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Brain Tumor Detection using Convolutional Neural Network

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Abstract -*Image processing is the one of the most demanding and promising field nowadays. Tumor is a abnormal growth of cell in human brain. The tumor can be categorized as benign(non-cancerous) and malignant(cancerous). Earlier stage of tumor is used to be detected manually through observation of image by doctors and it takes more time and sometimes gets inaccurate results. Today different automated tools are used in medical field. These tools provide a quick and precise result. Magnetic Resonance Images (MRI) is the most widely used imaging technique for analyzing internal structure of human body. The MRI is used even in diagnosis of most severe disease of medical science like brain tumors. The brain tumor detection process consist of image processing techniques involves four stages. Image pre-processing, image segmentation, feature extraction, and finally classification. There are several existing of techniques are available for brain tumor segmentation and classification to detect the brain tumor. There are many techniques available presents a study of existing techniques for brain tumor detection and their advantages and limitations. To overcome these drawbacks, propose a Convolution Neural Network (CNN) based classifier. CNN based classifier used to compare the trained and test data, from this get the best result.*

Key Words: Brain Tumor Detection, CNN, Image Pre-processing.

1. INTRODUCTION

The Image processing is a process of analyzing, manipulating an image in order to perform some operation to extract the information from it. Medical imaging seeks to disclose internal structures hidden by skin and bones and also to diagnose and treat disease. And also, it establishes a database of normal anatomy and physiology to make it possible to identify abnormalities. In today's world, one of the reasons in the rise of mortality among the people is brain tumor. Abnormal or uncontrolled growth of cell developed inside the human body is called brain tumor. This group of tumor grows within the skull, due to which normal brain activity is disturbed. Brain tumor is a serious life frightening disease. So, which not detected in earlier stage, can take away person's life. Brain tumors can be mainly three varieties called benign, malignant, pre-malignant. The malignant tumor leads to cancer.

Treatment of brain tumor depends on many factors such as proper diagnosis and the different factor like the type of tumor, location, size, and state of development. Previously stage of tumor is used to be detected manually with the help of observation of image by doctors and sometimes it takes more time and results may be inaccurate. There are many types of brain tumor and only expert doctor can able to give the accurate result. Today many computers added tool is used in a medical field. These tools have a property of quick and accurate result.

MRI is the most commonly used imaging technique for inspecting internal structure of human body. Proper detection of tumor is the solution for the proper treatment. Also require accurate diagnosis tool for proper treatment. Detection involves finding the presence of tumor. Detecting brain tumor using image processing techniques involves four stages. Image pre-processing, segmentation, feature extraction, and classification. The primary task of pre-processing is to improve the quality of the Magnetic Resonance (MR) images, removing the irrelevant noise and undesired parts in the background and preserving its edges. In segmentation the pre-processed brain MR images is converted into binary images. Feature extraction is the process of collecting higher level information of an image such as color, shape, texture and contrast. And the classification process, the classifier is used to classify the normal trained image samples and the input image sample.

1.1 LITERATURE SURVEY

[1] Capsule Networks for Brain Tumor Classification Based On MRI Images And Coarse Tumor Boundaries.

As stated by the WHO, cancer is deemed to be second leading cause of human casualties. Out of different types of cancer, brain tumor is perceived as one of the fatal due to its vigorous nature, diverse characteristics and relatively low survival rate. Discovering the type of brain tumor has remarkable impact on the choice of therapy and patient's survival. Human based identification is usually inaccurate and unreliable leading in a recent sweep of interest to automize this process using convolutional neural network (CNN). As CNN fails to completely utilize spatial relations, which may lead to incorrect tumor classification. In our technique, we have included newly evolved CapsNet to prevail this shortcoming. The main offering is to provide CapsNet with access to tissues neighbouring the tumor, without diverting it from the principal target. An improved CapsNet architecture is consequently proposed for the classification of brain tumor, that takes the coarse boundaries of tumor as additional input within its pipeline for surging the focus of the CapsNet.

