Quantifying Brain Abnormality by Multimodality Neuroimage Analysis

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Country

USA

Title of project or programme

Quantifying Brain Abnormality by Multimodality Neuroimage Analysis

Source of funding information

NIH (NIA)

Total sum awarded (Euro)

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Start date of award

01/04/2012

Total duration of award in years

5

The project/programme is most relevant to:

Alzheimer's disease & other dementias

Keywords

Acquired Cognitive Impairment... Aging... Alzheimer's Disease... Alzheimer's Disease including Alzheimer's Disease Related Dementias (AD/ADRD)... Bioengineering... Biomedical Informatics Research... Biomedical Information Resources... Biomedical Information Resources and Informatics Research... Brain Disorders... Dementia... Neurodegenerative... Neurosciences... Prevention

Research Abstract

? DESCRIPTION (provided by applicant): Alzheimer's disease (AD) develops for an unknown and variable amount of time before its symptoms fully manifest. But, when the symptoms become clinically observable, a significant neurodegeneration has already taken place. Thus, there is a largely unmet need for technologies that can aid the effective early diagnosis and prognosis of AD in an in vivo and more objective manner. The goal of this renewal project is to develop a set of advanced machine-learning techniques for precise in vivo quantification of pathological changes of brains with multimodality neuroimaging for both early diagnosis and prognosis of AD. AD is a highly heterogeneous neurodegenerative disorder with complex pathophysiology, thus very challenging to pinpoint its subtle pathologies without any aid from advanced computational technologies. To this end, we propose the following four specific aims to identify those subtle disease-induced alterations, derive robust diagnostic conclusions, and predict future disease trajectories. Specifically, in Aim 1, we will develop a multi-view feature representation technique to robustly extract complementary information from neuroimaging data with multiple representative atlases, and then identify a small subset of most discriminative features for AD diagnosis. This novel multi-atlas technique will deviate from the conventional single-atlas approaches in feature representation, which are often susceptible to inter-subject structural variability, registration error, and atlas selection bias. In Aim 2, we will further devlop two novel multi-view feature mapping techniques for collaborative fusion of multimodality information by explicitly considering the distribution heterogeneity of different categories of features extracted from different modalities. This will significantly avoid the unnecessary complexity of feature distributions after our collaborative fusion, thus increasing the efficacy of subsequent diagnostic classifiers. Specifically, a deep learning technique (with deep multi-layered architecture) will be adopted to hierarchically mine multimodality information that resides nonlinearly both within each modality and between different modalities. In Aim 3, we will develop a novel multi-task sparse learning technique for joint prediction of diagnostic status and clinical scores (e.g., ADAS-Cog and MMSE) by considering the inherent correlations between features and between training samples. This will also allow us to exploit the latent structure underlying the data for robust estimation of these highly variable clinical scores. Finally, in Aim 4, we will jointly predict clinical scores of each given subject in multiple future time points, by developing coupled random forests that can take advantage of all training subjects with complete or even incomplete multimodality data and further enforce temporal consistency of those estimated clinical scores. All the above-proposed techniques will be evaluated by a large image set of elderly subjects in ADNI. We expect that the successful completion of this renewal project will result in a comprehensive and effective diagnosis/prognosis framework for improving early detection of AD. The respective software tools will be released freely to the research community, as we have done with our HAMMER software, which has been downloaded by >5200 users from >20 countries.

Lay Summary

PUBLIC HEALTH RELEVANCE: The goal of this renewal project is to develop a set of advanced machine-learning techniques for precise in vivo quantification of pathological changes, afforded by multimodality neuroimaging data, for both diagnosis and prognosis of Alzheimer's diseases (AD). Specifically, we will explicitly exploit the distribution complexity and hierarchical nature of the multimodality data, for identifying subtle disease-induced alterations, deriving robust diagnostic conclusions, and predicting the future disease trajectory.

Further information available at:

Types:
Investments > €500k

Member States:
United States of America

Diseases:
Alzheimer's disease & other dementias

Years:
2016

Database Categories:
N/A

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