AUTOMATED ANALYSIS OF HAND RADIOGRAPHS BY USING MULTI-LEVEL CONNECTED ACTIVE APPEARANCE MODELS

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Objectives: Joint damage assessment in radiographs of hands is used for monitoring disease progression and outcome in drug trials in rheumatoid arthritis (RA). Current clinical scoring methods are based on manual measurements that are time-consuming and subject to intra and inter-reader variance. A solution may be found in the development of partially or fully automated assessment procedures. This requires reliable segmentation algorithms that recognise individual bones and joints.

Methods: For hand x-rays, we adapted a segmentation method based on multiple connected active appearance models (AAM) with multiple search steps using increasing quality levels. The quality level can be regulated by setting the image resolution and the number of landmarks in the AAMs. To test this method we digitized 80 film radiographs of single hands: 50 images were used for training the model and 30 for testing. We performed experiments using two models of different quality levels for shape and texture information. Both models included AAMs for the carpal region, the metacarpals, and all phalanges.

Results: By starting an iterative search with the faster, low-quality model, we were able to determine the initial parameters of the second, high-quality model. After the second search, the results showed successful segmentation for 22 of 30 test images. For these images, 70% of the landmarks were found within 1.3 mm difference from manual placement by an expert. The multi-level search approach resulted in a reduction of 50% in calculation time compared to a search using a single model. Results are expected to improve when the model is refined by increasing the number of training examples and the resolution of the models.

Conclusion: Although the system is not completed, increasing the training set and further adaptation of the model may help to make automated assessment of joint damage on hand X-rays a reality in the near future. The detection of the contours of individual carpal, metacarpal and interphalangeal bones will be followed by separate algorithms for the measurement of joint space widths. The method we have tested will also enable automated assessment of para-articular and midshaft bone mineral density and erosion. The end goal an objective and sensitive measure of joint damage in arthritis, comparable to the Sharp-van der Heijde and Larsen scores.

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