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DETECTION AND DIAGNOSIS OF BRAIN TUMOR USING SEGMENTATION AND CLASSIFICATION METHODS : A REVIEW

Harish Varma Alluri[1], T. V. Narayana[2], Burla Naga Ramya[3], B Rajesh[4]
[1,2]Assistant professor, [3,4]Student
ECE Dept, SRKR engineering college, Bhimavaram, Andhra Pradesh, India

Abstract:Cancer is hazardous disease in which the growth of uncontrollable cells begins in any part of the body. Approximately 100 types of cancer are noticed in this world. Some basic categories of cancer disease are brain tumor, ovarian cancer, breast cancer and lung cancer. The Information given in this research paper is about the brain tumor.The detection and diagnosis are crucial to save the lives of patients because it impacts on the people rapidly.Generally, a brain tumor is a collaboration of different groups which are initialized from the intracranial tissues. The tumor cells in the brain are categorized according to their size and location. The fundamental brain tumors are benign and malignant. The objective of this review is to give a better and more detailed perspective about the brain tumor. The basic information is provided which includes the classification, common sign and symptoms, risk factors and the preventions. Further, the detection systems are introduced which based on the biomedical image processing that used for the detection of the affected region of brain. The common systems are MRI (Magnetic Resonance Imaging) and CT scan (Computed Tomography). After this, the deep discussion is conducted about the diagnosis and for this purpose; several machine learning techniques are considered using image processing. These techniques are segmentation, image filters, morphological filters, naïve bayes algorithm, PNN (Probabilistic Neural Network) and decision tree.

Keywords: MRI (Magnetic Resonance Imaging), CAD (Computer Aided Diagnosis), PNN (Probabilistic Neural Networks), CT scan (Computed Tomography).

I. INTRODUCTION

Cancer is the unsafe diseases which occurred globally and affect the majority of people. It is confirmed via a survey which was finished in 2008 and implied that approximately 12.7 million cancers were noticed. The range of cancer patients are flourished rapidly. In simple terms, a cancer is a disease which produced in the blood cells and a form of cell which grows randomly and uncontrollable manner. To balance these kinds of cells is not an easy task. When the production of tumor cells is initialized it later moves toward the other body parts from its initial position. The growing speed of tumor cells is faster as compare to other blood cells. It influenced the great tissues in the human body as liver, brain, heart, etc. [1]. The cancer and tumor disease are classified into several categories of cancer for example kidney, liver, breast, lung, colon, pancreas, ovarian cancer, brain tumor heart diseases, etc.

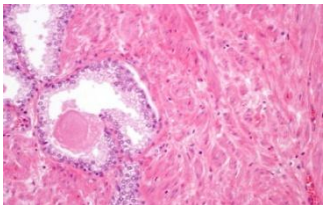

Figure 1. Patter Showing Cancer Cells in a Tissue [1]

A brain is the most important organ in body that controls the activities performed by a human. It is a complicated system which is responsible for everything. It creates a central nervous system which includes the senses, seeing, hearing, touching, smell and others. Generally, a brain is a soft tissue which is a combination of three parts as namely as the cerebrum, cerebellum and brain stem [2]. The brain tumor is a category of cancer disease in which the abnormal cells are produced in the brain tissue and partition the brain. The tumor cells are making their copies and also spread in the other tissues [3].

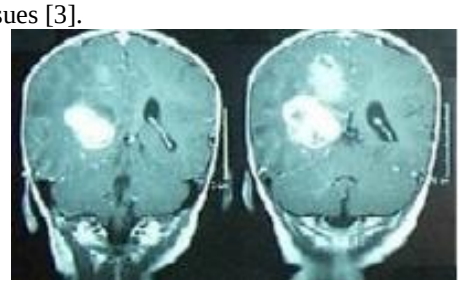

Figure 2. Presence of Abnormal Cells in Brain [3]

Figure 2 depicts the presence of abnormal cells in the brain tissue and the picture is captured by MRI (Magnetic Resonance Imaging) process.

The rest of theresearch paper is organized in different sections. The second section is about the background which composed of the initialization of brain tumor, its categories and the stages of disease. Third section includes a review of previous used approaches for the detection of brain tumor. The further section described the detection procedure of brain tumor and later various different methods are introduced for the diagnosis of this disease in section fifth. The last section represents the overview of the entire work and gives the use of current methods for the future processes.

II. BACKGROUND

The tumor production must be initialized from certain risk factors which increased the growth of cancer cells. The classification of tumor cells is based on its type, initial position and size of the cell.

