Alzheimer’s Disease Image Analysis and Recognition

Extensive research has addressed the diagnosis of Alzheimer’s disease (AD). In the ADIAR project we focused on the greater challenge of the diagnosis at the early stage, known as Mild Cognitive Impairment (MCI). By analyzing MCI and AD manifestations in both space and time dimensions, based on PET images, we were able to get a deeper insight into the disease, while producing more accurate diagnosis.

**GENERAL MOTIVATION AND OBJECTIVES**
During the last decades extensive research has focused on the potential of neuroimaging for the diagnosis of Alzheimer’s disease (AD). Currently, the greater challenge is the diagnosis at the early stage known as Mild Cognitive Impairment (MCI). Early detection is important because it is when treatments that can delay the progression of the disease can have the most impact. This is however a difficult task due to the variability of spatial patterns of brain degeneration in MCI along with changes in time, as the diseases progresses. Functional imaging modalities such as Positron Emission Tomography (PET) play an important role in detecting abnormalities useful in early diagnosis and in differentiating patients with MCI that will likely progress to AD. The goals of project ADIAR were the following: (i) to get a deeper insight into the manifestations of MCI and AD both in space and time dimensions; and (ii) to produce more accurate diagnosis tools using PET images of the brain.

**CHALLENGE**
Currently the diagnosis of AD has been performed mainly after the disease progressed to advanced stages. The goal is to develop a system that can advance the diagnosis process and assist doctors in making an early diagnosis of AD.

**WORK DESCRIPTION AND ACHIEVEMENTS**
In this work, clustering is used as the main tool for dimensionality reduction, intrinsically finding regions of interest in FDG-PET images that can better discriminate between the populations under study. The 3D images were first segmented into clusters based on their intensity and then a coherence matrix of pairwise comparisons between subjects that were constructed, where for each pair of subjects, and for each pair of clusters we count the number of voxels in common. From this matrix we identify the most coherent clusters, which correspond to the ones with a higher overlap with other clusters. Regions of interest are then created by joining all clusters with more than 50% overlap with the most coherent clusters. Finally, features are extracted from these regions. These are created by calculating a voxel degree of belonging for each identified region and then computing the product of the probability matrix with the region voxel intensities. This approach was compared with two other methods in terms of the classification accuracy achieved with three well-known classifiers (SVM, K-NN and GNB). The other methods consisted of using voxel intensity of regions manually identified by an expert and using voxel intensity features selected with Mutual Information feature ranking. Experimental results showed that the regions found automatically are very discriminative, outperforming results with expert-defined regions and voxel intensity features.

**PROJECT WEBPAGE URL**
https://www.it.pt/Projects/Index/1596