A Deep-Learning Based Automatic Dental Assessment for OPTs

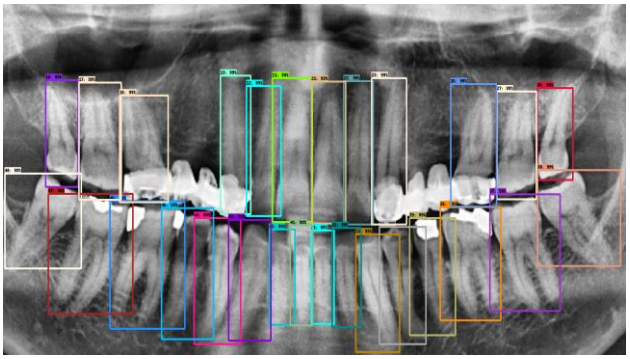

Figure 1: Automatic teeth FDI numbering in an OPT with several missing teeth (Picture: N. Sahraei Winkler).

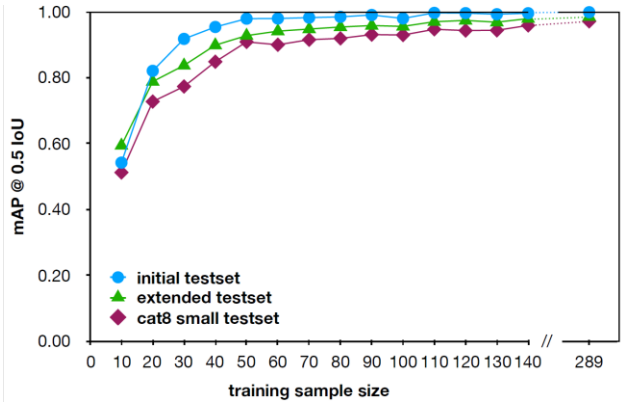

Figure 2: Variation of the mAP @0.5 IoU on three different test sets based on the number of OPTs used for training the object detector (Picture: N. Sahraei Winkler).

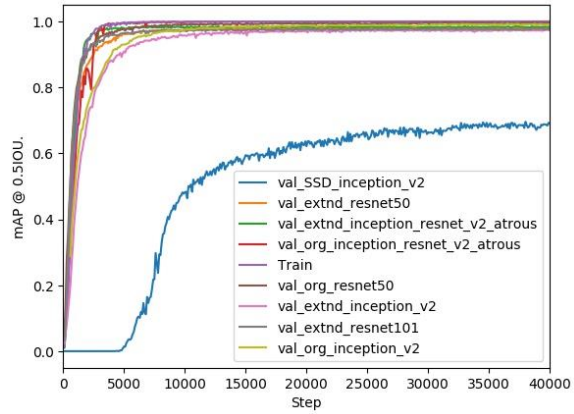

Figure 3: Difference of the mAP @0.5 IoU on a validation set for different SSD and Faster-RCNN based models (Picture: N. Sahraei Winkler).

Master´s Thesis by Negin Sahraei Winkler for the Master of Science in Biomedical Engineering.

X-ray imaging plays a vital role in dentistry and can be adopted in both diagnosis and treatment phases. Teeth characterization, as well as diagnosis of different pathologies using X-ray panoramic images (OPTs), is both time-intensive and error prone. As a solution, using an automatic diagnosis system for such purposes can be of great assistance to dentists by reducing detection time as well as providing a second opinion. In this thesis, a deep learning based automatic teeth detection and classification tool for OPTs has been developed.

For this purpose, initially, a dataset of 234 panoramic images and their corresponding ground-truth labels consisting of information on the bounding box and Federation Dentaire Internationale (FDI) notation of each tooth has been created. Due to small initial labeled OPT images for training a technique called transfer-learning was used. An object detector using different pre-trained CNNs from the TensorFlow object detection API was trained based on these images. For initial training different architectures based on SSD and Faster RCNN meta-architectures were adopted. Amongst all models trained on our dataset, The Faster R-CNN inception ResNet v2 Atrous baseline training showed the best performance and a mean Average Precision (mAP) of approximately 98% was achieved on the test dataset. The baseline results have been studied thoroughly and used to extend the dataset to 482 images to have a better-generalized object detector. The models were then trained using these 482 images dataset and a mAP of approximately 99% was achieved on a test dataset consisting of over 150 random OPTs including the ones with missing teeth. The promising results in this thesis suggest that the adopted method has very high accuracy even once trained on a very small dataset and can be developed further for computer-aided diagnosis (CAD) purposes.

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