Parkinson's Disease Prediction using Diffusion Tensor Imaging Features Fusion (Prédiction de la maladie de Parkinson basé sur la fusion des caractéristiques d'Images par Résonance Magnétique de Diffusion

Teză susținută pentru obținerea titlului de doctor în domeniul de doctorat
Stiinta Calculatoarelor

(sinteză)

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Rezumat:

Our research focuses in finding original solutions in software engineering for medical image processing and analysis using MRI images, with applications in Parkinson's Disease prognosis. We propose new image processing algorithms, independent on the patient variability, for detecting specific anatomical structures as volumes of interest. Our system is fusing information extracted from different medical image types. A rigid registration with automatic detection of the geometrical parameters, allows a fusion phase, by eliminating the volume variability. The analysis is possible by tracking the neuromotor fibers, even in the gray matter, and defining new metrics for the extracted fibers. The whole approach is automatic. Detecting the specific geometrical 3D features in each volume overcomes the inter-patient variability.

We study Parkinson's Disease (PD) using an automatic approach based on an intuitive specialized atlas. A total of 143 subjects, among who 68 patients diagnosed clinically with PD and 75 control cases, underwent DTI imaging. The EPIs have lower resolution but provide essential anisotropy information for the fiber tracking process. The two volumes of interest (VOI) represented by the Substantia Nigra (SN) and the Putamen are detected by our original algorithms on the EPI and FA respectively. We use the VOIs for a geometry-based rigid registration, before fusing the anatomical detail detected on FA image for the Putamen volume with the EPI.

After a 3D fibers growing, we compute the fiber density (FD) and the fiber volume (FV). Furthermore, we compare patients based on the extracted fibers and evaluate them according to Hoehn&Yahr (H&Y) scale. The determined fibers, evaluated with our own metrics, represent the source for the analysis module. This element uses the extracted features and using an Adaptive Network-based Fuzzy Inference System (ANFIS) adapted for our needs, performs PD diagnosis and prognosis.

This work introduces the method used for automatic volume detection and evaluates the fiber growing method on these volumes. Our approach is important from the clinical standpoint, providing a new tool for the neurologists to evaluate and predict PD evolution. From the technological point of view, the fusion approach deals with the tensor based information
(EPI) and the extraction of the anatomical detail (FA and EPI).

PDFibAtl@s represents a platform built for clinical Prove of Concept for Parkinson's Disease prognosis, including the image analysis technology proposed here, the artificial intelligence tools and the medical knowledge. We introduce a new approach for VOI detection, image segmentation and image analysis levels.

Principalele contribuții revendicate: *Introducing the use of medical imaging as a bio-marker in Parkinson's Disease detection and prediction; A new patient-independent segmentation approach; Methods capable based on the image-based features to predict the disease even on early stages; A fully automatic prototype performing image processing and analysis for Parkinson's Disease prediction*

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