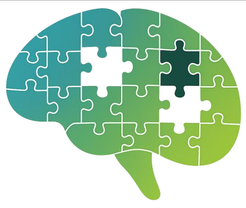
Radiomic feature robustness affected by magnetic resonance field strength for patients with Alzheimer's Disease

#45945
PG298

Jiqing HUANG[1], Yi CHEN[2,3], Christophe PHILLIPS[1]
[1] GIGA-CRC Human Imaging, University of Liège, Liège, Belgium
[2] AMIIC-Lab, College of Computer Science and Technology, Guizhou University
[3] The D-Lab, Department of Precision Medicine, Maastricht University
c.phillips@uliege.be
jiqing.huang@uliege.be

Introduction



Alzheimer's disease (AD), is recognized as the most common form of dementia. Currently, there are OVER 55M AD patients in the world.

Multi-site studies often mix 1.5T and 3T scans; different field strengths may impact the robustness and transferability of radiomic features.

Objective #1: Which specific radiomic features remain robust between 1.5T and 3T?

Objective #2: How useful are these stable features for AD-related classification?

Methods

Data & Cohort:

- *Source*: ADNI dataset with paired 1.5T/3T MRIs
- *Inclusion*: From 253 paired cases, 191 subjects with scan interval ≤ 3 months: health control (HC) vs. mild cognitive impairment (MCI) vs. AD, numbers 62/41/88 (Age 74.67 ± 7.21 years; Male/Female = 95/96)
- *Sequence*: ADNI is acquired with multi-site and multi-vendor. Siemens/Philips use MPRAGE and GE uses IR-SPGR, and all data were harmonized by pre-processing pipeline with QC.
- *Cognitive assessment*: ADNI collects a number of cognitive assessments and questionnaires for in-clinic participants (details in ADNI- Clinical Assessment)

Data processing:

- *Hippocampus segmentation*: bilateral hippocampus are segmented by the HippoDeep method[1] for 1.5T and 3T scan respectively.
- *Radiomic features extraction*: Shape-(3D:16, 2D:10), texture-(75), and intensity-(19) based features are extracted from the segmented hippocampi using Pyradiomics[2].
- *Feature analysis*: Nonlinear concordance correlation coefficient[3] (NCCC) to evaluated the reproducibility and robustness of the extracted features. Features with NCCC > 0.6 are considered as acceptable stable features .
- *Radiomics analysis*:
  a) Feature selection: Among the stable features, we ranked variables by mutual information with the target label and selected the top 10 most informative features for each task on training dataset.
  b) Classification: Distinguish between HC vs. MCI and MCI vs. AD with 1.5T or 3T scan.
  Classifier: Random Forest; Dataset split: train vs. test (80%/20%); 5-fold cross-validation on training dataset.

Results

Segmentation: Figure. 1 shows hippocampal segmentation from AD subjects' MRI at both 1.5T and 3T field strengths.

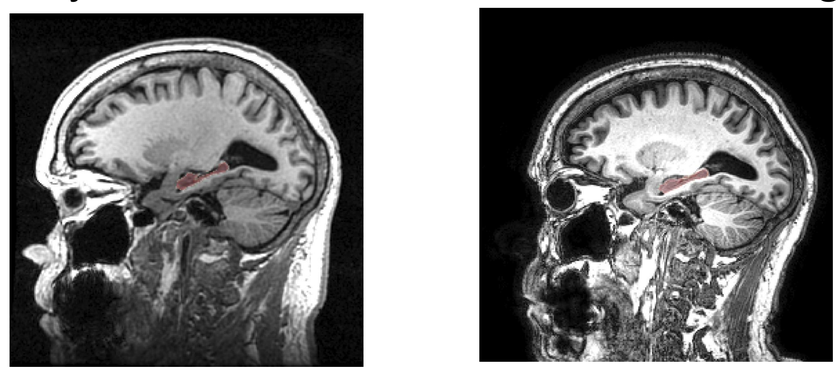


Figure 1: Bilateral hippocampus in AD patient (L: 1.5T, R: 3T)

Feature analysis: Among the 120 radiomic features, 27 features displayed acceptable concordance between 1.5T and 3T (NCCC > 0.6).

Classification performance: Figure 2 shows the classification performance based on area under curve (AUC) for distinguishing NC-vs-MCI and MCI-vs-AD groups at both 1.5T and 3T field strengths.

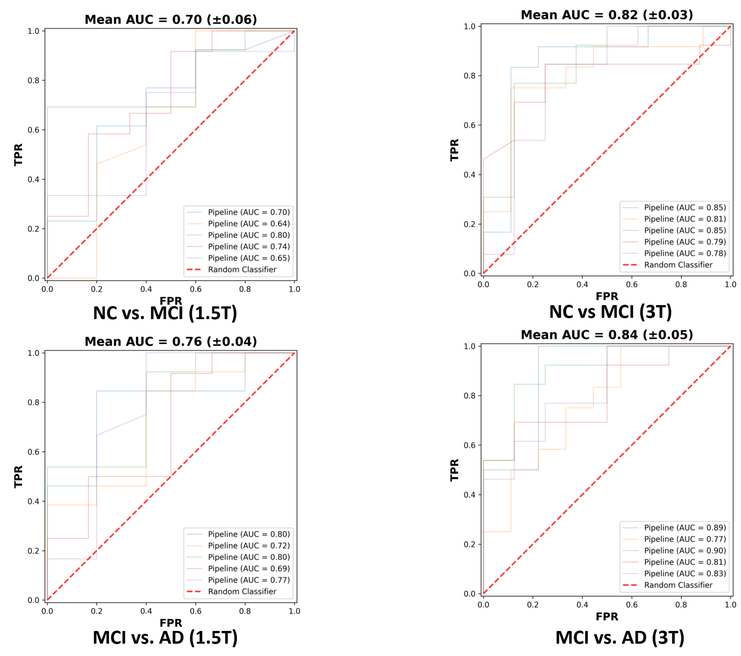


Figure 2: Random Forest performance on stable features for NC-vs–MCI and MCI-vs–AD classification from 1.5T and 3T MRI.

Discussion & Conclusion

Principal findings:

Stable cross-field radiomic features show potential for distinguishing HC, MCI, and AD.

- Identified field-strength-stable hippocampal radiomic features are mainly shape-based across 1.5T/3T.
- Using stable features, MCI vs HC are successfully classified with strong AUC (>0.80) while MCI vs AD remained challenging. [AUC 0.71 (1.5T) and 0.76 (3T)].

Likely reason:

- MCI encompasses diverse range of microstructure changes, making it a complex condition to classify.
- Subtle features captured by NCCC are insufficient to detect changes in MCI progression.

Next step: Finer MCI stratification, enhanced feature techniques

References: [1]Thyreau B, et al. Med. Image Anal.,2018; [2] Van G., et al. Cancer Res., 2017; [3] Schölkopf, B, et al. MIT press, 2002.

LIÈGE université
GIGA
CRC Human Imaging

fnrs
FREEDOM TO RESEARCH

Abstract & Poster

Git-Hub repository