A. Classification of Brain Tumor

- Typically, a brain tumor is classified into two fundamental categories as described below-
- Primary Tumor: The primary tumor sometimes called metastatic tumor. The initial form of cancer cells is the brain's own cells which slowly distributed its copies in the other sections of the brain. Benign tumors are primary tumor.
- Secondary Tumor: These are the glimas tumors that generated in the glial cell. This kind of tumor is most crucial to detect and diagnosis [4].
- Generally,gliomas formed into different categories for instance Astrocytoma, oligodendroglioma, brain stem gliomas, ependymoma and the combined tumor cells. Malignant tumor is a secondary tumor.

B. Sign and Symptoms

The common symptoms are seen in the patients of brain tumor disease. Some of the signs and symptoms are mentioned below-

- Head pain is the common symptom of brain tumor.
- Vomiting
- Issues while walking and running
- Signs of forgetting things (Memory loses)
- Seizures
- Pain in both legs and arms.
- Changes in mood and personality
- More tiredness
- Changes in voice and hearing
- Learning capability declined [5].

C. Stages of Tumor Disease

The stages of brain tumor areused to identify the levels of cancer cells. Basically, the tumor is segmented into four stages. The detection of tumor in early stages is more curable rather than the last stages.

Stage1. This is the initial stage of tumor cells in which the processing speed is slow and just distributed in the nearest tissues. The removal of cancer cells is easier.

Stage2. In this stage, the formation of slow cells is changed to the highly hazardousform which affects the other tissues and speed up the spreading process.

Stage3. This is the critical stages where the tumor cells seen different from the other normal cells and has more impact on the other tissues.

Stage4.The last and most crucial stage is stage 4 in which diagnosis process is harder anddifficult. The survival is long and more dangerous due to the challenges while detection of cancer cells [2].

III. LITERATURE SURVEY

Pereira, S., et al., (2016) [6] proposed a segmentation approach which relied on CNN (Convolutional Neural Networks) in medicated image processing as known as MRI (Magnetic Resonance Imaging) images. Basically, the brain tumor was a highly graded form of cancer disease that affects the people world widely. The treatment of brain tumor was crucial to decline the long survival of patients and to prevent the production of tumor cells at the early stages of the disease. MRI images were playing out important role for the detection and diagnosis of brain tumor.In the research, the proposed approach was image segmentation which count on CNN with the use of small kernels especially for the designing the better network. CNN performed well for the detection of brain tumor andfor the segmentation. The performance parameters were DSC (Dice Similarity Coefficient), PPV (Positive Predictive Value) and sensitivity with achieved results 0.81, 0.90 and 0.86 respectively to improve the core and to enhance the region.Shil, S. K., et al., (2017) [7] recommended an improved detection and classification schema for brain tumor. The brain tumor cancer was produced due to the abnormal growth of cells in the brain and cancer cells damaged the other cells. For the better detection and to classify the cancer through MRI (Magnetic Resonance Imaging) was performed. The detection was performed by firstly,viewing MRI of the brain and it composed of various steps as pre-processing, post-processing and finally, classification of data. In the current research, Ostu binarlization was trained by using K-mean clustering particularly for the segmentation. The features extraction and reduction of dimensions were completed by DWT (Discrete Wavelet Transform) and PCA (Principal Component Analysis). The reduced number of features was associated to the SVM (Support Vector Machine) and later classified the tumor and normal cells in different groups. The performance was evaluated by using three parameters as accuracy, specificity and sensitivity. The classification through these performance parameters was 99.33%, 99.17% and 100 % separately.Jayalakshmi, C., et al., (2016) [8]suggested the intelligent approaches for the better analysis of brain tumor. Brain was the primary tissue of body and several kinds of factors were being a cause of brain tumor. Hence, the detection was essential. Intelligent approaches were gaining a lot of attention in every field and these had been used in medical imaging also for the detection and diagnosis of diseases. The present research was introduced vast variety of intelligent approaches which were MRI (Magnetic Resonance Imaging), CT (Computerized Tomography) and MW (Micro Waves). These approaches were unable to detect the below the size of 3mm of the cell. Therefore, other methods were utilized as NII (Near Infrared Imaging), fuzzy clustering, seed growing, EMO (Electromagnetic Optimization) to track the tumor cells quickly and more accurately. The segmentation was basically preferred to divide the particular image in different regions. EMO had been analyzed in various forms. The comparison was shown which compared the performance of these techniques on the basis of speed, accuracy, time consumption and the overall performance.Hunnur, M. S. S., et al., (2017) [9] described the image processing approach for the detection of brain tumor. Generally, the digital image processing was considered as the most crucial field which fully worked on the construction of images and it had been used in the medical field from many years ago. MRI was one of the most common methods used specifically for the detection of different diseases such as cancer. The research was all about the detection procedure of the brain tumor which completed by using the thresholding approach which

proceeds in different steps and finally generates the desired output. It had the tendency to track the tumor cells form the MRI image form the huge dataset of patients. The proposed research depicts that the detection of tumor cells was simple in this way and being a useful tool for the physicians. The major key-terms utilized in the research were grayscale images, MRI, edge detection performed by sobel operators, filtration and finally the thresholding approach. A complete study was done on the above-mentioned approaches for the detection of tumor cells.Aslam, A., et al., (2015) [10]enhanced the edge detection process for the segmentation of brain tumor. Segmentation of images was basically preferred to partition the images from their backgrounds and to improve the quality of images with the grouping of relevant images together and different images in other groups. Segmentation was come up to as a dynamic tool for the medical imaging. The proposed work was related to the improved detection of edges in the segmentation. The entire proposed work was relied on sobel approach with the combination of thresholding approach. The discovery of different regions was done by using CCA (Close Contour algorithm). In this way, the tumor cells were captured from the different images and determined as well. The planned strategy was executed using C and the performance was evaluated on the basis of the outcome of it. The experiment demonstrated that, the new proposed approach was more willingly than any other conventional segmentation procedures. For generating the best outcome, a comparison was performed among various segmentation processes. The performance parameters were GU (Gray Level Measure). QP (Q Parameter), RUMA (Relative Ultimate Measurement Accuracy)

TABLE I. Literature Survey with Proposed Techniques

Author's Name & Year	Proposed Technique	Performance parameters	Research Challenges
Pereira, S., et al., (2016)	CNN	DSC (Dice Similarity coefficient), PPV (Positive Predictive Value), Sensitivity	To manage huge amount of data, more time consumption
Shil, S. K., et al., (2017)	Ostu binarlization, K-mean clustering, DWT, PCA, SVM	Accuracy, Specificity, Sensitivity	Better solution for the classification of large data
Jayalakshmi, C., et al., (2016)	Fuzzy clustering, EMO, region growing, Near infrared imaging	Speed, Time consumption, Accuracy, Overall performance	Detection of cells which were below 3mm in size
Hunnur, M. S. S., et al., (2017)	Thresholding approach, sobel operators	Elapsed Time	-
Aslam, A., et al., (2015)	CCA, Improved edge detection, Sobel detection	RUMA, QP, GU	Automatic detection approach

IV. RISK FACTORS AND PREVENTIONS

Some factors which are initialized the process of tumor cells in the brain. The diagnosis process is being difficult to be performed in the last stages of disease. The preventions are useful and better option for the early detection and to prevent the formation of cancer cells. So, the people can save theirselves from these kinds of hazardous diseases. If some precautions are considered against these factors then, the cancer cells automatically prevented.The major factors which influenced the brain are as following-

- Genetic is the common factor which has certain kinds of inherited syndromes and family history.
- Ionising radiation which is also common cause of cancer.
- Mobile phones because these have radiofrequency signals. The energy level is more which easily damaged DNA (Deoxyribonucleic Acid).
- Immune factors for example: different viruses, allergies and infections.
- Use of chemicals on head such as hair dyes and sprays.
- Head trauma and serious injuries [11].
- Seizures, epilepsy.
- Excessive use of alcohol, tobacco and medications.
- Pollution is also risk factor such as air, water which comes when breathing in that air and drinking impure water.
- Lack of good health due to the less amount of vitamins and good diet.
- Certain kind of radio frequency exposures.
- Addiction of drugs [12].

V. DETECTION TECHNIQUES

Biomedical image processing is the simple image processing methods which used for the detection and diagnosis of diseases especially brain tumor or other kind of cancer diseases. To cure the diseases at early stages, it is essential to use the biomedical imaging. Due to the enhancement of technology, the detection processes become better for the health care of the patients and generates the highly accurate results. These are mainly utilized for the segmentation, identification and to detect the infected area from a certain region inside the body [13]. The basic process of image processing to detect the tumor cells is described in figure 3.

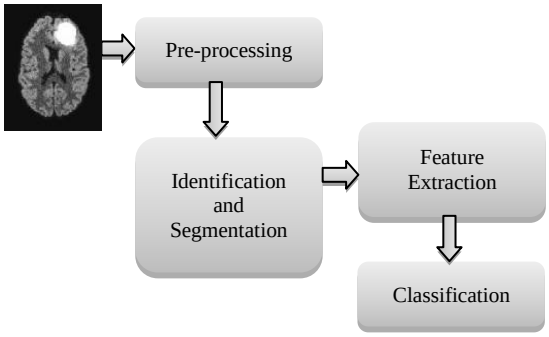

Figure 3. Medical Image Processing [14]

Pre-processing: Preprocessing is the first step which considered after capturing an image. In preprocessing, the noise and low contrast is removed from the image to clear the visibility and it normalized the intensity of pixels in an image [14].

