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Review on Brain Tumor Cells Detection using Image Processing

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Abstract - *Brain is the major part which controls the human body. It regulates various functions such as knowledge, personality, memory, hearing, vision, problem solving and many more functions. The main reason for brain tumors to develop is the uncontrolled growth of brain cells. Many health institutions have recognized brain tumor to be one of the major concerns that is causing most deaths all over the world. Identifying the brain tumor at an initial stage offers a hope of successful medical treatment. Use of MRI images have turned out as more accurate and more reliable images compared to CT images. The MRI images are then fed to the system as input on which the analysis is done to detect presence of tumor cells in our brain. The model performs three major tasks which include Image Processing, Feature Extraction and Classification. The image processing involves the extraction and segmentation of the input MRI image using image processing techniques. The feature extraction is done using the Genetic Algorithm that helps to select and extract the useful features of the segmented image obtained from Watershed Algorithm. The Classification task uses a classifier which is modelled using the Convolutional Neural Network (CNN) that will classify the input image as with tumor cells or not based on the features extracted from the segmented image.*

Key Words: **Image Processing, Feature Extraction, Classification, Genetic Algorithm, Watershed Algorithm, Convolutional Neural Network (CNN)**

1. INTRODUCTION

Brain tumor is the collective mass of abnormal cells that is accumulated in the brain. A skull, that encloses the brain, is very rigid & strong. Any growth inside the confined space of the skull can lead to issues. Brain tumors can be classified as cancerous (Malignant Cells - which are harmful) & non-cancerous (Benign Cells – which does no harm to the individual). Benign tumor Cells are less harmful compared to malignant tumor as malignant cells develop fast, while benign are slow growing and cause less harm when compared to malignant Cells. When benign or malignant tumors tend to grow, it creates a pressure difference inside the skull to increase. This may lead to permanent damage to the brain, and it can lead to death of an individual. Brain tumors can be classified into primary or secondary. The first tumor develops in the brain. Many primary brain tumors are benign, whereas the secondary tumor, which is also called as the metastatic brain tumor, which is diagnosed when cancer cells spread to the brain from other organs, such as a lung or the breast. At present, there are many biological or technical methods for the treatment of brain tumor. Therefore, this paper focuses on the detection of the tumor cells which plays a crucial factor in the treatment and further increases the survival rate after the treatment. Also, if brain tumor is detected, an attempt is made to predict the survival rate of the patient post-surgery which will help the doctors to take the proper decision for the medication and also to decide if it is good to carry in with the operational procedure or to drop operating the patient. Medical imaging technique creates a visual image of the interior structure of the body of a human for medical as well as research purposes and non-invasive possibilities can be diagnosed by this. A varied set of medical imaging technologies based on non- invasive approaches like; MRI scan, CT scan, SPECT, PET Ultrasound, and X-ray are available. When compared to other techniques, Magnetic Resonance Imaging (MRI) is majorly used as it is cost effective and it provides images with greatest contrast of the brain cells and cancer-causing tissues. Therefore, identifying the brain tumor can be done easily done using the MRI images.

2. LITERATURE SURVEY

In 2020, Suresha D and others (1), proposed a methodology for detecting the tumor cells by combining K means technique and SVM. In the first step, the initial image is converted to a gray-scale image with binary thresholding technique and the spots that are detected is represented in terms of the intensity of the spot, to differentiate between a normal brain and a tumor infected brain. The set of features that are extracted is later featured by K Means algorithm, then the tumor recognition is done with the SVM. The designed modules include Binary Thresholding, SVM classifier and K- means clustering. The SVM is used to analyze the data that belongs to one or another category.

In 2020, Shargunam S and others (2), proposed a methodology which aims at identifying the tumor affected cells using MRI images and compared it with the performance of various classifiers like Support Vector Machine and Artificial Neural Network using the image processing Techniques. Initially image preprocessing was carried out on MRI images which involved steps such as gray-scale image conversion, noise reduction, and image reconstruction. Filtered image was segmented using the Otsu segmentation technique and then feature extraction was done. It was found 90.1% and 95.3% accuracy for SVM and ANN methods respectively.

