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Fast 3D Reconstruction of the Spine by Non-expert Users Using a Statistical Articulated Model

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Introduction: Three-dimensional spine reconstruction methods currently used to study scoliosis require manual identification of several anatomical features, which is time-consuming, costly and error-prone.

Objectives: To provide fast 3D reconstructions of the spine that may be accomplished by non-expert users. More specifically, recovering the 3D position of 6 anatomical landmarks per vertebra based on a pair of radiographs with minimal user interaction.

Materials and Methods: Splines approximating the spine midline were identified by end-users using a small number of control points (typically 4 to 7 points on each radiograph). Then, vertebrae location, rotation and 3D anatomical landmarks were recovered by deforming a statistical articulated model that captures inter-vertebrae variability (compiled using 291 prior reconstructions). The deformation optimizes both the fit with the user's splines and the prior probability given by the statistical model.

A set of 14 in vivo exams of scoliotic patients were used for validating the method. 3D reconstructions obtained using a previously validated method were compared with reconstructions using the proposed method performed by 2 volunteers with limited knowledge on spine radiology. Volunteers only had 20 minutes of training with the software tool (figure 1).

Results: The mean reconstruction errors were 3.4mm for the endplates and 4.8mm for the pedicles. Furthermore, the average reconstruction time was 1min28s.

Conclusion and Significance: Results show that rough reconstructions of the spine may be rapidly achieved by non-expert users with very little training. This makes the method attractive when fast reconstructions are required, or when dedicated personnel would be too expensive.

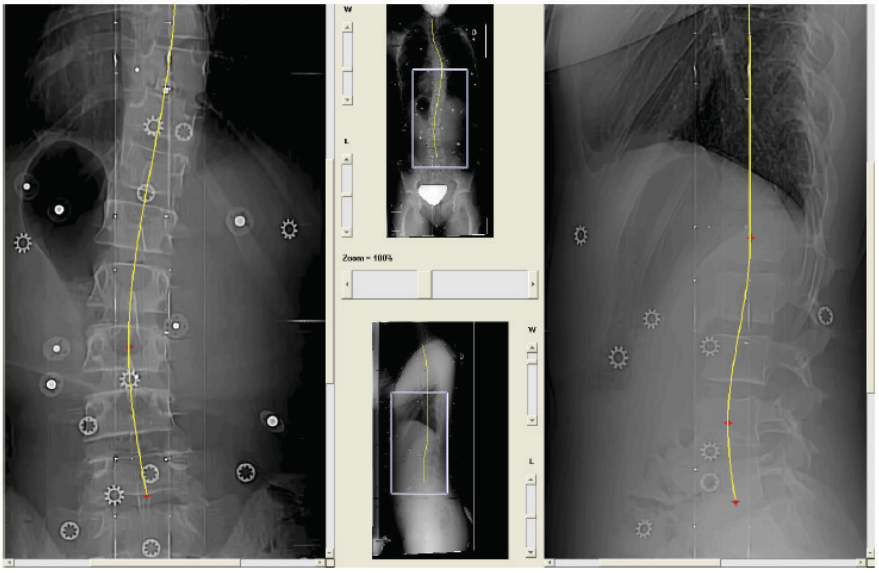

Figure 1 – Screenshot of the developed software tool.