

MRI Brain Abnormality Detection Using Conventional Neural Network(CNN)

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Abstract. Brain tumours has huge heterogeneity and there is always a familiarity between normal and abnormal tissues and hence the extraction of tumour portions from normal images becomes persistent. In this paper, MRI brain tumor detection is performed from a brain images using Fuzzy C-means(FCM) algorithm and subsequently Convolutional Neural Network(CNN) algorithm is employed. Here, firstly preprocessing step is performed by Skull Stripping algorithm followed by Segmentation process. Fuzzy C-means algorithm is used to segment the Cerebrospinal Fluid(CSF), Grey matter(GM) and White Matter(WM) from the database. The third part is to extract features to find whether the tumor is present or not, here eleven features are extracted like mean, entropy, S.D(Standard Deviation). The final part is the classification process done by Convolutional Neural Network(CNN) in which it is able to differentiate whether the input image is normal image or an abnormal image. Compared to other methods, here the values of the features extracted are higher for normal images than for abnormal Images and it is shown from the graphs drawn from the extracted features.

Keywords. Fuzzy C-means, Convolutional neural network, Skull stripping, CSF, GM, WM, ROI.

1. Introduction

Magnetic resonance imaging (MRI) is a medical imaging technique utilized in radiology to make pictures of the anatomy and physiological processes of the body. MRI detects various problems like tumours, swelling, cysts, bleeding, infections, problems with the blood vessels, developmental and structural abnormalities and inflammatory conditions which are spread of conditions of brain. MRI can also tell if a shunt(small passage or hole) is working and finds whether the brain is damaged by any stroke or injury. Chronic diseases of the system a nervosum, like MS(Multiple Sclerosis) can also be detected. It can also provide images that cannot be identified even by CAT scan, X-ray, ultrasound in regions of brain, especially diagnosing defects and deficiencies in brain stem and pituitary glands. So here, MRI brain images are being employed and detected whether the given image is normal or abnormal using segmentation and classification methods.

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2. Related works

Sofiane tchoketch kebir et.al[1] has proposed a supervised and automatic MRI Brain abnormalities detection procedure drew on raw MRI images of brain using CNN deep learning network and K-means algorithm. Tonmoy Hossain et.al[2-3] and Qi Dou et.al[4-7] presented a novel automatic method to detect CMBs from magnetic resonance (MR) images by exploiting the 3D convolutional neural network (CNN). Yu Zhao et.al[8-9] presented a deep 3D CNN structure for effective, accurate and automatic classification and identification of huge number of functional brain networks reorganize by scanty potrayal of total brain fMRI signals. Jinglong du et.al[10] proposed a different and new dilated convolutional encoder-decoder (DCED) network to enhance the resolution of MRI .