Segmentation:Generally, segmentation is a process to partition the images in some kind of relevant group which called super pixels. The images are partitioned according to the data. The same images considered in one group and other are set according to the similarity or difference. The main objective is to identify the affected region form the entire image [15].

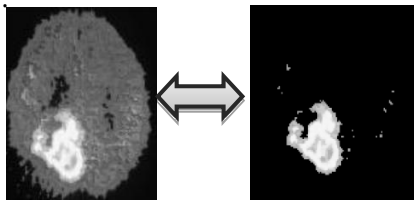

Figure 4. Normal and Segmented Image [15]

Feature Extraction: This is the most important part which extracts the unique features from the image and converted them in the binary from (1's and 0's). It is performed because the intensity of pixels is not always same. The mathematical equation followed while the feature extraction is as below-

$$\text{Img}(x,y) = \begin{cases} \text{img}(x,y) I_D = 1 \\ \text{img}(x,y) \text{x} 0.4 \quad I_D = 0 \end{cases}$$

Where Img (x,y) is the output of an image and I_D is the dilated image where features region is shown.

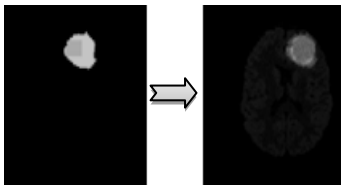

Figure 5. Dilated Image and Tumor Containing Imager

After these things, the erosion is takes place which declined the noise and minimizes the image to extract the tumor region properly [16].

Classification:The last step in the image processing when the detection process of tumor cells is initialized. The different tumor cells are classified in their different groups. It enhanced the quality of image and increased the accuracy.

Categories of Medical Imaging

The basic medical images are X-Ray, MRI (Magnetic Resonance Imaging), CT scan, CAD (Computer Aided Diagnosis), etc.

MRI:Magnetic resonance imaging is a computerized picture which accessedto capture the image form the internal structure of body. It is a dynamic magnet which is seen by the monitor and later it is printed. Further, for the more detailing of features, a special kind of dye is used to characterize the differences in the tissues [5].

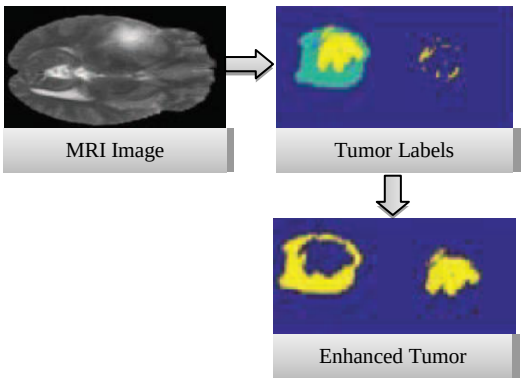

Figure 6 MRI Imaging [17]

CT (Computed Tomography) Scanning: It is a scanning machine which is associated to the computer and worked in the similar way as x-ray machine. It captures a huge number of detailed images of head. The patient takes an injection which intrudes the special form of chemical or dye in the brain. After this, the brain described the clear picture of internal tissues.

Additional, there are several kinds of detection methods which are preferred for the detection of tumor cells in the brain. Some of these are Angiogram, skull x-ray, spinal tap, myelogram, biopsy and needle biopsy [5].

VI. DIAGNOSIS AND DIFFERENT TECHNIQUES

The diagnosis is crucial for the brain tumor patients due to the long survival at the last stages. It is easy to cure the diseases at early stages on other the hand, itis difficult at the last stage. But the diagnosis is always required even the tumor at the earlier stage or at the last stages.

Machine learning methods are highly demanded in every field and it is showing a great attention in the detection and diagnosis of some critical diseases. Brain tumor is one of them that required to be cured as soon as possible. Further, the image processing is also assists to detect the affected region of a particular tissue by using some medical image processing methods as MRI, CT scan, etc. as explained in above section. Some of the best techniques are explained below-

A. Image Segmentation

Brain tumor segmentation is a major task which considered in the medical image processing and detection of disease in the early stages is identified using these kinds of methods. Basically, image segmentation is processes which partition the images and manage them into their relevant groups as described in the above section. For the detection of brain

tumor, two kinds of segmentation approaches are used as-

- Manual Segmentation: It firstly required the information which is acquired by using MRI images and the access of anatomical knowledge extracted by training and experiences. The process is performed in number of steps and draws the tumor region carefully.
- Semi-Automatic Segmentation: There are basically three major objectives of segmentation as to initialize, intervention and to evaluate.Initialization is assists to describe the region of interest and contains the tumor region. Inventions utilized other kinds of methods which automatically move to obtain the desired output. The last one evaluation is used to determine the final result obtained from the segmentation procedure [4].

