EXTENDING LOCAL BINARY PATTERNS TO 3D FOR THE DIAGNOSIS OF ALZHEIMER’S DISEASE

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Introduction

Alzheimer’s disease (AD) is the most common form of dementia. Its early detection (still at the Mild Cognitive Impairment (MCI) stage) is essential to improve patients’ life quality and extend life expectancy. This work explored the textural information of FDG-PET images to build an automated diagnostic system for AD and MCI. Textural information was retrieved using a novel generalization of Local Binary Patterns (LBP) to 3D. The proposed approach, unlike previous ones [1,2,3], is able to reproduce closely the uniformity and rotation invariance concepts in a 3D space.

Materials and methods

Automated diagnostic system

- Image Preprocessing
  - Reduce meaningless differences between images.
  - Orientation alignment.
  - Rescaling and intensity normalization.
  - Registration to the same anatomical space;
- Texture Extraction
  - Extract textural information from FDG-PET images.
  - Local binary patterns;
- Feature Selection
  - Reduce the number of features by selecting the most relevant.
  - Mutual information between each feature and the class;
- Classification
  - Linear SVM (support vector machine);

Results

We compared the novel LBP extension, in the diagnosis of AD and MCI against normal controls (NC), with two approaches:
- Using the original 2D LBPs as the texture extraction procedure;
- Using the voxel intensities directly as features.

Discussion

Most LBPs structures are non-uniform. However, the few uniform LBPs are the most frequent. Therefore, we avoid the use of frequencies of occurrence of rare LBPs as features.

Uniformity and rotation invariance reduced greatly the number of features. In our experiments, they were reduced from 2^24 to 96.

The proposed approach achieved the best accuracy in both diagnostic problems, indicating that extremely relevant features are extracted using 3D LBPs.

Conclusions

- The proposed generalization of LBPs is able to closely replicate in three dimensions the key concepts proposed for 2D texture analysis.
- The texture of FOG-PET images contains discriminative information for the diagnosis of AD and MCI.
- Texture features extracted with the novel procedure based on 3D LBPs outperformed the original 2D LBPs applied to axial cuts of the image and the common approach based directly on the voxel intensities.

References


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