Artificial-Intelligence & Machine-Learning Based Models in Evaluating Alzheimer's disease & its association with Diabetes Mellitus

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Background

Volumetry of various brain structures is critical for monitoring Alzheimer's disease (AD), particularly in patients with Diabetes Mellitus (DM), which accelerates structural changes in brain. Artificial-Intelligence based automated tools can segment the various brain structures with high accuracy and can also determine the additive effect of DM that have not been described in existing Medical Literature. *Hence, this study aimed to systematically compare AI-based volume of various brain structures in AD patients with and without diabetes and to determine its performance using machine-learning (ML) based models*.

Methods and materials

MRI brain data from 30 patients with AD were analysed:15 with DM and 15 without it. Volumes were extracted using tools such as *NeuroShield^{NVA}* and *uAI-Brain volume analysis* across the following regions - *Global/whole brain, Temporal & hippocampal, Other lobar regions*, *Subcortical nuclei, Cerebellum & brainstem*.

Statistical analyses included paired t-tests or Wilcoxon tests, correlation (Pearson/Spearman) and Bland-Altman limits of agreement. Additionally, ML classification (Random Forest + 5-fold cross-validation) was performed to distinguish AD with DM from those without using both NeuroShield^{NVA} and uAI-derived volumes separately.

Results

Agreement analysis showed that no brain region exhibited a statistically significant mean difference (all $p > 0.05$) between the two volumetric tools across hippocampal, temporal, lobar, subcortical, cerebellar, brainstem, and whole-brain structures. Strong correlations were observed for most regions (Pearson $r > 0.85$), including total hippocampus ($r = 0.99$), left temporal lobe ($r = 0.87$), and right temporal lobe ($r = 0.84$). Bland-Altman plots revealed narrow mean differences but relatively wide limits of agreement in several cortical and lobar regions, indicating potential proportional bias. For classification, NeuroShield^{NVA}-derived features yielded an accuracy of 82.50% (AUC = 0.87) in distinguishing D-AD from ND-AD, while uAI-derived features achieved 80% accuracy (AUC = 0.85). Temporal lobe and hippocampal volumes were the most discriminative predictors.

Conclusion

AI-based brain volume analysis tools provide comparable volumetric estimates across multiple brain regions in AD patients, with no significant mean differences. However, Bland–Altman findings highlight variability in absolute agreement, limiting full interchangeability. Machine learning analysis suggests that both tools can differentiate AD patients with DM from those without, with good accuracy, underscoring their clinical utility. Cross-tool calibration and harmonization, however, remain important for multi-center studies. Larger, multi-disease validation is required to confirm generalization of the study-results.

a)