[2] A Hybrid Feature Extraction Method with Regularized Extreme Learning Machine for Brain Tumor Classification

Classification of the brain tumor is the crucial step that depends upon understanding and expertise of the physician. The automated classification system of the brain tumor is vital to assist radiologists and physicians to identify the tumor. Nonetheless, the precision of the current systems needs to be improved for the successful treatment. In this paper the proposed approach consists of, (1) brain image pre-processing, (2) feature extraction of the image & (3) brain tumor classification. Initially the input images of the brain are transformed into intensity brain images using min-max normalization rule resulting into enhanced and improved contrast of the edges and regions of the brain. Then by applying feature extraction to the brain images using hybrid feature extraction and then computing the covariance matrix of the features extracted to project them into a notable set of features using principle component analysis (PCA). Ultimately, the type of brain tumor is classified using regularized extreme learning machine (RELM). As per the results the suggested approach proved to be more effectual compared to the current approaches. Also the performance in terms of accuracy of the classification improved from 91.51% to 94.233% for the experiment.

[3] Tumor Detection and Classification of MRI Brain Image using Different Wavelet Transforms and Support Vector Machines

The brain is the principal organ of human body. An abnormal growth of cells leads to the brain tumor. This abnormal growth of cells results in unusual functioning of brain and eradication of healthy cells. The brain tumors can be classified as malignant(cancerous) and benign(non-cancerous) tumors. In this paper the proposed approach includes (1) Pre-processing, (2) Training the SVM & (3) Submit training set to SVM and output the obtained predictions. At first stage denoising the medical images using different kind of wavelets while maintaining the important features. In segmentation for the extraction of the features, Otsu method is used for converting grey-level image to binary image. Finally, the data has two classes and we can apply SVM for classification. The outcome shows that SVM with proper training dataset is able to differentiate between normal and abnormal tumor regions and categories as malignant tumor, benign tumor or a healthy brain.

[4] Segmentation and Recovery of Pathological Mr Brain Images Using Transformed Low-Rank and Structured Sparse Decomposition

A general framework is proposed for the concurrent segmentation and recovery of pathological magnetic resonance images (MRI), where low rank and sparse decomposition (LSD) schemes have been used extensively. Due to the lack of constraint between low-rank and sparse components, conventional LSD techniques often construct recovered images with distorted pathological areas. For resolving this issue, a transformed low rank and structured sparse decomposition (TLS2D) method is proposed, that is vigorous for taking out pathological regions. By using structured sparse and computed image saliency as adaptive sparsity constraint the well recovered images can be acquired. The exploratory results on the MRI images of brain tumor shows that the TLS2D can successfully provide adequate performance on image recovery as well as tumor segmentation.

[5] Brain Tumor Segmentation Using Convolutional Neural Networks in MRI Images

Out of different types of brain tumors, malignant tumors are assertive and commonly occurring, decreasing the life expectancy. MRI is extensively used imaging method for assessing the tumors. Due to the huge amount of data produced by MRI stops the manual segmentation in a fair time, restricting the use of accurate quantitative measurements in clinical practices. For resolving this, an automatic segmentation technique based on CNN is proposed, exploring small kernels. Employing small kernels allows designing a deeper architecture, alongside having an advantage against overfitting, given the small number of weights in the network. Use of intensity normalization in pre-processing with data augmentation has proven to be effectual for brain tumor segmentation in MRI images.

[6] Development of Automated Brain Tumor Identification Using MRI Images

Brain tumor is a prime reason for human casualties every year. Magnetic resonance imaging (MRI) is a commonly used technique for brain tumor diagnosis. An automated approach which incorporates enhancement at an early stage to reduce gray scale colour variations. For better segmentation the unnecessary noises were decreased as much as possible using filter operation. The proposed approach uses threshold-based Otsu segmentation rather than colour segmentation. Ultimately, the feature information provided by the pathology experts was used to identify region of interests. The exploratory results demonstrate that the proposed approach was able to provide adequate results as compared to present available approaches in terms of accuracy.

[7] Brain Tumor Segmentation to Calculate Percentage Tumor Using MRI

Brain tumor is a type of disease that damages the brain through an uncontrolled growth of cells. The details of the brain tumor is obtained through MRI. For giving right treatment the analysis of the tumor must be performed accurately. Segmentation method is used for the purpose of analysis, and is done to distinguish the brain tumor tissue from other tissues such as fat, edema and normal tissue. The MRI image must be maintained at the edge of the first image with median filtering, followed by segmentation process that requires thresholding. Segmentation process is performed by giving a mark on the area of the brain and area outside the brain using watershed method then clearing the skull with cropping. 14 brain tumor images are used as an input in this study. The segmentation result compares brain tumor area with brain tissue area. The tumor was determined with average error rate of 10 percent.

