Brain MRI Image Classification for Cancer Detection Using Deep Wavelet Auto-encoder-Based Deep Neural Network

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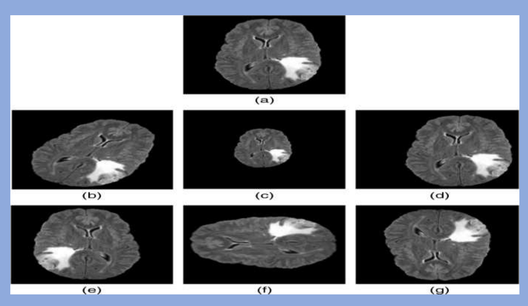
Introduction

The brain is the most important organ in the human body which controls the entire functionality of other organs and helps in decision-making. It is primarily the control centre of the central nervous system and is responsible for performing the daily voluntary and involuntary activities in the human body .The tumour is a fibrous mesh of unwanted tissue growth inside our brain that proliferates in an unconstrained way. Technology and the rapid growth in the area of brain imaging technologies have forever made for a pivotal role in analysing and focusing the new views of brain anatomy and functions. The mechanism of image processing has widespread usage in the area of medical science for improving the early detection and treatment phases. The latest advances in machine learning (especially deep learning) help identify, classify, and measure patterns in medical images. The most common methods used to analyse a tumour in the brain are positron emission tomography (PET), magnetic resonance imaging (MRI), and computerized tomography (CT). MRI is a familiar applicator is used for diagnosing and analysing many diseases like brain tumours, neurological disorders, epilepsy, etc.

Objectives

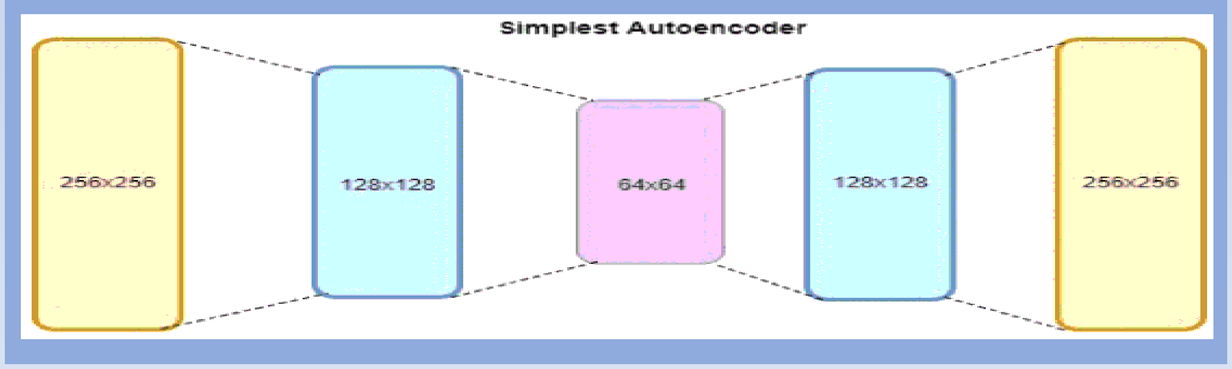
One of the factors for reducing death is the early diagnosis of an affected person with the help of the initial detection of a malignant region. The aim is to build a system that would help in cancer determination and detection of the Brain MRI image through the process of the proposed image classifier



Materials & Methods

Deep neural networks (DNN) have so far shown excellent performance in classification and task segmentation. Taking this into account, a technique for image compression utilising a deep wavelet auto encoder (DWA) is given in this study. This technique combines the basic feature reduction function of auto encoder with the picture decomposition property of wavelet transform. The size of the feature set for enduring future classification tasks utilising DNN is greatly sunk by the combination of both. A collection of brain images was collected, and the suggested DWA-DNN image classifier was taken into account. The suggested technique outperforms the current methods when performance criteria for the DWA-DNN classifier are compared with other existing classifiers like auto encoder-DNN or DNN.

Auto encoder can be regarded as the bestrew-processing technique for image classification using deep neural network



Results

A comparison between DNN, Auto encoder-based DNN, and the suggested DWA-DNN approach has been made.

Classification Technique	Accuracy	Specificity	Sensitivity	F-Score
DNN	0.89±0.18	0.88±0.26	0.91±0.19	0.90±0.22
AE-DBN	0.90±0.19	0.89±0.24	0.91±0.18	0.90±0.23
DWA-DNN	0.93±0.14	0.92±0.16	0.94±0.26	0.93±0.15

DNN vs. DWA-DNN and AE-DNN vs. DWA-DNN performance comparison using McNamara's statistical test. To test whether the two techniques behave statistically differently, McNamara's test, a base standardized normal test statistic, is utilized. The statistic is calculated in accordance with eq. (1)

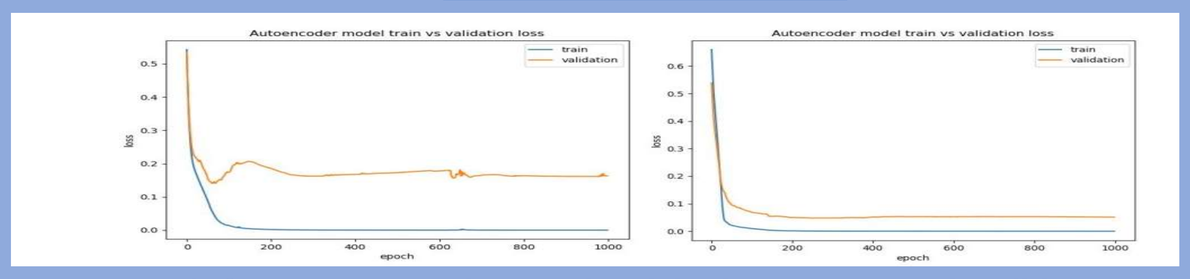
$$MN_{ij} = \frac{mn_{ij} - mn_{ji}}{\sqrt{mn_{ij} + mn_{ji}}}$$

where mnij denotes the number of samples misclassified by i classifier but not by j classifier. Similarly, mnji denotes the number of samples misclassified by j classifier but not by i classifier. This is basically derived from the chi-squared distribution shown in eq.(2)

$$\chi^2 = \frac{(b-c)^2}{b+c}$$

Under the null hypothesis, mnij is equal to mnji. That is equivalent to the number of counts for

$$mn_{ij} = mn_{ji} = (mn_{ij} + mn_{ji})/2$$



Loss graph for Auto encoder model. (a) Simple AE model. (b) Wavelet AE model.

Conclusion

Deep learning network models have obtained good results in recent years in the medical image analysis field. Interpretation of medical image datasets has always been a time-consuming process and handling them is itself a challenge. In this paper, the solutions dealt with made us think from the perspective of DNN, AE, and wavelet transformation. The proposed DWA-DNN classifier have achieved a great result in terms of accuracy, specificity, sensitivity, and other performance measure when compared to the existing classifiers like DNN, AE, etc

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