In 2020, Ajay Khunteta and others (3), proposed a methodology to detect the brain tumor cells with the help of MRI Images and Support Vector Machine Classification using Gray-Level Co-occurrence Matrix Features. In the first stage filtering is done using median filtering technique, then brain tumor segmentation process is performed for separating brain tumor tissues from the MRI images of the brain using water segmentation method, in the next stage the features extracted using the GLCM methods using the MATLAB software. These images are then classified using SVM, this system then achieves an accuracy of 93%. This accuracy obtained was accepted to be better than other techniques.

In 2019, Tonmoy Hossain and others (4), presented a methodology to extract brain tumor cells from a 2D Magnetic Resonance Image of the brain by Fuzzy C-Means clustering algorithm that is then succeeded by traditional classifier and convolutional neural network. In a traditional classifier, there are many traditional classifiers namely Support Vector Machine, Naïve Bayes Algorithm, Logistic Regression Algorithm, K-Nearest Neighbor Algorithm, Multilayer Perceptron Algorithm and Random Forest Algorithm which are then implemented for the sci-kit learn. By using TensorFlow and Keras Convolutional Neural Network (CNN) is obtained which gives better performance advantages over the previous techniques. Main motive is to this methodology is to differentiate between the abnormal & normal pixel. Textual based and statistical based features are applied for much better understanding. Also proposed an effective method that helps in detection and segmentation of tumor cells without human presence based on CNN and traditional classifiers. In their work, CNN achieved an accuracy of up to 98%.

In 2019, Jagadeesh Kakarla and others (5), proposed a methodology that had an adaptive threshold selection method for the detection of brain tumor. This method implemented Adaptive Threshold Selection Network (ATSN) in two different stages: In the first stage, training and testing was the common preprocessing step. In the training stage, pre processed images of the brain and their raw images can be extracted to achieve an adaptive threshold. In the testing stage, the tumor segment is extracted from the pre processed image by thresholding technique. They have used over 2295 images of the brain with three different brain related diseases: namely meningioma, glioma and pituitary tumor. The precision of this proposed method is evaluated using five different and essential measures: accuracy, sensitivity, specificity dice similarity and jacard coefficient. This method achieved great results with respect to specified measures, but lacked in accuracy and sensitivity when compared to other methods.

In 2018, Krishnappa H.K and others (6), provided a framework in which MRI image is accepted initially and then processed to extract tumor cells in that image. Various pre processing techniques are used to reduce irregularities from the image. Later, K means clustering algorithms is applied and from the clustered image, skull is eliminated by morphological operations to identify the tumor cells easily. At the end, image thresholding technique is implemented and then it is followed by level set segmentation to extract the tumor cells. Performance parameters such as precision, True Positive, True Negative, False Positive, False Negative and recall that measures the accuracy is evaluated. Experimental results prove that, proposed detects and bounds the abnormal cells in MRI images dynamically even if the shape & dimension of the brain tumor cell is too complicated.

In 2018, Marium-E-Jannat and others (7), described a process for Detecting and analyzing the tumor cells from MRI by Integrating the two processes namely: Thresholding and Morphological Process using Histogram involved method. They have used the dataset obtained from BRATS which contains the magnetic resonance images. To get improved results on the accuracy of brain tumor detection, a computer aided image processing-based method is implemented and then the size of tumor is calculated and the location of the tumor is identified through this method. Many brain tumor regions were detected through these MRI image. The accuracy rate was 86.84%. Result was more accurate than previous TMP method.

In 2018, Sumir.R.M and others (8), implemented method based on multimodal image fusion technique, to detect brain tumor which had associate innovative methodology. The paper explained how MRI and CT scanned image of the brain having a tumor is combined which resulted in extraction of the complementary and redundant data used for enhancing the tumor detected inside the consolidated image. Weiner filtering method was used, which provides a better spatial resolution. To achieve a contrasty fused resultant image, a process called contrast limited adaptive histogram equalization is carried, the resulting image fusion gives doctors a better representation of the images for better treatment of brain tumor. Texture analysis is done by gray-level co-occurrence matrix. 41.9897 and 4.126 were PSNR and MSE values for MRI.

