Grade I: The tissue is benign. The cells look nearly like normal brain cells, and they grow slowly.

Grade II: The tissue is malignant. The cells look less like normal cells than do the cells in a Grade I tumor.

Grade III: The malignant tissue has cells that look very different from normal cells. The abnormal cells are actively growing (anaplastic).

Grade IV: The malignant tissue has cells that look most abnormal and tend to grow quickly.

The most common types of tumor are:

a. ***Astrocytoma:*** The tumor arises from star-shaped glial cells called astrocytes.

b. ***Meningioma:*** The tumor arises in the meninges. It can be grade I, II, or III. It's usually benign (grade I) and grows slowly.

c. ***Oligodendroglioma:*** The tumor arises from cells that make the fatty substance that covers and protects nerves. It usually occurs in the cerebrum. It's most common in middle-aged adults. It can be grade II or III.

Of these Meningioma account for 27% of all brain tumors. These tumors grow from the meninges, the layers of tissue covering the brain and spinal cord. The WHO classification divides Meningioma into three grades: Grade I: Benign Meningioma, Grade II: A typical Meningioma, Grade III: Malignant (Anaplastic) Meningioma [4].

Meningioma subtype classification basically involves classification between four different subtypes of Meningioma namely Fibroblastic, Meningiothelial, Transitional and Psammomatous [5]. These four subtypes refer to four stages of the tumor. These Meningioma subtypes can only be seen and identified under a microscope. WHO graded each of these Meningioma subtypes into one of three categories based primarily upon the likelihood of recurrence and the rate of

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growth exhibited by each. The overall classifications are benign (Grade I), atypical (Grade II) and malignant (Grade III)[6]. Some level of variation may exist when a pathologist is trying to categorize the particular subtype of a Meningioma, as some subtypes have similarities in appearance. One pathologist might look at the tissue and decide that it is a type of Meningioma that falls into the atypical, Grade II category, while a different pathologist may look at the same tissue and decide that the Meningioma should be classified as a subtype that falls into the benign, Grade I category.

II. METHOD

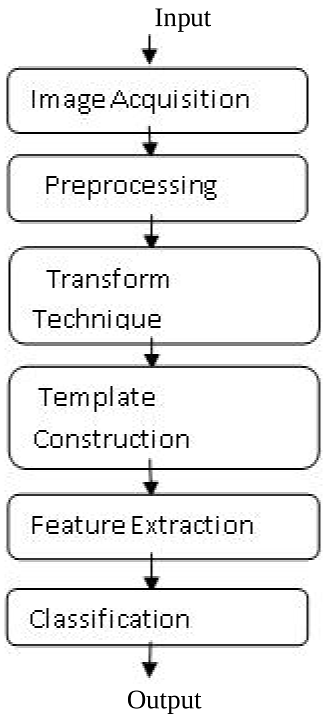

Figure 1: Flow diagram for Meningioma subtype classification

A. *Image Acquisition:*

Samples are extracted either through the brain biopsy or are extracted during the surgery. These samples are then converted in the form of slides.

B. *Preprocessing:*

Images that are obtained through biopsy are real world images. Prior to offering these images to the computer processing, preprocessing is essential. It improves the quality of the image. Hence here the color images are converted into gray. Colors in an image may be converted to a shade of gray by calculating the effective brightness or luminance of the color and using this value to create a shade of gray that matches the desired brightness.

The effective luminance of a pixel is calculated with the following formula [7]:

Y=0.3RED+0.59GREEN+0.11Blue

C. *Transform Technique:*

The wavelet packet transform has a number of applications. One of these involves the calculation of the "best basis", which is a minimal representation of the data relative to a particular cost function. The "best basis" is used in classification of Meningioma subtypes. Wavelet packet analysis is an important generalization of wavelet analysis [8], [9], [10], [11]. Wavelet packet functions are also localized in time, but offer more flexibility than wavelets in representing different types of signals. The wavelet decompositions of a 2D signal can be viewed as nodes of a tree. This Wavelet packet approximators are based on translated and scaled wavelet packet functions Wd, p, q, where d is the depth and p, q are the frequency indices. An image is subjected to wavelet transform to get its respective subbands and then each subband is further subjected to wavelet transform until a predefined maximum depth is reached [5].

D. *Template Construction:*

Now the next issue is selection of the subband that represents maximum information. In order to select most appropriate subbands, a probability density function (pdf) is obtained for each subband. A probability density function (pdf) is a function that describes the relative likelihood for this random variable to take on a given value. The probability density function is nonnegative everywhere. The probability function is obtained using the normalized energy for the subband coefficients. The probability function estimates the textural information in a subband. Hellinger distance can be used to obtain the discriminating power of each subband so that the subband with more textural information is obtained.

E. *Feature Extraction:*

Since the subband data obtained is too large to be processed it will be transformed into a reduced representation set of features (also named features vector). Transforming the input data into the set of features is called feature extraction. If the features extracted are carefully chosen it is expected that the features set will extract the relevant information from the input data in order to perform the better classification of Meningioma subtypes. A best Feature Selection algorithm may be used that will give the subset of the features that will best information representing original data. Principle components are the projection of the original features onto the Eigen vectors corresponds to the largest eigenvalues of the covariance matrix of the original feature set.

F. *Classification:*

Classification includes a broad range of decision-theoretic approaches to the identification of images. Classification algorithms assumes that the Meningioma subtype image in question depicts one or more features i.e. spectral regions and that each of these features belongs to one of several distinct and exclusive classes. The classes may be specified a priori (as in supervised classification) or automatically clustered (i.e. as in unsupervised classification) into sets of prototype classes. Support Vector Machines (SVMs) are supervised classification technique that may be appropriate for this Meningioma subtype classification. By their nature SVMs are essentially binary classifiers, however, they can be adopted to handle the multiple classification tasks common in Meningioma image classification [12].

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III. RESULTS

The above given method has shown some experimental results. Using SVM classifier we have achieved high detection rate for Psammomatous Meningioma. This is therefore very useful for the doctors as Psammomatous is the one of the most common form of the tumor and is developed because in it the cancerous cells surround themselves with protein and form psammoma bodies.

Table 1. Result of classification of Meningioma images.

Meningioma	Total Test Images	Correct Detections	Classification Rate
Meningiothelial	10	4	43
Psammomatous	10	4	43
Fibroblastic	10	4	43
'Psammomatous'	10	10	100

IV. CONCLUSION

Meningioma subtype classification is one of the important problems because there are four subtypes in Meningioma tumor which represent different stages of the tumor and hence requires proper diagnosis. Thus with some computer assisted technique the diagnosis can prove useful to the doctors. Here a wavelet based method for classification of the Meningioma subtypes is discussed which uses SVM classifier and some results have been displayed.

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