ProMiSi Architecture – A tool for the estimation of the progression of multiple sclerosis disease using MRI

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***Abstract*—The aim of this work is to present the architecture of the ProMiSi tool, a software for the analysis of magnetic resonance imaging and the extraction of information on the progression of multiple sclerosis disease. ProMiSi is based on the automatic processing, segmentation and post-processing of MRI for the automatic labeling, visualization and volumetric quantification of segmentable brain structures from magnetic resonance image. The combination of the above mentioned volumetric results with other type of information (e.g. clinical, demographic etc.), through autonomous learning intelligent techniques, allows the evaluation of the severity and the progress prediction of the multiple sclerosis and consequently the personalized management of the disease. A proof of concept study with 30 patients will take place for the validation of the algorithms, while ProMiSi will be evaluated in terms of functionality, usability, reliability, performance and supportability.**

Keywords—MRI, segmentation, multiple sclerosis, progression estimation

I. Introduction

Multiple Sclerosis (MS) is among the most common cause of neurological impairment in young adults, after trauma. It is an autoimmune inflammatory disease of central nervous system and it is characterized by widespread inflammation, focal demyelination, and a variable degree of axonal loss [1-2]. Although the etiology of MS disease is largely unknown, epidemiological data indicate that both environmental and genetic factors play a key role in the development of MS [1, 3]. MS is more common in women than in men with the female-to-male ratio increasing from 1.4 to 2.3. The MS affects 2,500,000 people worldwide, with the distribution of the disease to be uneven around the world [1, 4-5].

The diagnosis of MS is based on findings referable to the central nervous system. More specifically, the objective evidence of two separate central nervous system (CNS) lesions compatible with MS and separated both in space and time of occurrence, while other potential causes for the CNS lesions have been ruled out are the two basic MS diagnostic criteria [6]. Medical history, neurological examinations, lab tests, lumbar puncture, myelography, and MRI are the tools for diagnosing MS. MRI is the most sensitive non-invasive method that contributes existence multiple demyelinating plaques, old and new in the CNS. Quantitative analysis of MRI lesions can be useful for decision-making purposes to achieve optimal treatment for patients and to improve their clinical course [6].

Towards this direction several studies have been reported in the literature presenting algorithms for the segmentation of MS lesions from magnetic resonance images. A review and a comparison of these algorithms is provided in [7]. In terms of software, QBrain [8], Icometrix [9], NeuroQuant [10], LesionQuant [11] are the most commonly used software tools for the segmentation of MRI and the extraction of volumetric information for brain structures allowing the experts to diagnose and closely monitor neurodegenerative brain disorders such as MS. The value of machine learning methods for the estimation of the severity and the progress of MS has been examined in several studies exploiting clinical and/or MRI findings [12-19]. The studies present classification and/or prediction models based on supervised learning classifiers taking as input demographic, clinical and features extracted by MRI images, as well as on deep learning techniques.

ProMiSi aims to develop an integrated software system for evaluating MS that it can be used by radio-diagnostic centers as an additional high-level service, by neurologists for individual management of MS patients, by pharmaceutical companies as a tool for assessing medical substances treating MS, by researchers to extract new knowledge. Furthermore, is not limited to automatic, accurate segmentation and extraction of objective volumetric information of MS lesions from MRI images, but combines this information with clinical and non-clinical data to provide an automatic assessment of the disease stage as well prognosis of its evolution. Finally, it can be easily integrated into the clinical practice, it can be adapted to any MRI protocol, MS type and it is not limited by the duration of the disease.

II. ProMiSi Architecture

The architecture of ProMiSi is depicted in Fig. 1. It consists of the following basic modules: