Cervical motion
Segmentation of cervical spine vertebrae in cinematographic recordings.

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Background

The term 'physiological motion of the spine' is commonly used, although there is no proper definition of normal cervical spine motion. Probably because analyzing motion of the cervical spine remains a challenge. We are interested in researching the relation of motion patterns in the cervical spine and several pathologies. Moreover, we want to investigate the influence of specific surgeries to the cervical spine. In a previous study by our group, motion patterns in radiographic recordings of flexion and extension were investigated. Contours of the occiput (C0) and cervical vertebrae (C1-C7) were manually drawn and corrected, which is very labor-intensive (±30h per recording). Moreover, this can only be done by trained and experienced individuals. We aim to use the annotated data to train a deep learning segmentation model to recognize and track motion of cervical vertebrae.

Dataset

Radiographic flexion-extension recordings of healthy volunteers and pre-operative patients with cervical degenerative disc disease were used. Vertebrae C0 to C7 were manually annotated in all successive frames of the recordings. The sequence of segmental contributions is determined by calculating the relative rotations of each segment.
In order to achieve the localisation of vertebrae across multiple frames, a segmentation network was already developed with Mask-RCNN. This network was trained for segmentation of C0 to C7 in 4171 images and tested on 468 images.

Current model

The proof of principal Mask RCNN model accurately identifies and tracks cervical vertebral contours throughout cinematographic recordings when assessed visually (Fig. 1).

Student task description

The student will improve the current proof of principal in several aspects. For example, by adding time as a factor. Intraclass correlation coefficients (ICC) between the motion patterns of the ground truth and predicted contours in the test set show highly variable results. In good quality recordings, the ICCs are high for C3-C4, C4-C5, and C5-C6. We suspect that this is caused by the fact that the contours predicted in the separate do not have a consistent shape throughout all separate frames of the recordings. Another step would be to train the model with recordings of patients with anatomical variants or implants in-situ. However, the majority of these recordings only have manual annotations from C4-C7. Ultimately, the aim is to develop a user-friendly interface to upload and analyze the recordings.

This can be executed in the form of a short-term external internship, or a longer thesis graduation project. You will be able to work alongside other researchers in a workspace in the Maastricht UMC+ hospital, or digitally.
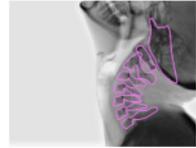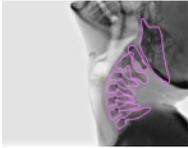
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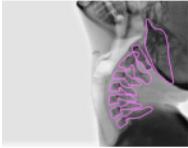
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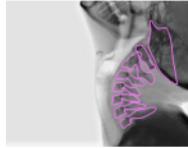
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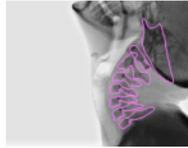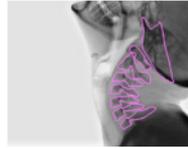HC_12_Flex_T2_ (4).png

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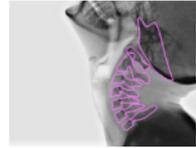HC_12_Flex_T2_ (6).png

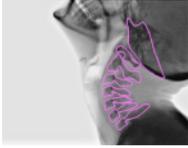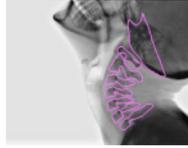HC_12_Flex_T2_ (7).png

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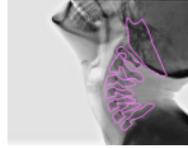

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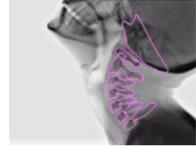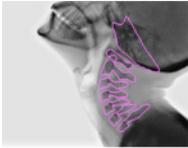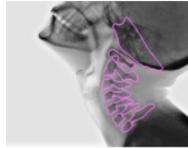

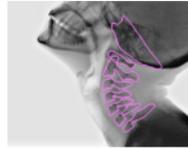HC_12_Flex_T2_ (10).png

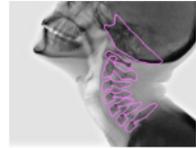HC_12_Flex_T2_ (11).png

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