

AUTOMATIC SEGMENTATION OF THE HIPPOCAMPUS USING U-NET BASED DEEP CONVOLUTIONAL NETWORKS

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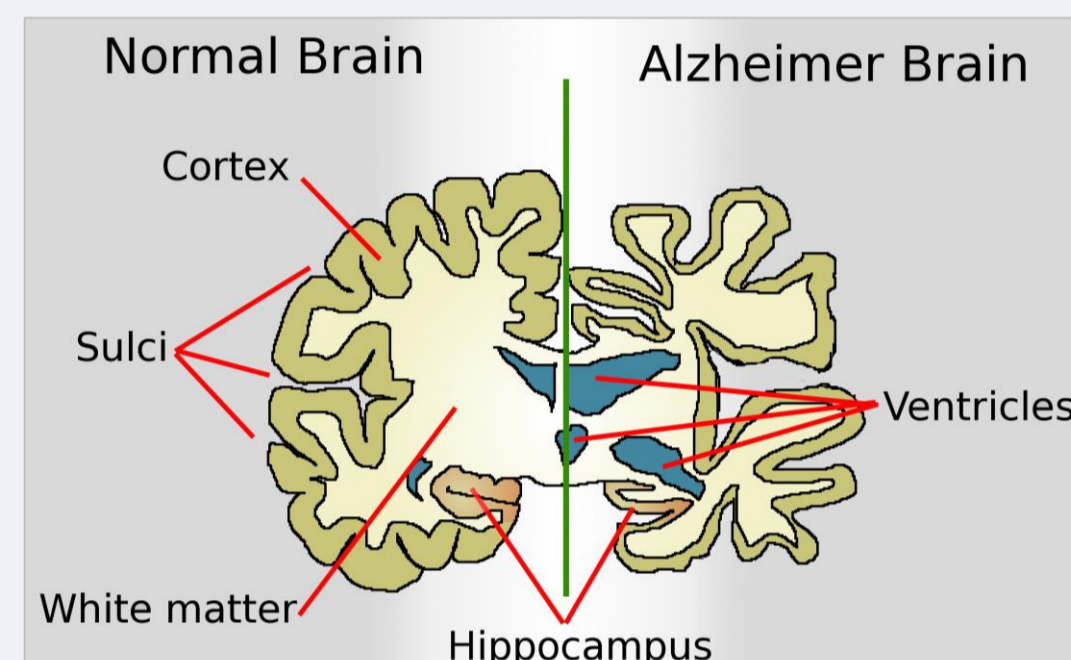
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Abstract

Accurately segmenting the hippocampus from brain MRI data is a crucial task, since its structural integrity is related to Alzheimer's disease progression. Our work implements a segmentation pipeline by using U-Net based deep learning and then combining it with shape modeling. The use of a U-Net-based approach was successful in terms of both time efficiency and accuracy in three different diagnostic groups. However, the segmentation result did not benefit from the inclusion of shape information.

Introduction

- The hippocampus is one of the first brain parts to be damaged by **Alzheimer's disease (AD)** [1].
- Patterns of atrophy have been reported also on subjects with mild cognitive impairment (MCI).
- By measuring the hippocampal volume and analyzing its shape, we can **early detect** the presence of AD, as well as its level of **progression** [2, 3].



