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A Survey on Alzheimer's Disease Diagnosis Techniques

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Abstract— Alzheimer's is a type of dementia that causes problems with memory, thinking and behavior**.** Symptoms usually develop slowly and get worse over time, becoming severe enough to interfere with daily tasks. Alzheimer's is diagnosed through a complete medical assessment. There is no single test that can show whether a person has Alzheimer's**.** In this survey, detailed description of Alzheimer's disease and its diagnosis is presented. Additionally, this study provides an extensive comparison of various Alzheimer's disease diagnosis architectures.

Keywords— Alzheimer's, plaques, tangles ,mild cognitive impairment.

I. INTRODUCTION

In imaging science, image processing is processing of images using mathematical operations by using any form of signal processing for which the input is an image, such as a photograph or video frame; the output of image processing may be either an image or a set of characteristics or parameters related to the image. Most image-processing techniques[1] involve treating the image as a two-dimensional signal and applying standard signal-processing techniques to it.

Medical imaging is the technique and process of creating visual representations of the interior of a body for clinical analysis and medical intervention. Medical imaging seeks to reveal internal structures hidden by the skin and bones, as well as to diagnose and treat disease. Medical imaging also establishes a database of normal anatomy and physiology to make it possible to identify abnormalities.

One of the main goals of brain imaging and neuroscience—and, possibly, of most natural sciences—is to improve understanding of the investigated system based on data. Brain imaging field has come a long way from anatomical maps and atlases toward data driven feature learning methods, such as seed- based correlation , canonical correlation analysis, and independent component analysis (ICA).[2]

Classification of human brain data is typically used merely as a way to evaluate the performance of a pro- posed feature (e.g., percent signal change of an activation map within a set of ROIs, identification of a subset of voxels, or a specific network of interest such as default mode) relative to previously proposed features.[2] Features (and feature selection approaches) are used since classification methods—including the most accurate ones—do not often perform well on raw data and, when they do, the reasons for their accuracy are rarely intuitive or informative. Commonly, if that answer's accuracy improves when a new discriminative feature (biomarker) is proposed, this biomarker is considered an improvement. While a perfect classification approach would be of use, the process of suggesting biomarker candidates would still be a subjective and difficult process. Typical approaches to classification must be preceded by a feature selection step which is not needed for deep learning methods.

Deep learning methods[2] are breaking records in the areas of speech, signal, image, video and text mining and recognition and improving state of the art classification accuracy by, sometimes, more than 30% where the prior decade struggled to obtain a 1–2% improvements What differentiates them from other classifiers, however, is the automatic feature learning from data which largely contributes to improvements in accuracy. This represents an important advantage and removes a level of subjectivity from existing approaches. With deep learning this subjective step is avoided. Another distinguishing feature of deep learning is the depth of the models. Based on already acceptable feature learning results obtained by shallow models currently dominating neuro imaging field—it is not immediately clear what benefits would depth have. Considering the state of multimodal learning, where models are either assumed to be the same for analyzed modalities or cross-modal relations are sought at the (shallow) level of mixture coefficients , deeper models better fit the intuitive notion of cross- modality relations, as, for example, relations between genetics and phenotypes should be indirect, happening at a deeper conceptual level.

Alzheimer's disease (AD)[1], also known as Alzheimer disease, or just Alzheimer's, accounts for 60% to 70% of cases of dementia. It is a chronic neurodegenerative disease that usually starts slowly and gets worse over time. The most common early symptom is difficulty in remembering recent events (short-term memory loss).As the disease advances, symptoms can include problems with language, disorientation (including easily getting lost), mood swings, loss of motivation, not managing self care, and behavioural issues. As a person's condition declines, they often withdraw from family and society. Gradually, bodily functions are lost, ultimately leading to death. Although the speed of progression can vary, the average life expectancy following diagnosis is three to nine years.

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The cause of Alzheimer's disease is poorly understood. About 70% of the risk is believed to be genetic with many genes usually involved. Other risk factors include a history of head injuries, depression, or hypertension. The disease process is associated with plaques and tangles in the brain. A probable diagnosis is based on the history of the illness and cognitive testing with medical imaging and blood tests to rule out other possible causes. Initial symptoms are often mistaken for normal ageing. Examination of brain tissue is needed for a definite diagnosis. Mental and physical exercise, and avoiding obesity may decrease the risk of AD. There are no medications or supplements that decrease risk.