3. Proposed method

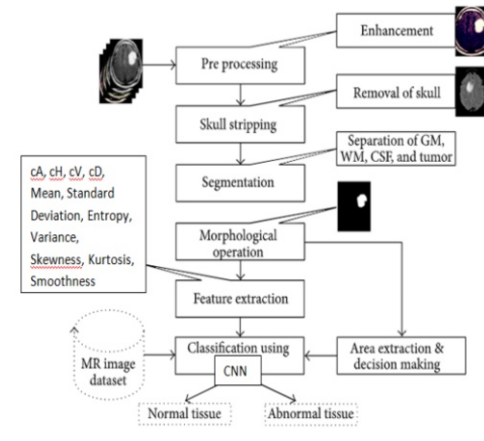


Figure 1. Block diagram for proposed Brain image classification using CNN

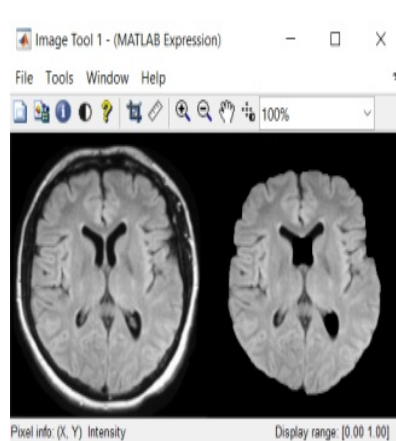


Figure 2. Skull stripped

Figure 1 shows how the flow of the proposed system goes. Here, the MRI image set is first preprocessed and removal of skull is performed by skull stripping. Then segmentation is performed by Fuzzy C means algorithm for CSF, WM and GM Segmentation. After the morphological operation is done, features are extracted for getting ROI(Region Of Interest) region and to classify whether the tumor is present or not. Finally, classification using(CNN) is done to classify normal and abnormal images. Skull stripping being a preliminary step, designed to eliminate non-brain tissues from MR brain images. FCM is a sort of clustering during which each datum can belong to one cluster. The technique of extracting the features is useful when a huge data set is used and need to reduce the number of resources without losing important or relevant information. Here, eleven features are extracted namely cA(Approximation Coefficient), cH, cV, cD(horizontal, vertical, diagonal detail coefficients), Mean, Entropy, Variance, Standard Deviation, Skewness, Smoothness, Kurtosis. DWT(Discrete Wavelet Transform) and GLCM(Grey Level Co-occurrence Matrix) are used for Feature Extraction.

4. Brain classification using CNN

The main advantage of this network is that it is often used for a giant set of datasets and more data are often trained. It uses smaller parameters related to a totally combined network by reclaiming an equivalent parameter several times.

- $cA = \text{mean2}(cA)$;
- $cH = \text{mean2}(cH)$;
- $cV = \text{mean2}(cV)$;
- $cD = \text{mean2}(cD)$;
- $\text{Mean} = \text{mean2}(J)$;
- $\text{Standard_Deviation} = \text{std2}(J)$;
- $\text{Entropy} = \text{entropy}(J)$;
- $\text{Variance} = \text{mean2}(\text{var}(\text{double}(J)))$;
- $\text{Smoothness} = 1 - (1 / (1 + a))$; [$a = \text{sum}(\text{double}(J(:)))$];
- $\text{Kurtosis} = \text{kurtosis}(\text{double}(J(:)))$;
- $\text{Skewness} = \text{skewness}(\text{double}(J(:)))$;

Here, the features are calculated for 40 images from the above mentioned formulas.

5. Results And Discussion

First, the algorithm is applied to an abnormal image and preprocessing is applied. Then, segmentation is carried out followed by classification using CNN after features are extracted.

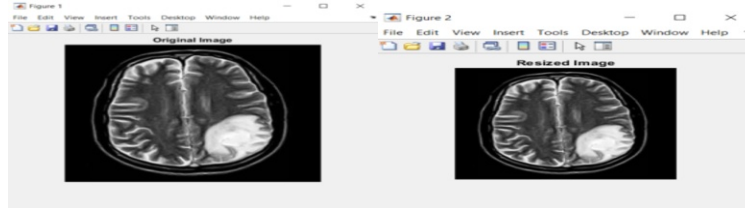


Figure 3. Abnormal image

Figure 4. Resized image

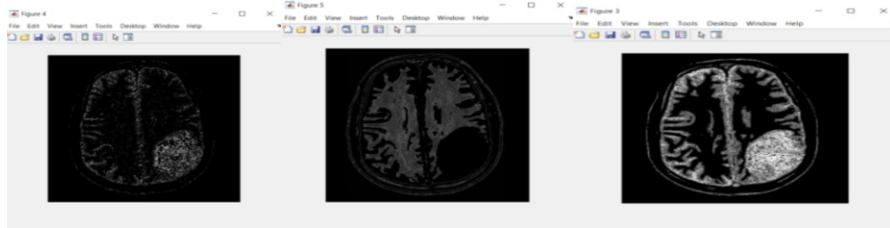


Figure 5. CSF, GM, WM Segmentation

Figure 3 shows the Abnormal image. Figure 4 shows the resized image of the Abnormal image. Figure 5 shows the segmentation of CSF(Cerebrospinal fluid), GM(Grey matter) and WM(White matter) using Fuzzy C means algorithm. Figure 6 shows the ROI region where the tumour is isolated without noise. Figure 7 shows the tumour cropped region from the original image and figure 8 shows a dialog box stating tumor is present. Now, the same process is applied to a normal image.

