EE577 Project Proposal

Large Scale Vertebrae Segmentation

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1 Overview

The idea of this project comes from VerSe'20: Large Scale Vertebrae Segmentation Challenge[3], MICCAI 2020. Spine or vertebral segmentation is a crucial step in all applications regarding automated quantification of spinal morphology and pathology. With the advent of deep learning, for such a task on computed tomography (CT) scans, a big and varied data is a primary sought-after resource. Based on the dataset Verse[2], the target of this project is to develop a accurate and stable deep learning based method to achieve large scale vertebrae segmentation.

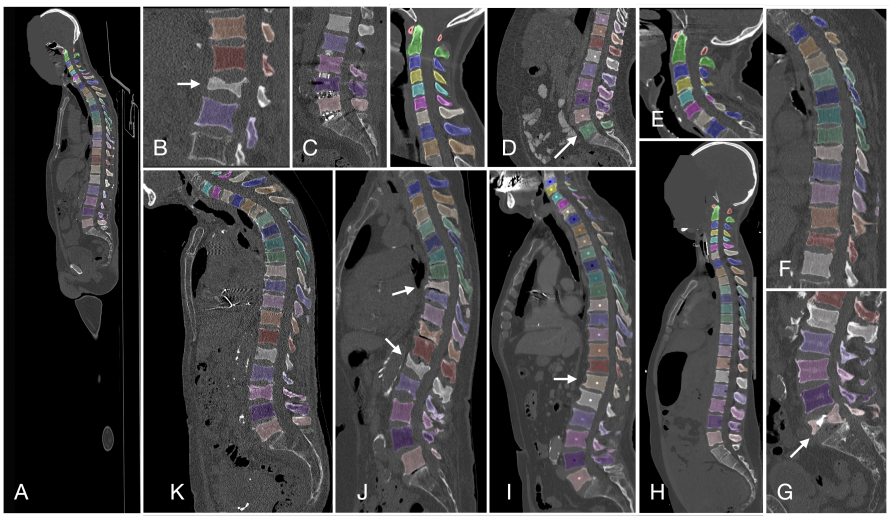

Figure 1: Example scan slices from the VerSe datasets.

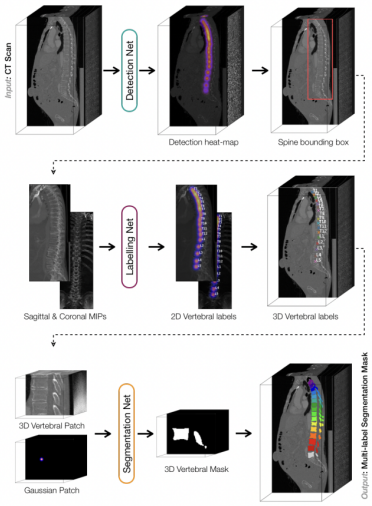

Figure 2: Task pipeline.

2 Objective

2.1 Vertebral Labelling.

Labelling here is a multi-class detection task, superscribing localisation by assigning a 3D coordinate as well as a class to the vertebra (C1-C6, T1-T13, L1-L5, as well as T13 and L6). To evaluate the labelling performance, we compute two factors, the *Identification Rate* (*id.rate*) and *localisation distance* (d_{mean})[2]. The Spatial Configuration-Net[**10.1007/978-3-319-46723-8˙27**] is our main algorithm reference.

The objective is implementing the SC-Net and improve its performance. The objective matrix is with *id.rate* higher than 94.25% and d_{mean} smaller than 4.27, which are the overall best scores of VerSe'19. Possible methods of improvement is to implement some SOTA detection network, like YOLO and Mask RCNN.