Alzheimer's disease is usually diagnosed based on the person's medical history, history from relatives, and behavioural observations. The presence of characteristic neurological and neuropsychological features and the absence of alternative conditions is supportive. Advanced medical imaging with computed tomography (CT) or magnetic resonance imaging (MRI), [1] and with single-photon emission computed tomography (SPECT) or positron emission tomography (PET) [1] can be used to help exclude other cerebral pathology or subtypes of dementia. Moreover, it may predict conversion from prodromal stages (mild cognitive impairment) to Alzheimer's disease.

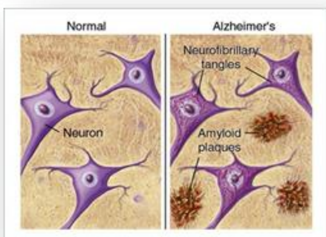

Figure 1. Abnormal pathology characteristic of Alzheimer's disease. Illustration courtesy of Alzheimer's Disease Research, a program of the American Health Assistance Foundation. © 2012. http://www.ahaf.org/alzheimers

Of the many medical imaging techniques available, single photon emission computed tomography (SPECT) appears to be superior in differentiating Alzheimer's disease from other types of dementia, and this has been shown to give a greater level of accuracy compared with mental testing and medical history analysis. Advances have led to the proposal of new diagnostic criteria.

PiBPET[1] remains investigational, but a similar PET scanning radiopharmaceutical called florbetapir, containing the longer-lasting radionuclide fluorine-18, has recently been tested as a diagnostic tool in Alzheimer's disease, and given FDA approval for this use.

Amyloid imaging is likely to be used in conjunction with other markers rather than as an alternative. Volumetric MRI can detect changes in the size of brain regions. Measuring those regions that atrophy during the progress of Alzheimer's disease is showing promise as a diagnostic indicator. It may prove less expensive than other imaging methods currently under study.

II. RELATED WORKS

S NO	TITLE	DESCRIPTION
1	Alzheimer's diagnosis using eigenbrains and support vector machines[8]	This paper presents a CAD tool based on a PCA and a support vector machine (SVM) classification method for improving the AD diagnosis by means of SPECT images.
2	Construction and Application of Bayesian Network in Early Diagnosis of Alzheimer Disease's System[11]	This paper used heuristic search method to construct Bayesian model for early diagnosis of the presence of the mild cognitive impairment from structural MR images and behavioral data.
3	Early diagnosis of Alzheimer's disease with deep learning[4]	This paper presents a deep learning architecture, which contains stacked auto-encoders and a softmax output layer to aid the diagnosis of AD and MCI
4	Neurological image classification for the Alzheimer's Disease diagnosis using Kernel PCA and Support Vector Machines[9]	This paper presents a CAD tool for the early diagnosis of the AD, based on Kernel PCA dimension reduction of the feature space in combination with LDA.
5	Multimodal EEG, MRI and PET data fusion for Alzheimer's disease diagnosis[6]	This paper combine EEG, MRI and PET data using an ensemble of classifiers based decision fusion approach, to determine the diagnostic accuracy over any of the individual data sources when used with an automated classifier
6	Identification of brain white matter regions for diagnosis of Alzheimer using Diffusion Tensor Imaging[5]	This paper delineates specific regions of interest in the WM that may be probable indicators for the diagnosis of Alzheimer disease (AD). Genetic algorithm has been used as feature reduction method to determine prominent regions in the WM that are indicators of AD.
7	Multiresolution analysis for early diagnosis of Alzheimer's disease[12]	This paper describes a new effort using multiresolution wavelet analysis on event related potentials of the EEG to investigate whether a link can be established.
8	Computer aided diagnosis of the Alzheimer's disease combining SPECT-based feature selection and random forest classifiers[10]	This paper shows a CAD technique for the early detection of the Alzheimer's disease based on SPECT image feature selection and a random forest classifier.
9	Matrix-Similarity Based Loss Function and Feature Selection for Alzheimer's Disease Diagnosis[3]	This paper presents a novel matrix-similarity based loss function and imposes the information to be preserved in the predicted response matrix.
10	Boosting Alzheimer Disease Diagnosis Using PET Images[7]	This paper presents a study on the use of PET images of the ADNI database for the diagnosis of AD and MCI.

III. CONCLUSION

Alzheimer’s disease diagnosis is made by clinical, neuropsychological, and neuro imaging assessments. Medical image processing has a great role in this. This paper highlights various techniques for the diagnosis of Alzheimer’s disease. Among all methods deep learning architecture is found to be more powerful for the early diagnosis of Alzheimer’s disease.

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