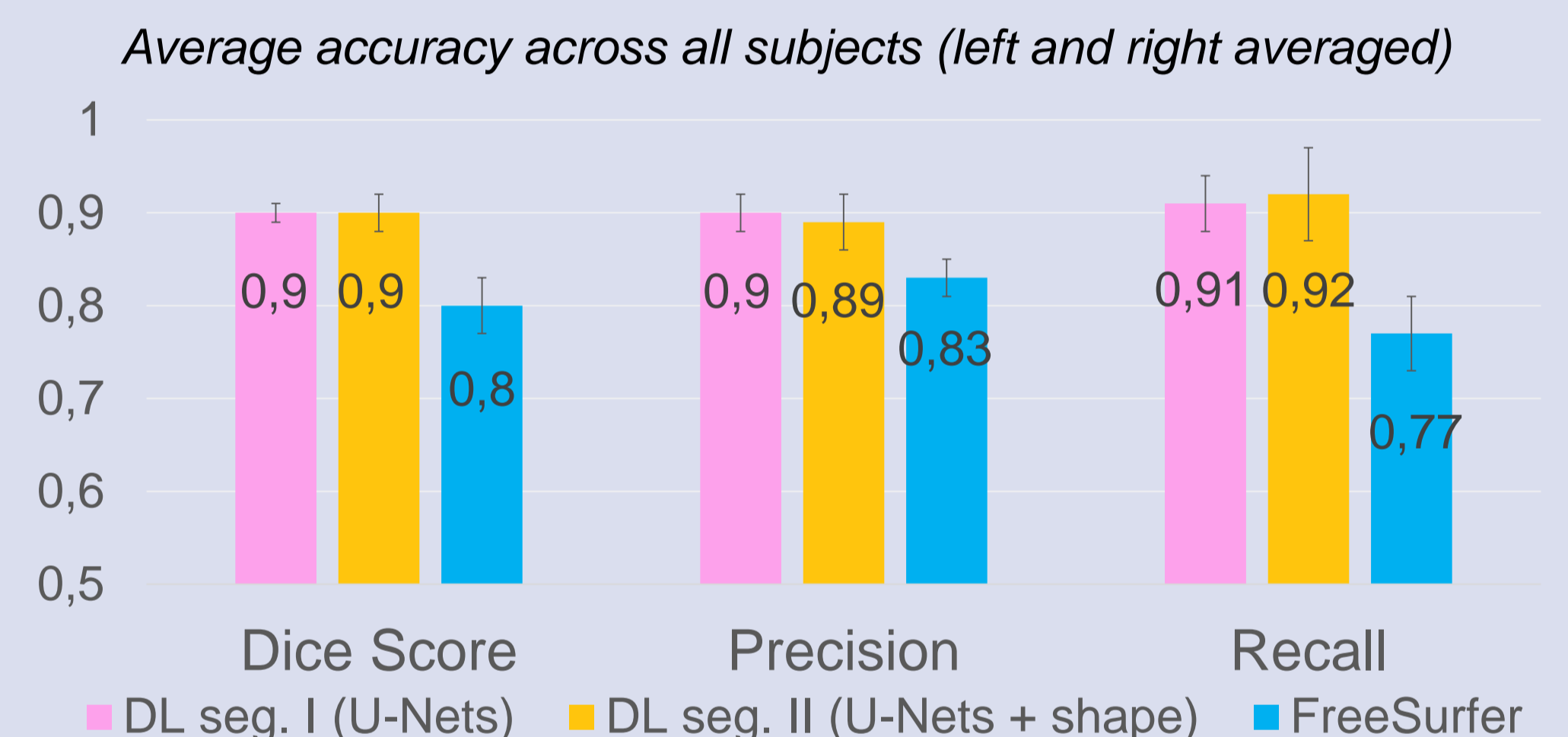
Aim of the study

- Implementing a **deep learning-based hippocampal segmentation** pipeline using U-Nets [4].
- Combining the pipeline with shape information derived from **statistical shape models** [5].
- Analyzing the accuracy of the two approaches and comparing it with the one from FreeSurfer 6.0.

Results

The pipeline was trained and tested using 9-fold cross validation on **54 subjects** equally distributed in terms of field strength (**1.5T and 3T**) and diagnosis (**AD, MCI and healthy controls**).

Each individual segmentation took about **1 minute**.