In 2017, Akshata Raut and others (9), aimed to detect brain tumor cells using thresholding technique. This method can be used for detecting and extracting tumor cells from MRI images received from a database of patients. The proposed work is based up on three major processes, namely thresholding, morphological operation and extracting the tumor region for further analysis. The method applies 'T' that is constant over the image. Applied method is also known as global thresholding. If value 'T' is varied then it is called variable thresholding. Experiment is carried out using MATLAB. Steps involved in the process were obtaining the image, converting into grayscale, filtering, thresholding,

morphological operations, detecting tumor, image shrinking, area calculation, display stage of tumor.

In 2017, Vidya Dhanve and others (10), presented a method for detecting the brain tumor cells using the K means segmentation technique based on object labelling algorithm. This processing technique involves four stages namely: Pre-Processing of the Image, Morphological opening, Image Segmentation and Object labelling algorithm. Accuracy of the system was tested using contingency matrix. It has 2 classes namely output class and target class. Confusion matrix and matching matrix are used for both supervised learning and as well as unsupervised learning respectively. A total of 12 MRI images were taken as input and converted into contrast form of the image. For removing noise median filter was applied. Object labelling algorithm is used for tumor detection. An accuracy of 75.5% was achieved.

In 2017, S V Vaishnavi and others (11), proposed a system that classifies the input MRI images into two types that is malignant and benign. Second order of the text features and support vector machine classifier were used to detect the brain tumor cells and their severity. Homogeneity, Energy, Entropy and correlation which are called as second order features were used in building the system. Tumor detection involved these steps, pre-processing which includes feature extraction, training the images on Support Vector Machine classifier, testing with different kernels. The linear kernel provided highest specificity, sensitivity and accuracy that is 90%, 80% and 80% respectively. Obtained results presents robust nature of the system in classification and identification of brain tumor.

In 2017, C. Hemasundara Rao and others (12), presented a methodology which proposed an automated technique for detection and segmentation of brain tumor affected regions. The stated method consists of these important phases which are Initial segmentation of images, modeling of the energy function and optimizing the energy function. They used info present in the MRI images for reliable segmentation. To combine data obtained in T1 and Flair in probablistic domain, Conditional Random Field framework was applied. CRF based framework has advantages such as one can model complex designs easily and use the results in energy function. This method has able to achieve a Dice Coefficient of up to 88%.

In 2017, S. K. Shil and others (13), provided a framework which comprised the Otsu binarization process followed by K-means clustering for segmentation process, Discrete Wavelet Transform (DWT) for extracting the feature and reduce the dimensions of the features followed by Principal Component Analysis. The reduced features were provided for Support Vector Machine classification.

In 2014, R. Preetha and others (14), proposed a methodology which uses fuzzy K means or fuzzy C means technique. Fuzzy clustering provides method to assign membership level to every data element and later allocates that data element to its clusters. Aimed at reducing the objective function, wrt membership value and cluster centers. The Fuzzy C algorithm is known for clustering the processed of feature extraction and their classification was helpful in detecting the brain tumor cells.

In 2013, Pavel Dvorak and others (15), proposed a methodology that implements T2-weighted MRI images, in which head of the image is vertically set. The tumor cells are then detected based on verifying the left-right symmetry of the brain, that is assumed as a normal brain. This method is then tested by a new five step cross-validation method on a dataset of 72 MRI images of the brain which has tumors and 131 MRI images of a normal brain. This technique achieved a TP rate of 91.16% and the TN rate of 94.68%.

3. CONCLUSION

This paper includes the literature survey on 15 papers which proposed different methods used for detection of brain tumor. We have gone through each & every method available for images processing and finally came to a conclusion about these important algorithms namely: Fuzzy C Means Clustering algorithm, K means algorithm, Object labeling algorithm, Watershed algorithm and many more. Mainly used classifiers were Artificial Neural Network (ANN), Support Vector Machine (SVM), and Convolutional Neural Network (CNN). It was found that the classifier implemented using the CNN model gave higher accuracy and watershed algorithm has advantages over K-means clustering algorithm. We are applying watershed algorithm and implementing CNN classifier in our proposed system used for detecting the brain tumor cells. The proposed system that we are about to implement has overcome a lot of disadvantages that were faced in similar methods & in few of the methodologies above, it provides the most optimal accuracy for the segmentation of the images.

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