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Brain Tumor Detection using Naïve Bayes Classification

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Abstract - *Brain tumor is caused due to the population of abnormal cells called glial cells that reside in the brain. The number of patients who are diagnosed with brain cancer is increasing with respect to the aging population, which is a worldwide health problem. The objective of this paper is to develop a method to detect the brain tissues which are affected by cancer called Glioblastoma multiforme (GBM). GBM is one of the most malignant cancerous brain tumors as they are fast growing and more likely spread to other parts of the brain. In this paper, Naïve Bayes classification is utilized for recognition of a tumor region accurately that contains all spreading cancerous tissues. Brain MRI database, pre-processing, morphological operations, pixel subtraction, maximum entropy threshold, statistical features extraction, and Naïve Bayes classifier-based prediction algorithm are used in this research. The goal of this method is to detect the tumor area from different brain MRI images and to predict that detected area whether it is a tumor or not. When compared to other methods, this method can properly detect the tumor located in different regions of the brain including the middle region (aligned with eye level) which is the significant advantage of this method. When tested on 50 MRI images, this method develops 81.25% detection rate on tumor images and 100% detection rate on non-tumor images with the overall accuracy of 94%.*

***Key Words*: Brain Tumor, Naïve Bayes, Glioblastoma Multiforme, Magnetic Resonance Image, Segmentation**

1. INTRODUCTION

The brain and spinal cord contain the nerve cells called neurons and neurons are surrounded by glial cells. brain tumor can develop from different types of glial cells, tumor that grow from different types of glial cells are called astrocytes and are called astrocytoma.it has 4 levels of cancer (Grade 1 to 4).grade 4 astrocytoma is called Glioblastoma multiforme (GBM) which contains cancerous tissues and they are very likely to spread. The medical imaging technique used for cancer diagnosis plays an important role in solving diagnosis problems, depending on the clear visualization and quality of the results. There are various monitoring techniques for the brain tumor detection such as X-ray, Magnetic Resonance Imaging Scanning (MRI scan), Computer Tomographic Scanning (CT scan) and the quality of the images obtained by those techniques become better and better over the years. However, MRI is the most common technique for brain tumor diagnosis to observe the cancerous tissues and to locate the affected tissues in the brain which is effective for detection and classification of different types and grades of tumors in clinical diagnosis. Besides medical imaging techniques, processing tool that is used for extracting the medical images is also important for identification and classification of the type of diseases. Image processing technique has been proven to be one of the most effective and efficient tools for various medical applications. The aim of medical image processing is to develop a system to help the doctors in solving medical diagnosis problems with the help of computers.

2. METHODOLOGY

The procedural diagram for detecting brain tumor from brain magnetic resonance images is shown in Fig 1.the brain tumor detection algorithm is implemented through four distinct steps, pre-processing, Segmentation, feature extraction, and naive Bayes classifier-based detection. All samples of MRI (Magnetic resonance image) of brain tumor images in this paper are from the Rembrandt database. Rembrandt database for brain cancer images contains 130 MRI images of patients in multi-sequence with the clinical data analysis.

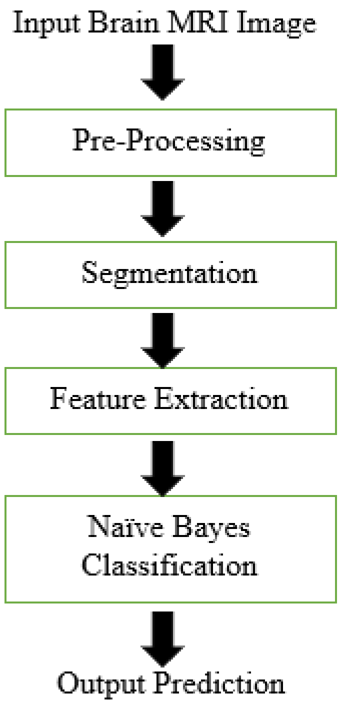


Fig1. System Analysis

2.1 Image Database

All sample MRI brain tumor images in this paper are from the Rembrandt database [6]. REMBRANDT database for brain cancer imaging contains MRI images of 130 REMBRANDT patients in multi-sequence with the clinical data analysis in the form of DICOM. Those DICOM images are further converted into JPEG format and stored in a local database for processing. A total of 114 MRI images with 24 normal and 90 tumors are used. Figure 2 shows normal images and tumor images located in different positions, obtained from the REMBRANDT database.

2.2 Pre-Processing

Firstly, the input image is converted into grayscale image, and pixel subtraction is applied to obtain the brain tumor area without having the skeleton part for further processing. the most important part is detecting the entire cancerous tissue. fig 2. shows the Normal and abnormal brain MRI image. Morphological operation is used to separate the boundary region and skeleton part of the image. the pixel subtraction is applied to obtain the brain tumor area. Firstly, the skull part is separated by subtracting opened image from original images. after that, the undesired regions are removed from the skull image. finally, the image of the brain tumor is obtained without the skull part.

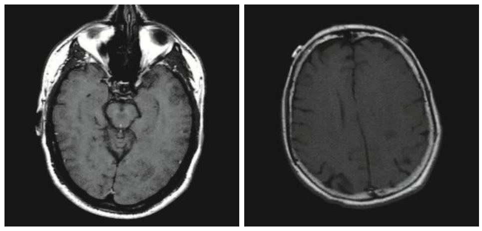
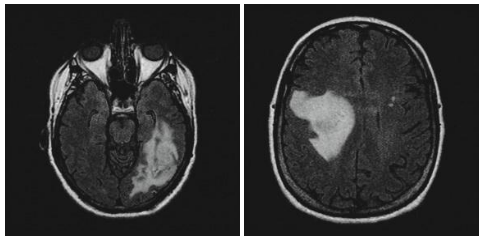


Fig 2. (a) Normal brain MRI Image



(b) Abnormal brain MRI Image

2.3 Segmentation

For segmentation, Otsu's threshold is adaptive when compared to other threshold methods due to its intensity variation of both foreground and background of MRI image, this method has been successfully applied in many medical images to obtain the entire tumor region.