2. PROPOSED SYSTEM

As per literature survey, it was found that automated brain tumor detection is very necessary as high accuracy is needed when human life is involved. Automated detection of tumor in MR images involves feature extraction and classification using machine learning algorithm. In this paper, a system to automatically detect tumor in MR images is proposed as shown in figure.

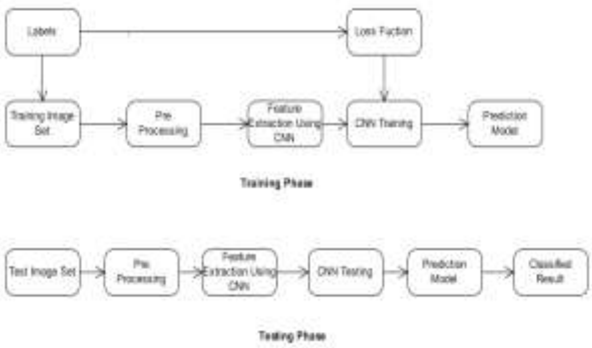


Fig.1:- System Architecture

METHODOLOGY (CNN):

The process took place in two step i.e. training and testing phase. Training phase always takes place before testing phase. The feature extraction and classification is done by convolution neural network (CNN). Training image set are used to train the model and testing dataset are used to validate the model. Loss function is used to improve the accuracy of the model. Less the value of loss function more accurately the prediction is done. Generally, labelled image set are used to train the model (Fig 1).

Convolutional neural network (CNN, or ConvNet) is a form deep learning and most commonly applied to analysing visual imagery. CNNs use a variation of multilayer perceptron designed to require minimal pre-processing. They are also known as shift invariant or space invariant artificial neural networks (SIANN), based on their shared-weights architecture and translation invariance characteristics. Convolutional networks were inspired by biological processes in that the connectivity pattern between neurons resembles the organization of the animal visual cortex. Individual cortical neurons respond to stimuli only in a restricted region of the visual field known as the receptive field. The receptive fields of different neurons partially overlap such that they cover the entire visual field. CNNs use relatively little pre-processing compared to other image classification algorithms. This means that the network learns the filters that in traditional algorithms were hand-engineered. This independence from prior knowledge and human effort in feature design is a major advantage. They have applications in image and video recognition, recommender systems, image classification, medical image analysis, and natural language processing. A CNN consists of an input and an output layer, as well as multiple hidden layers. The hidden layers of a CNN typically consist of convolutional layers, pooling layers, fully connected layers and normalization layers.

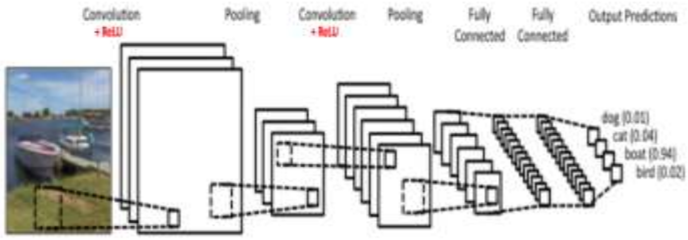


Fig2. Simple ConvNet

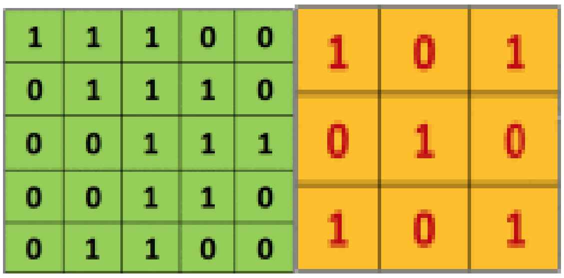
The Convolutional Neural Network in Fig. is similar in architecture to the original LeNet and classifies an input image into four categories: dog, cat, boat or bird. There are four main operations in the ConvNet shown in fig. above:

1. Convolution
2. Non-Linearity (ReLU)
3. Pooling or Sub Sampling
4. Classification (Fully Connected Layer)

An Image is a matrix of pixel values. Essentially, every image can be represented as a matrix of pixel value Channel is a conventional term used to refer to a certain component of an image. An image from a standard digital camera will have three channels – red, green and blue – you can imagine those as three 2d-matrices stacked over each other (one for each colour), each having pixel values in the range 0 to 255.