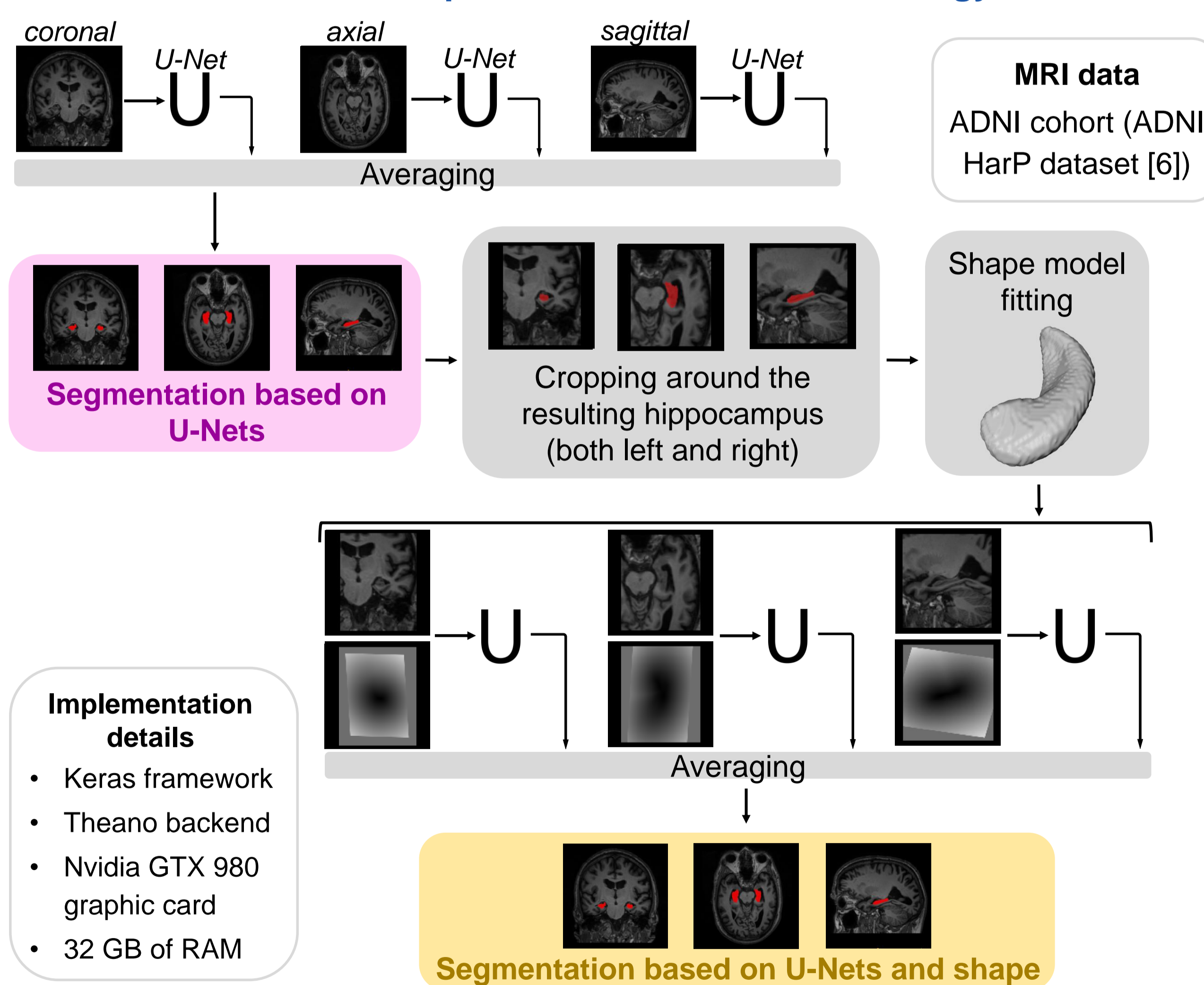
Conclusions

- Segmenting the hippocampus with a U-Net-based approach resulted to be **successful** in both **time efficiency** and **accuracy** when compared to the widely used pipeline from FreeSurfer.
- Adding **shape context layers** did not show an **improvement** in the—already high—segmentation performance.

Future work

- Testing the pipeline on new unseen data from another cohort.
- Re-training the network to segment other brain structures.
- Analyzing the performance of a new pipeline using 3D U-Nets.

Schematic representation of the methodology



References: [1] Vinters H.V. et al., *Annu Rev Pathol*, 2015; [2] Liu Y. et al., *Neurobiol Aging*, 2010; [3] Lindberg O., *J Alzheimers Dis*, 2012; [4] Ronneberger O. et al., *Med Image Comput Comput Assist Interv*, 2015; [5] Leventon M.E. et al., *Proc IEEE Comput Soc Conf Comput Vis Pattern Recognit*, 2000; [6] Boccardi M. et al., *Alzheimers Dement*, 2015.