2.4 Feature Extraction

In this stage, from grayscale image of segmented tumor area, many morphological and features are extracted features like (area, eccentricity, perimeter, diameter, major axis length, minor axis length).

2.5 Naive Bayes Classification

The Naïve Bayes classification is a supervised classification of machine learning, based on a probabilistic approach which uses Bayes theorem of probability. The main reason why we use this algorithm is it assumes that the features occurrences are independent of each other. As in most fields that deal with events under randomness, probability considerations become significantly effective due to

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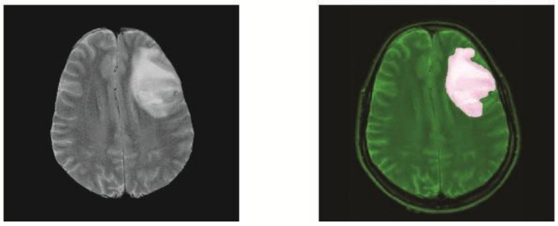
independence on the occurrence of the extracted features. The extracted features matrix is subjected to be trained in the Naïve Bayes classifier so that it could predict the test image whether it is normal or tumor. Falser tumor objects are trained than tumor objects for better performance since the false tumors are detected in different locations.

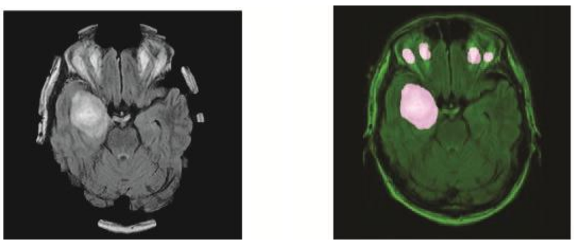
3. EXPERIMENTAL RESULTS

Although the segmentation correctly detects the tumor which located in the upper level of the brain as in Fig 3, detecting the tumors located in the middle level of the brain is more challenging due to the false positive result of the eyes as in Fig 4. Hence, to correctly detect the tumor only without affecting the remaining cancerous tissues, the matrix containing eleven features of all detected objects are trained with Naïve Bayes classifier. With the use of this classifier, the entire spreading tumor tissues are detected without deformation due to further segmentation processes.



(a)extracted image (b) detected image

Fig 3. Segmented image with one detected object



(a)extracted image (b)detected image

Fig 4. Segmented results with five detected objects

From all 114 MRI image database, 221 objects are detected by the segmentation. Although the database is not much, it is enough for Naïve Bayes classifier prediction, with each object containing eleven features. 171 objects out of 221 objects are trained and 50 objects are tested in this paper. The trained 171 objects contain 79 tumors, 38 bone parts, 42 eyes objects and 12 false tumors (46.2% tumors and 53.8%, not tumors). And the test 50 objects contain 20 tumors, 9 bone parts, 15 eyes objects and 6 false tumors (40% tumors and 60%, not tumors). The following equations are used to calculate the accuracy of the occurrence of brain tumor.

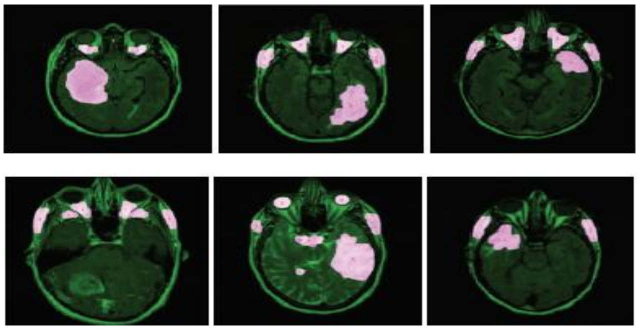


Fig 5. Some detected objects with true and false objects

Sensitivity =TP / (TP+TN); successful detection of a tumor.

Specificity = TN / (TN+FP); successful detection of not tumor.

Accuracy = TN+TP / (TN+TP+FN+FP); successful detection.

- TP (True Positive): Tumor exists and detected.
- TN (True Negative): Tumor does not exist and not detected.
- FP (False Positive): Tumor does not exist and detected.
- FN (False Negative): Tumor exists and not detected.

Table 1. Performance of the Method

Test	TP	TN	FP	FN	Sensitivity	Specificity	Accuracy
50	13	34	0	3	81.25%	100%	94%

According to the result, 47 out of 50 objects were correctly evaluated by the Naïve Bayes classification. Since 34 non tumor objects were correctly evaluated with 100% success, the proposed method can reliably distinguish between tumors and non-tumor objects.

4. CONCLUSIONS

The proposed method can help the medical staffs such as surgeons and radiologists to diagnose the brain cancer from MRI images especially for GBM which requires the detection of all possible spreading cancerous region. In this method, brain tumors have been detected using Naïve Bayes classification with the help of maximum entropy threshold. The REMBRANDT database is used in this study. The developed algorithm can accurately detect the tumor in all possible locations of the brain that the tumor can exist, including the temporal lobe (which align with the eye level). The algorithm yields 81.25% detection rate on tumor images and 100% detection rate on non-tumor images with the overall accuracy 94%.

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