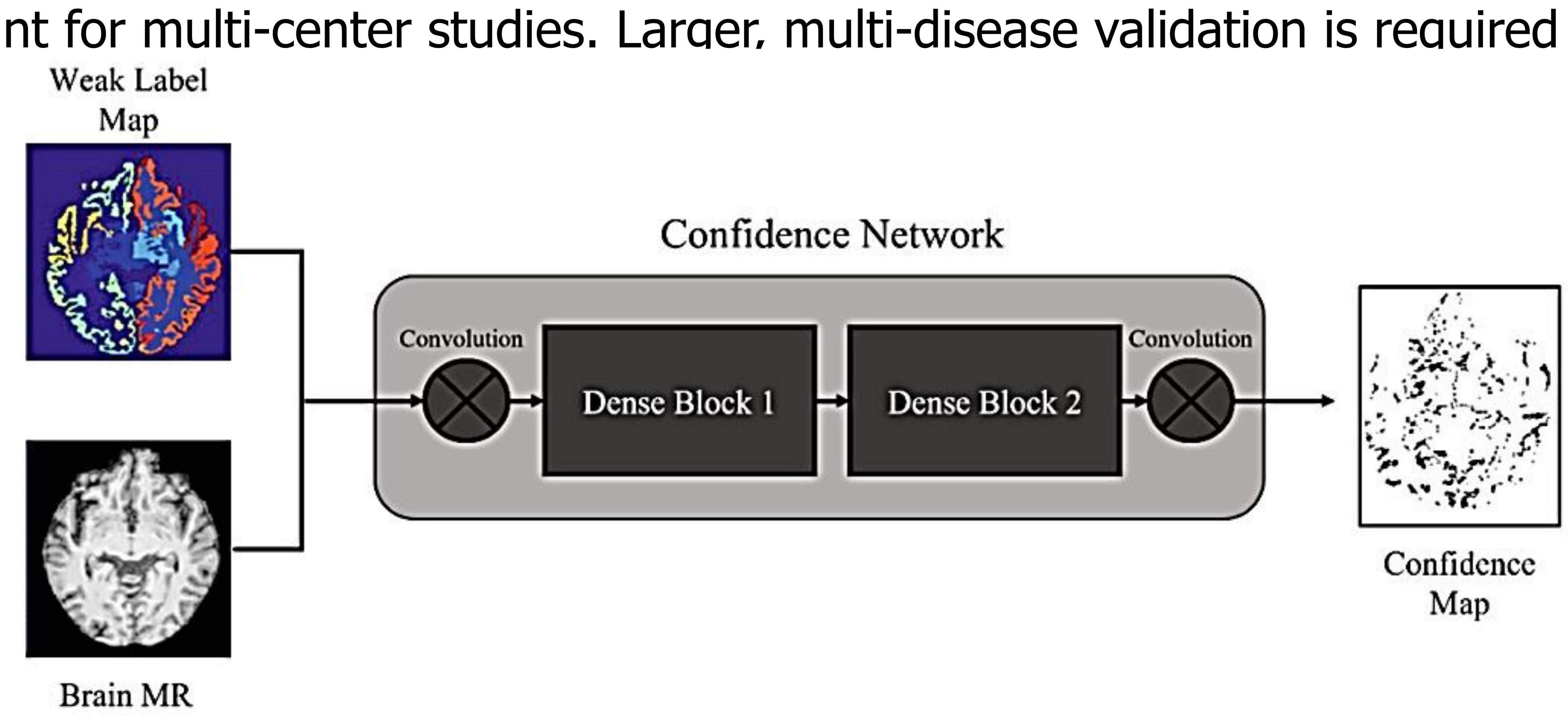
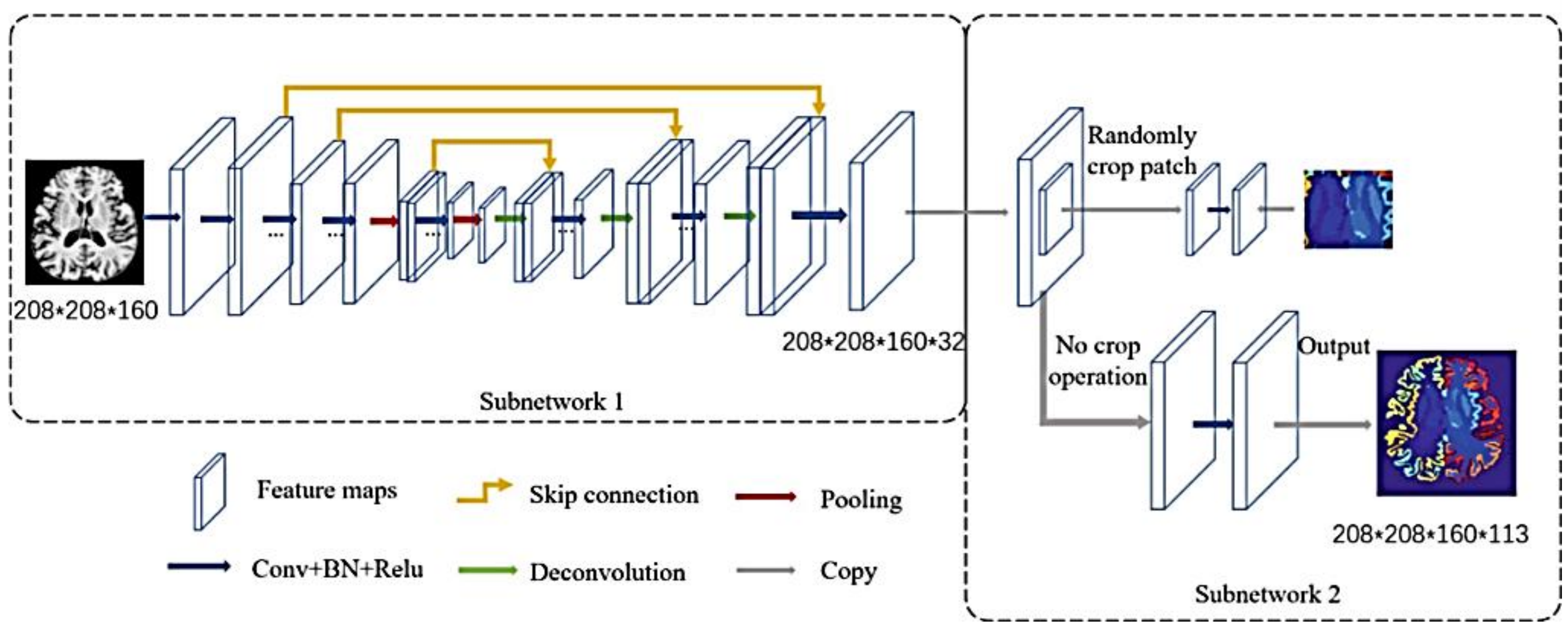


Figure 1.

(a) *Architecture of the Confidence Network, which generates confidence maps for weakly labelled data.*

(b) *Illustration of the two-stage Confidence Integration Network (CINet), which integrates confidence maps into the segmentation pipeline to enhance accuracy*

b)



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