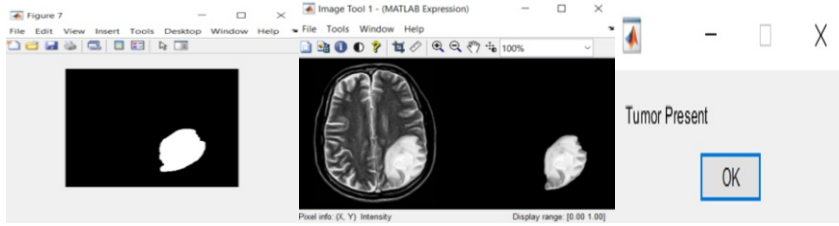


Figure 6. ROI image Figure 7. Tumour presented image Figure 8. Dialog box

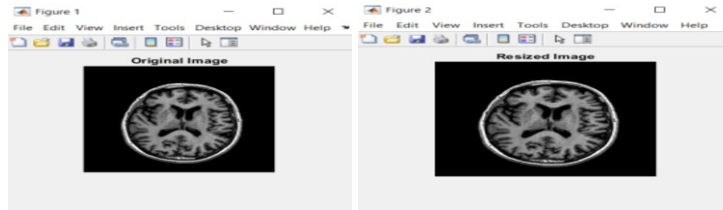


Figure 9. Normal image Figure 10. Resized normal image

Figure 9 shows the normal image of the normal tissue. Figure 10 shows the resized image of the normal image.

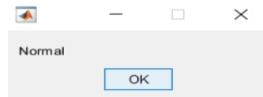


Figure 11. Dialog box

Figure 11 shows the dialog box stating that the image is normal without any tumor. The below graphs are plotted based on the values calculated from the feature formulas. The below table shows the accuracy comparison table between the existing method (ANN) and proposed(CNN) method.

Table 1. Comparison table between existing and proposed method

Classification methods	Accuracy
Existing method(ANN)	92.7%
Proposed method(CNN)	95.5%

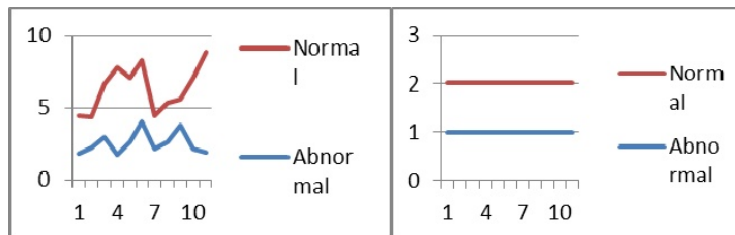


Figure 12. Comparison graph for Mean Figure 13. Comparison graph for S.D.(Standard Deviation)

Figure 12 and figure 13 shows the graph for Mean and Standard Deviation(S.D) for both normal and abnormal images. Similarly, graphs have been plotted for all the remaining features too. All the graphs denote that the values are higher for normal images than abnormal images.

6. Conclusion

In this proposed work, different sizes of MRI Brain images have been used and done preprocessing to remove skull. Segmentation is done by Fuzzy C-Means algorithm to segment CSF, GM and WM Regions. And 11 features are extracted to find the Region Of Interest region to find whether tumour is present or not. Here, it has classified the normal and abnormal images by Convolutional Neural Network(CNN) and shown that the extracted features values like mean are higher for normal images than abnormal images. So, here the algorithm is able to differentiate whether a image is normal image or abnormal image and has achieved 95.5% accuracy. In future, the calculated feature will be used to train NN(Neural Network) to identify the given input image.

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