

Fully Automatic Proximal Femur Segmentation in Pelvic Radiographs Using Random Forest Regression Voting

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WHY? Extraction of bone contours from radiographs plays an important role in diagnosis, pre-operative planning, and treatment analysis in diseases such as osteoarthritis or osteoporosis.

WHAT? We present a fully automatic method to fast and accurately segment the proximal femur in 2D pelvic radiographs by placing 65 landmarks points along its contour (see Fig.1).

HOW? A number of candidate positions are produced by a global search with a detector. Each is then refined using a statistical shape model together with local detectors for each model point. Both global and local models use Random Forest regression to vote for the optimal positions, leading to robust and accurate results. Runtime performance is optimised using convergence and confidence monitoring to avoid unnecessary search iterations.

RESULTS: The performance of the system is evaluated using cross-validation experiments on a set of 839 images of mixed quality. We show that the local search significantly outperforms a range of alternative matching techniques (see Fig.2), and that the fully automated system is able to achieve a mean point-to-curve error of less than 0.9mm for 99% of all 839 images (see Fig.3 & Fig.4). On average, it takes 30s to fully automatically segment the femur from an image.



Fig.1 Segmentation of the proximal femur using 65 landmarks (ground truth).

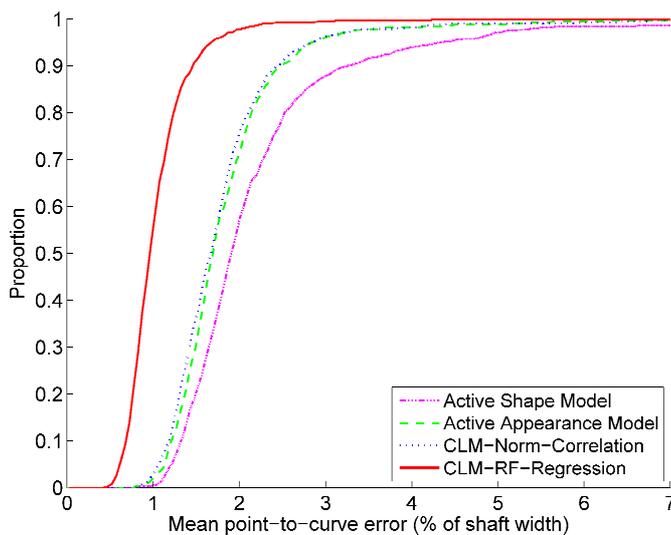


Fig.2 Local search results starting from mean shape at true pose. (The shaft width was estimated to be 37mm on average.)

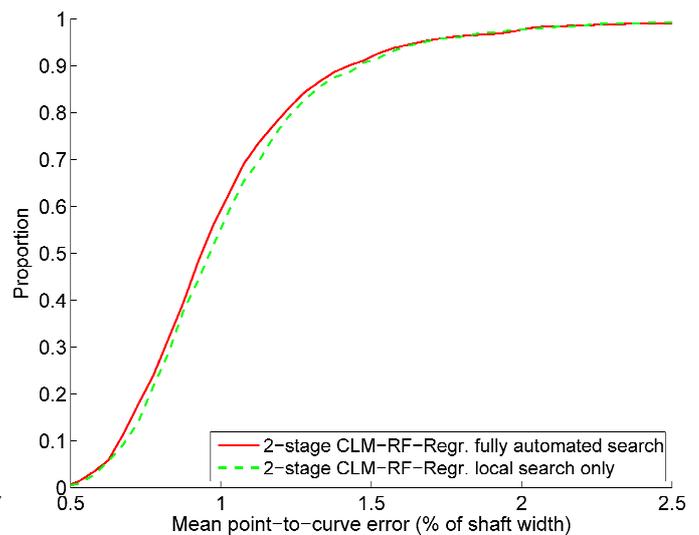


Fig.3 Fully automated search results compared to local search results. (The shaft width was estimated to be 37mm on average.)

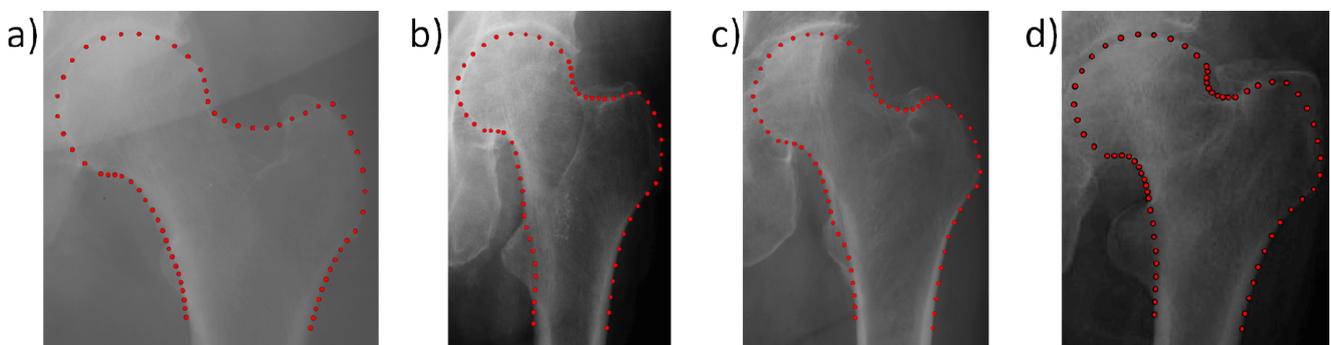


Fig.4 Segmentation examples of the fully automated system (sorted by the mean point-to-curve error percentiles, [] gives the mean point-to-curve error): (a) 50% [0.4mm]; (b) 91.2% [0.6mm], based on highest global search error; (c) 99.0% [0.9mm]; (d) 100% [2.7mm].

To the best of our knowledge, this is the most accurate fully automatic method for segmenting the proximal femur in pelvic radiographs yet reported.