The Convolution Step:

ConvNets derive their name from the “convolution” operator. The primary purpose of Convolution in case of a ConvNet is to extract features from the input image. Convolution preserves the spatial relationship between pixels by learning image features using small squares of input data. We will not go into the mathematical details of Convolution here, but will try to understand how it works over images as we discussed above, every image can be considered as a matrix of pixel values. Consider a 5 x 5 image whose pixel values are only 0 and 1 (note that for a grayscale image, pixel values range from 0 to 255, the green matrix below is a special case where pixel values are only 0 and 1.



Also, consider another 3 x 3 matrix as shown. Then, the Convolution of the 5 x 5 image and the 3 x 3 matrix can be computed as shown in the animation in Fig below:

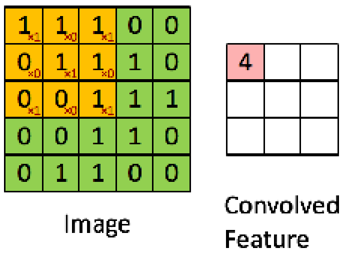


Fig3. The Convolution operation

The output matrix is called Convolved Feature or Feature Map. Take a moment to understand how the computation above is being done. We slide the orange matrix over our original image (green) by 1 pixel (also called 'stride') and for every position, we compute element wise multiplication (between the two matrices) and add the multiplication outputs to get the final integer which forms a single element of the output matrix (pink)[8]. Note that the 3×3 matrix "sees" only a part of the input image in each stride. In CNN terminology, the 3×3 matrix is called a 'filter' or 'kernel' or 'feature detector' and the matrix formed by sliding the filter over the image and computing the dot product is called the 'Convolved Feature' or 'Activation Map' or the 'Feature Map'. It is important to note that filters act as feature detectors from the original input image.

Introducing Non-Linearity (ReLU):

An additional operation called ReLU has been used after every Convolution operation in Figure above. ReLU stands for Rectified Linear Unit and is a non-linear operation. Its output is given by:

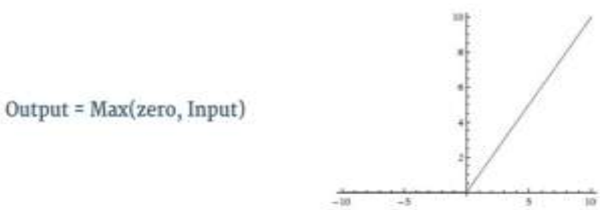


Fig4:- ReLu function

ReLU is an element wise operation (applied per pixel) and replaces all negative pixel values in the feature map by zero. The purpose of ReLU is to introduce non-linearity in our ConvNet, since most of the real-world data we would want our ConvNet to learn would be non-linear (Convolution is a linear operation – element wise matrix multiplication and addition, so we account for non-linearity by introducing a non-linear function like ReLU).

The Pooling Step:

Spatial Pooling (also called subsampling or down sampling) reduces the dimensionality of each feature map but retains the most important information. Spatial Pooling can be of different types: Max, Average, Sum etc.

In case of Max Pooling, we define a spatial neighborhood (for example, a 2×2 window) and take the largest element from the rectified feature map within that window. Instead of taking the largest element we could also take the average (Average Pooling) or sum of all elements in that window. In practice, Max Pooling has been shown to work better.

shows an example of Max Pooling operation on a Rectified Feature map (obtained after convolution + ReLU operation) by using a 2×2 window.

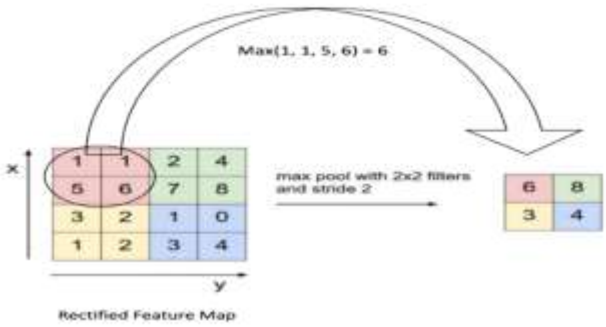


Fig5. Max Pooling

We slide our 2 x 2 window by 2 cells (also called 'stride') and take the maximum value in each region. As shown in Figure, this reduces the dimensionality of our feature map.

3. CONCLUSION

The In summary, we propose a CNN-based method for segmentation of brain tumors in MRI images. There are several existing of techniques are available for brain tumor segmentation and classification to detect the brain tumor. There are many techniques available presents a study of existing techniques for brain tumor detection and their advantages and limitations. To overcome these limitations, propose a Convolution Neural Network (CNN) based classifier. CNN based classifier used to compare the trained and test data, from this get the best result.

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