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Neurodegenerative Diseases classified based on Salient Brain Patterns

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Abstract: The MRI brain images can save various lives by identifying defects. A method for identifying neurodegenerative Alzheimer's disease in brain MRI images involves a comprehensive workflow. First, convert the input brain image into a grayscale format to simplify the data. Following this, generate a saliency map from the pre-processed image, which highlights the most relevant areas in the brain image. Normalization of this saliency map ensures that the data falls within a standardized range, enhancing consistency. The critical step involves applying kernel fusion to the normalized saliency map to extract features from the image. These features encompass elements like strength, textural characteristics, statistical information, and binary tissue segmentations. Feature extraction is crucial as it reduces the dimensionality of the data while preserving essential information. Finally, you employ a Support Vector Machine (SVM) classifier, which is fed with these extracted features to classify brain images as indicative of Alzheimer's disease or not. While your proposed algorithm aims to streamline the computational process and reduce irrelevant features, it is essential to validate its effectiveness using diverse MRI brain images and collaborate with medical professionals for thorough evaluation and clinical applicability. The claim that salient regions identified by your method are systematically relevant for Alzheimer's disease discrimination should be substantiated through empirical evidence and validation studies to ensure its clinical utility.

Index Terms ----Alzheimer’s disease (AD), automated pattern recognition, magnetic resonance imaging (MRI), support vector machines (SVMs).

1. Introduction

Present studies suggest neuroimaging may become a valuable tool in the early diagnosis of neurodegenerative diseases by extracting anatomical patterns and revealing hidden relations from structural magnetic resonance (MR) images. The value of neuroimaging against bedside, neuropsychological, and biochemical analysis remains to be demonstrated in large representative populations, yet there exists sufficient proof in small series of patients with different states of neurodegenerative disorders. The usual study workflow is performed by expert neurologists, who are able to figure out complex anatomical patterns and subtle changes with clinical meaning. The process that an expert follows when examining a particular case involves two different kinds of tasks: those related with image intuition, such as visual search or exploration paths, and others associated with different skills, mainly related to diagnostic reasoning and decision making. An expert structures a scientific determination by using contextual knowledge and fusing information from different kinds of sources, a process that has been recently understudy. At analysing structural brain MR images, a main aim is to find anatomic changes, either local or global, related to functional disturbances. In particular, experts examine images by looking at distinctively regions and compare them by searching differences .Alzheimer's disease is a neurological disorder in which the death of brain cells causes memory loss and cognitive ability decline. A neurodegenerative type of psychiatry, the disease starts mild and gets progressively worst. Alzheimer's disease is the most common cause of psychiatry. It is suspected there will be more than 520,000 people in the UK with this particular Alzheimer's disease in 2015. The term 'dementia' describes a set of symptoms which can include loss of intellectual capacity, mood changes, and problems with communication, personality integration. These symptoms occur when the brain is damaged by destined diseases, including Alzheimer's disease. This printed sheet outlines the symptoms and risk factors for Alzheimer's disease, and describes what treatments are presently available. Alzheimer's disease, first investigated by the German neurologist Aloes Alzheimer, is a physical disease influenced to the brain in a harmful way. During the course of the disease, 'plaques' and 'tangles' develop in the structure of the brain, stellar to destroy of brain cells. People with Alzheimer's also have a less amount of some important chemicals in their brain. These chemicals are involved with the change of messages within the brain.

2. Existing System

Existing studies suggest neuroimaging may become a valuable tool in the early diagnosis ofneurodegenerative diseases by extracting anatomical patterns and revealing hidden relations from structuralmagnetic resonance (MR) images. The value of neuroimaging against clinical, neuropsychological, andbiochemical analysis remains to be demonstrated in large representative populations, yet there exists sufficientevidence in small series of patients with different kinds of neurodegenerative disorders.

The process that an expert follows when examining a particular case involves two different kinds of tasks: those related with picture perception, such as visual search or exploration paths, and others associated with different skills, mainly related to diagnostic reasoning and decision making. An expert structures a diagnosisby using contextual knowledge and fusing information from different sources, a process that has been recently under study. Currently, a morphometric brain analysis consists of a set of strategies aimed to extract and quantify anatomical differences between groups of subjects. Commonly, this analysis comprises two mainprocesses: first, all images are warped or registered together to a common reference frame or template, and second, a amplitude of the estimated local deformation required to registry is computed, producing specific measurements of interest. Voxel-based morphometric (VBM) and deformation-based morphometric (DBM) are currently the most used techniques to balance populations. In VBM, local differences, found in brain tissue parts, are voxel-by-voxel statistically analysed, while DBM statistically compares information coming from the deformations fields obtained after registration to the template. With these methods, one-to-onecorrespondences between subjects are assumed and statistics are computed for the same voxel across allsubjects.

3. Proposed System:

Here we proposes an automatic image analysis method inspired by the radiologist visual perception.The method builds on a visual saliency model and extends it to involve a learning process that mimics theadaptation of a radiologist visual perception. The method performs a multiscale analysis of saliency maps thatare optimally

Combined. This method is able to map any brain to a set of visual patterns that previously havebeen learned as associated to the pathological or normal case. This is not about certain salient points butsalient regions, whereby the whole brain structure results classified either as pathological or normal while noelastic registration among brains is required. The proposed method has been validated by accurately classifying Patients from two public brain MR Datasets (OASIS and MIRIAD) as probable AD subjects or normal controls.