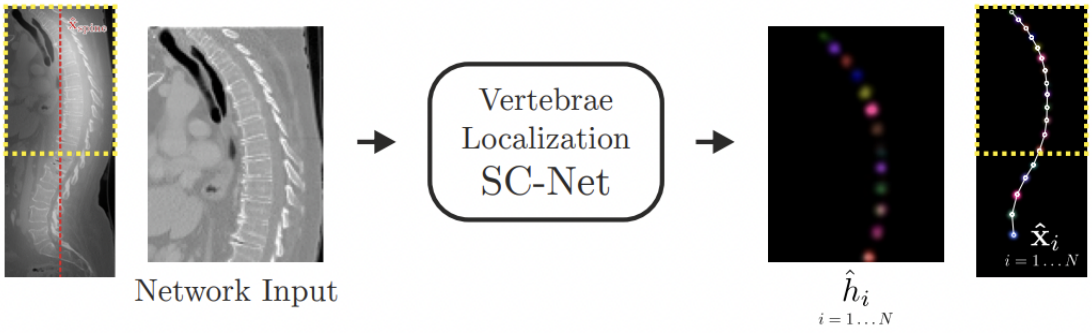

Figure 3: SC-Net for vertebral segmentation.

2.2 Vertebral segmentation. (Optional)

Vertebral segmentation here is a voxel-level, multi-class segmentation task, where in each vertebra level has a defined class label (e.g. C1→1, C2→2, T1→8 etc.). Two factors, the *ubiquitous Dice coefficient* (Dice) and *Hausdorff distance* (HD)[2] are used to evaluate the performance of segmentation.

The objective is implementing the U-Net[**DBLP:journals/corr/abs-1905-07710**] method used in [1]. The object matrix is with Dice higher than 90.90% and HD smaller than 6.35, which are also the overall best scores of VerSe'19.

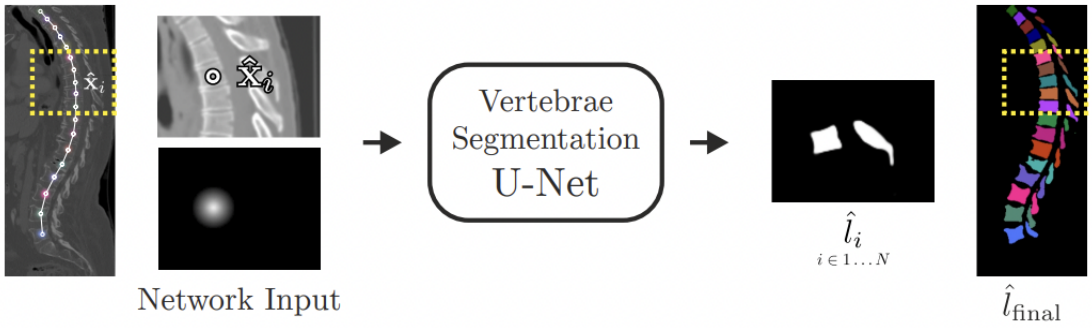

Figure 4: U-Net for vertebral segmentation.

3 Timeline

- 11/07: Environment setup. Dataset and loading scripts ready.
- 11/14: Implement SC-Net for labelling. Model training. Evaluating scripts writing.
- 11/21: Improve performance of labelling. Achieve matrix with objective values. Status-report writing.
- 11/28: Implement U-Net for segmentation. Model training. Evaluating scripts writing.
- 12/05: Finishing work. Analyse results and do visualization.
- 12/12: Final report writing.

References

[1] Christian Payer et al. "Coarse to Fine Vertebrae Localization and Segmentation with SpatialConfiguration-Net and U-Net". In: *Proceedings of the 15th International Joint Conference on Computer Vision, Imaging and Computer Graphics Theory and Applications - Volume 5: VISAPP*. Vol. 5. 2020, pp. 124–133. DOI: 10.5220/0008975201240133.

[2] Anjany Sekuboyina et al. "VerSe: A Vertebrae labelling and segmentation benchmark for multi-detector CT images". In: *Medical Image Analysis* 73 (Oct. 2021), p. 102166. ISSN: 1361-8415. DOI: 10.1016/j.media.2021.102166. URL: http://dx.doi.org/10.1016/j.media.2021.102166.

[3] Anjany Sekuboyina et al. *VerSe'20: Large Scale Vertebrae Segmentation Challenge*. https://verse2020.grand-challenge.org/. 2020.