Chapter 22
Neuro-Imaging Machine Learning Techniques for Alzheimer's Disease Diagnosis

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ABSTRACT

Alzheimer's disease (AD) is considered one of the most common dementia's forms affecting senior's age staring from 65 and over. The standard method for identifying AD are usually based on behavioral, neuropsychological and cognitive tests and sometimes followed by a brain scan. Advanced medical imagining modalities such as MRI and pattern recognition techniques are became good tools for predicting AD. In this chapter, an automatic AD diagnosis system from MRI images based on using machine learning tools is proposed. A bench mark dataset is used to evaluate the performance of the proposed system. The adopted dataset consists of 20 patients for each diagnosis case including cognitive impairment, Alzheimer's disease and normal. Several evaluation measurements are used to evaluate the robustness of the proposed diagnosis system. The experimental results reveal the good performance of the proposed system.

INTRODUCTION

Alzheimer's disease (AD) is the most common cause of dementia which affecting seniors age staring from 65 and over. AD progression has raised a great medical research interest recently in the United States. The main symptoms of AD are tissue brain loss and nerve cell death which resulted in shrinking brain tissue and reduces larger ventricles. Advanced medical imaging modalities such as magnetic resonance imaging (MRI), single photon emission computed tomography (SPECT), computed tomography (CT), positron emission tomography (PET) are used in excluding other subtypes of dementia or cerebral pathology (Schroeter, Stein, Maslowski, & Neumann, 2009). Moreover, they can predict conversion from

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mild cognitive impairment (prodromal stages) to Alzheimer's disease (Schroeter et al., 2009), which is considered the most critical stage affecting the senior population.

Machine learning techniques and medical image processing tools can help neurologists for predicting whether the patient is developing the Alzheimer disease. In earlier AD stages, usually patients are having an amnestic Mild Cognitive Impairment (MCI). The standard criteria for detecting AD from affected subjects are usually based on neuropsychological assessment and cognitive tests and often followed by a brain scan (Schroeter et al., 2009). This procedure is tedious and time consuming. Also it is reported that the early detection of AD is the most effective way to treat it (Solomon & Murphyb, 2008).

The main contribution of the chapter is (1) to aid physicians in detecting AD through proving an automated system for AD detection and (2) to compare two different anatomical views of the brain and identify the best representative view of AD. In this paper, five bio-inspired algorithms including Grey Wolf Optimizer (GWO), Moth Flame Optimization (MFO), flower pollination algorithm (FPA), whale optimization algorithm (WOA) and Genetic Algorithm (GA) are presented and compared with each other.

The proposed system first read the original MRI image without extracting specific regions, then the original is enhanced through applying median filter and removing the background of the image, then a set of features from different categories are extracted from the extracted ROI image including statistical, texture, energy and fractal features, then different features selector algorithms are adopted in order to extract the best representative features subset, and finally these features are used to feed Support Vector Machine (SVM) in order to be classified to AD or MCI or Normal. 7-fold cross validation algorithm is used to proof the robustness of the proposed system.

BACKGROUND

Several machine learning systems for AD diagnosis are developed and proposed in literature. The proposed system in (Davatzikos, Fan, Wu, Shen, & Resnick, 2008), starts from segmenting the MRI image into grey matter (GM), white matter (WM) and cerebrospinal fluid (CSF) regions, then using Pearson correlation coefficient and a leave-one-out procedure in order to discriminate normal and MCI images. A watershed clustering algorithm is used to determine brain regions.

In the other hand, the proposed system in (Magnin et al., 2009), first cluster the image into multiple regions by using anatomically labeled brain template to get probability of GM, WM, and CSF, then SVM is used to classify the subjects and statistical procedures based on using bootstrap resampling method into AD and control subjects (CS). Likewise, the proposed system in (Robinson, Hammers, Ericsson, Edwards, & Rueckert, 2010), it uses the principal component analysis (PCA) and maximum uncertainty linear discriminant analysis followed by classifier fusion in order to classify.

Moreover, Zhang et al. in (Zhang, Wang, Zhou, Yuan, & Shen, 2011) extracted different bio-markers modality to accurately distinguish between AD or MCI and healthy subject controls. The authors use a kernel combination method and atlas warping algorithm. Moreover they apply SVM to evaluate the classification accuracy, using a 10-fold cross-validation. In (Cuingnet et al., 2011), An automatic classification system used to distinguish between patients with MCI or AD and elderly controls (CN) from structural T1-weighted MRI and it has compared with 10 methods based on ADNI database.