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Classification of Brain Magnetic Resonance Images using ICA-MLP

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Abstract

The central nervous system controls all the functions of the body. Brain is the vital organ of our body and it can be suffered from various diseases. In order to treat various brain diseases, the physicians use Magnetic Resonance Imaging (MRI) technique in recent days for the treatment. Manual analysis and classification of brain images into normal or deceased is a tedious task. So different supervised learning techniques are used in this purpose. In this paper, Independent Component Analysis (ICA) has been used for feature reduction and Multilayer Perceptron (MLP) has been used for classification task. The experimental study is conducted on two of the brain image datasets i.e. Glioma and Alzheimer and the results suggested that ICA-MLP produced better results than MLP.

Keywords: Magnetic Resonance Imaging, Classifier, Independent, Deceased.

1. Introduction

The central nervous system is the important component of the human body. The human body is controlled by brain. Brain can be affected with several diseases in the life cycle [1].It is a challenging task for the doctors in treating the brain diseases. Brain imaging procedures are adopted in this context. Out of the different imaging techniques, Magnetic Resonance Imaging (MRI) technique is the noninvasive method used in the analysis and identification of brain diseases in the recent days [2, 3].The faulty diagnosis may be produced from the manual study and interpretation of brain MRI images. So the computer assisted methods are beneficial in this context. Various researchers have used machine learning techniques in classifying the brain images as normal and pathological [4]. The authors in [5] applied random forest as the classifier for the brain MRI image classification. PCA and neural networks are widely used in classification of brain images [6, 7].The authors in [8] adopted Principal Component Analysis (PCA) for feature selection from the extracted brain images. They applied Multilayer Perception (MLP) for the classification purpose that outperformed k-Nearest Neighbor (k-NN) classifier. Independent Component analysis (ICA) has also been used as dimension reduction techniques [9, 10]. The objective of this study is to collect the brain MRI image datasets and then perform data pre-processing. ICA has been used as dimension reduction purpose. Then MLP has been applied for the classification purpose. The accuracy values are compared for determining the efficient classifier. This paper is organized as follows. The methodologies are described in second section. The experimental work is described in third section. Finally, section 4 discusses the conclusion.

2. Methodology

The different feature reduction and classification techniques are discussed in this section.

2.1 Independent component analysis (ICA)

ICA is one of the unsupervised dimension reduction strategy used in neuro imaging studies. It groups the original dataset into a set of independent features [11, 12]. These independent components are also most relevant to the classification task.

2.2 Multilayer perceptions (MLP)

MLP is one of the feed forward neural network structure used for classification purpose. It is completely based on the functionality of human brain. It belongs to the group of supervised learning [13]. It has one input layer, one or more hidden layer and one output layer. During classification, the number of input neurons will be the number of features. The numbers of hidden nodes are randomly determined. For binary classification problem, there is only one output neuron.

2.3 Proposed Model

The work proposed in this paper is summarized in the figure 1. The brain images of the two disease are collected and preprocessed using Discrete Wavelet Transformation (DWT) and ICA. Then the MLP classifier is used for classifying the brain images into normal or diseased. The accuracy values are recorded for the performance measurement.

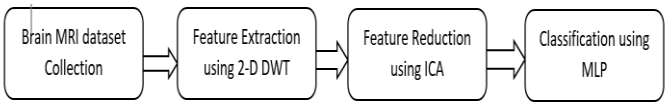

Fig.1. Proposed Workflow

3. Simulation Study

The experimental study is conducted on MRI image datasets of two brain disease i.e. Glioma and Alzheimer. These two datasets are collected from the Website of Harvard School of medicine. The Glioma dataset contains 122 images and the Alzheimer dataset contains 100 images where each image is of size 288 X 288.

3.1 Feature Reduction

2D DWT is used for feature extraction. Using this procedure, 1296 number of features are extracted. In this work, ICA is used for feature reduction. The numbers of reduced features are shown in the Table 1.

Table.1.Feature Reduction using ICA

Brain diseases	No. of Samples	Total Features	Reduced Features
Glioma	122	1296	122
Alzheimer	100	1296	100

3.2 Classification

The datasets are divided into train and test datasets for the supervised learning. In this work, the Glioma and Alzheimer data sets are divided as 75% for training and 25% for testing purpose. The MLP classifier is considered for the experimental study.The loss occurred during training and testing of the datasets using ICA+MLP classifiers for the Glioma and Alzheimer datasets are shown in the Figure 2 and 3 respectively.

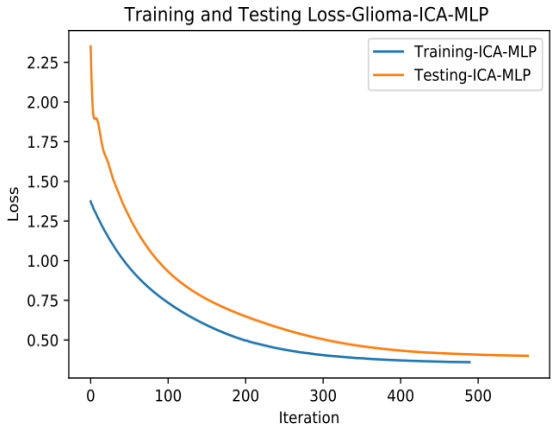

Fig.2.Training Loss using ICA+MLP for Glioma Dataset

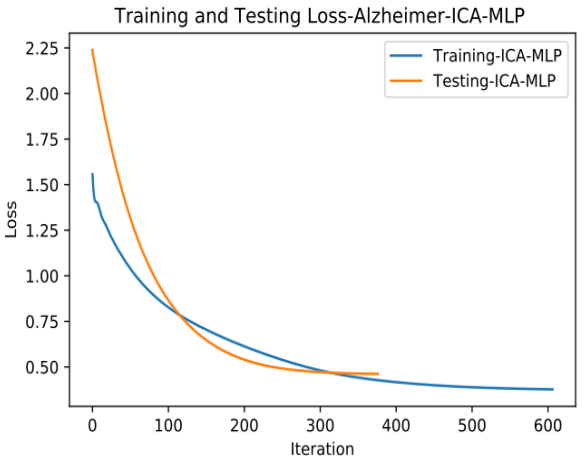

Fig.3. Training Loss using ICA+MLP for Alzheimer Dataset

The accuracy values found during the classification of the brain diseases are stored in Table 2 for Glioma and Alzheimer image datasets.

Table.2. Accuracy values

Datasets	Models	Accuracy (%)
Glioma	MLP	93.2%
	ICA+ MLP	95.73
Alzheimer	MLP	88.4%
	ICA+ MLP	91.45%

From Table 2, it is found that ICA with MLP classifier better accuracy values i.e. 95.73% for classification of Glioma images into normal and pathological brain. Similarly it is found that ICA with MLP classifier better accuracy i.e. 91.45% values for classification of Alzheimer images into normal and pathological brains.

Conclusion

This work discusses the performances of MLP classifier along with the ICA for the brain MRI image classification of Glioma and Alzheimer datasets. The 2D DWT is used to extract the features from the brain images. Then ICA is employed in this work to reduce the feature sets. The experimental results suggest that the ICA with MLP produced highest accuracy values for the classification of brain images for these two brain diseases.

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