B. Filters

In image processing, various kinds of filters are trained for enhancing the quality of image and to remove the noise, low contrast and blurring effects.

The major objective of using filters is to highlight the fine details and remove the low details. There are various kinds of filters are used.

1) Mean Filter: The filter which based on the average values of the current pixels and linked to the nearest pixels. The main work is to shuffle the values of the current pixel with the nearest pixel. The average is assumed as the new value of a pixel.
2) Median Filter: These filters are considered as a form of non-linear filters which specifically reduces the noise such as salt and pepper noise. It generally does not vary with the values when compared with the nearest neighbor pixels.
3) High-Boost: The purpose of using high boost filters is to improve the frequency which represented the details of an image without accessing to the components which are low even it is trying to increase the frequency of components.
4) Homomorphic Filtration: Thefilters are basically trained to eliminate all the impurities and illuminations from the image and restore it to enhance the quality of image [18].

C. Morphological Operators

The morphological operators are utilized for the extraction of shapes and boundary regions from the images which are captured for the detection of brain tumor. It simply changed the arrangement of pixels values and relied on the structural element and the input which is a sample image. The structural elements are the characteristics which described the feature of interest or the interested region from a particular image.The fundamental operators used in the morphological process are dilation and erosion.

1) Dilation: It simply performed to combine the pixels in the boundary region of an image. It used the highest value of pixels.
2) Erosion: It is different from dilation it simply used to eliminate the pixels form the boundary area. It accesses to them lowest value of the pixels which are present at the boundary region.

The overall process of morphological operators is dependent upon the structural element [13].

D. Probabilistic Neural Networks (PNN)

In the beginning of 1990's, D.F Specht discovered the other feed forward neural network which named as probabilistic neural networks. The main origin of this network is from Bayesian network with the statistical algorithm that named as kernel fisher discriminant algorithm. The architecture of PNN is basically partitioned into four layers as same as the conventional neural network. The only difference is the pattern layer and other three layers are same as input, output and hidden layer. It simply evaluated the weighted nearest neighbors for the creation of neural network. The input layer contains P number of neurons and that are based on the variables. The weight is constant for each neuron as considered as 1. Later, these values are processed in the hidden layer to obtain the desired result. In the pattern layer, the radial function is determined and sent to the last layer as output layer [19].

E. Decision Tree

Generally, a decision tree is a group ofsome simple and easy rules. These are non-parametric due to the no requirement for the distribution of variables in classes. Each node in a decision set contains a feature and partition into two forms. The first one is the features which are more relevant and the other one is the features that are less relevant. The entire process is repeated until the spitting process is terminated. The process is initialized from the root node to the leaf node. It is a rule based classifier and the most essentialproperty isits simplest architecture.

It begins from the training set which contains the group of other object that is completely defined by the large number of attributes. The leaf node finally, generated the output [20].

F. Naïve Bayes

It is a simple and easy algorithm which worked as a classifier and relied on the probabilistic values. It determines the group of probabilistic values by using the frequency and combination of different values in a particular data. It is an extension of bayes theorem and considered all the features in terms of independent and allocated the value to the class variables. This assumption is truly used in the real-time application form various purposes to manage the huge amount of data when the requirement of probabilistic measurements. It has also the tendency to perform properly in the presence of supervised learning issues. The other supportive theory is the total probability [21].

VII. CONCLUSION AND FUTURE SCOPE

In the research, the primary objective is to define the basic information about the brain tumor and its common risk factors. These days, the image processing methods are utilized in each and every field, it has also a great significance in the medical field. MRI, X-ray, CT scanning

all come under the systems which based on the image processing and proven as the highly efficient processes to detect the cancer cells from the body especially for the detection and diagnosis of brain tumor. The major goal is to cure the diseases at the early stages so that the patients can get relief from the long survival and save their lives. For the better detection and diagnosis, several kinds of machine learning methods are preferred such as decision tree, PNN, naïve bayes, segmentation, morphological operators and the other filters that improved the overall performance of the diagnosis systems.

In future, the detection and identification of cells that are normal and abnormal become easier for physiologist and diagnosis process gives more effective results.

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