A main augmentation of this work is a fusion strategy that learns, from training data, the discriminantstructural patterns of neurological disorders, in particular, the Alzheimer's disease. Another importantcontribution is the model interpretability since the learned patterns can be mapped to the original brain and used to quantitatively estimate the importance of each region, normal or pathological, for the final classification.Technical contributions include: the use of a 3-D multistate analysis of the brain saliency inspired by whatradiologists do when examining cases, the use of low-level features that scarify data, the formulation of amodel and fusion strategies as a max-margin multiple-kernel optimization problem, and a regional analysismethod that completely avoids any no rigid preregistration step, which at the end constitutes another importantvariability source. An extensive parameter analysis of the influence of the image features as discriminativefactors is also carried out. The classification accuracy between normal controls and probable AD subject's is improved by applying this approach, outperforming a recently proposed technique (FBM).To the best of our knowledge, this kind of visual-saliency-based pattern extraction approach has not beenpreviously investigated for AD characterization and classification in structural MR images.

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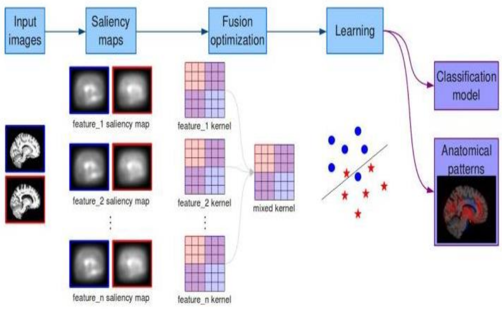

Fig. 1: Graphical overview of the proposed method. Different feature-scale saliency maps are extracted, then a Learning algorithm fuses optimally this information.

4**. Methods**

This method involves implementing a kernel function for feature extraction to identify neurodegenerative Alzheimer's disease in brain images. It begins by converting the input brain image to grayscale, followed by preprocessing to create a saliency map image. Normalization is then applied to the saliency map, and kernel fusion is used to extract image features. Finally, an SVM classifier is employed to classify these features, enabling the identification of anatomical regions within the brain image associated with Alzheimer's disease.

This involves following steps:

Saliency map

This module generates a saliency map for a given input image, where each feature in the image is mapped to its neighboring pixel features, and the degree of difference is calculated using the Euclidean function. The resulting saliency map combines related information from individual features into a global measure. Saliency is typically computed by analyzing the contrasts between the feature's location and its surrounding neighborhood, helping to highlight the most relevant or distinctive parts of the image

Normalization

The process describing involves changing the intensity values of pixels in an image, and it's commonly referred to as contrast stretching or histogram stretching. This technique is used to enhance the contrast in an image, making it easier to distinguish between different regions or features. It typically involves mapping the original pixel intensity values to a new range, which can help bring out details in the image.

Kernel Feature Extraction

Support Vector Machines (SVMs) are indeed a popular machine learning method used for classification and regression tasks. They can be particularly effective in various applications, including image classification and pattern recognition. One key aspect of SVMs is their use of a kernel method for feature extraction or transformation.

SVM Classifiers

Support Vector Machines (SVMs) are a type of supervised learning model used for data analysis and classification tasks. These algorithms require labeled training data to learn and make predictions. In the context of classification, SVMs excel at identifying patterns within the data, helping to distinguish between different classes or categories. The core of their functionality lies in their ability to accurately map the trained data. SVMs aim to find a hyperplane or decision boundary that maximizes the margin, or the distance, between different classes in the feature space. This margin maximization results in accurate and robust classification, even when dealing with complex and non-linear data. SVMs are widely used in machine learning because of their versatility and effectiveness. They find applications in diverse fields, such as image classification, text classification, and biological data analysis, where the identification of patterns and precise classification is essential.

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Anatomical interpretation

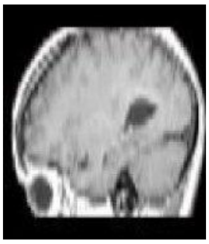
Blue regions are normality for identification of brain diseases and red regions are pathology . In this way anatomical interpretation is done

Performance analysis

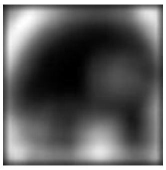
Based on accuracy, sensitivity and specificity, performance analysis is done.

5. Result

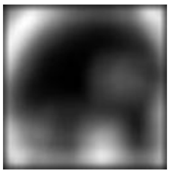
INPUT IMAGE



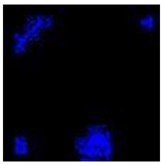
Saliency Image



Normalized Image



Anatomical Image



Pathology Image

6. Discussion

The paper presents an innovative and fully automated approach for storing structural brain patterns related to neurodegenerative diseases. The fundamental idea behind this strategy is to capture and store the patterns commonly identified by expert doctors when analyzing similar brain images. To achieve this, the paper utilizes a fusion strategy, which is acquired through the kernel k-means method. This method effectively stores structural brain patterns. Then, a Support Vector Machine (SVM) classifier is employed to classify new brain images and determine if they exhibit signs of neurodegenerative diseases based on the stored patterns. This approach combines machine learning techniques and expertise in neurology, offering the potential to assist medical professionals in diagnosing and monitoring such diseases more efficiently and accurately.

7. Conclusion

Here we have introduced a fully automatic strategy that reveals structural brain patterns associated tothe presence of the Alzheimer's disease in a public dataset of brain MR images. The underlying idea behind this proposal is that it is possible to find the discriminant patterns that an expert clinician might discover in similar images. This is accomplished using a fusion strategy that mixes together bottom-up and top-down information flows, achieving accurate classifications of probable AD patients or healthy controls. The bottom-up representation is given by a visual saliency method that automatically highlights relevant regions correlated with the AD diagnosis, using contributions from different multi-scale visual features. On the other hand, the top-down scheme allows to adaptively select the meaningful part of the representation, identifying patterns associated to pathological stages. The whole strategy allows to find anatomical regions with clinical meaning that can be quantitatively related to the diagnosis, and therefore, may be suitable for an objective graduation and understanding of the different AD stages.

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