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AUTOMATIC SEMANTIC PARSING OF CT SCANS VIA MULTIPLE RANDOMIZED DECISION TREES

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PURPOSE

We introduce a new, efficient algorithm for the automatic detection and localization of anatomical structures within 3D CT images.

Our algorithm builds upon recent randomized decision tree classifiers and produces accurate posterior probabilities for each of the classes (e.g. organ labels) in the training set. Accurate results are obtained by exploiting the high level of generalization offered by the classifier. Furthermore, its massive parallelism yields high computational efficiency.

METHOD AND MATERIALS

Multiple decision trees (different from one another) are trained on labelled data to detect and localize anatomical structures within 2D or 3D scans; independently of their resolution, cropping and other common transformations.

During testing the trees are applied to previously unseen images and the relevant anatomical structures automatically recognized and segmented.

3D spatial context is modelled by means of efficient visual features built upon integral volume processing. The output of our algorithm is probabilistic thus allowing uncertainty modelling as well as fusion of multiple sources of information.

Our algorithm does not necessitate the use of atlases, with all the issues that that entails.

RESULTS

A database of labelled CT images has been split into training and testing. Quantitative results have been reported on the testing subset only, to make sure the algorithm learns to generalize.

Excellent accuracy (localization accuracy of around 2 cm) has been observed in detecting organs such as liver, heart, kidneys, lungs, eyes, and head. Comparison with state of the art algorithms such as SVM and GMMs show superior performance for our technique.

CONCLUSION

We present a new algorithm for the automatic recognition of anatomical structures within CT scans.

Our technique has been shown to produce accurate results while avoiding issues typical of atlas-based techniques. The algorithm's parallel nature and the efficiency of its visual features account for its high computational efficiency. The shape and context information captured by our visual features together with the use of multiple trees account for the high level of accuracy.

CLINICAL RELEVANCE/APPLICATION

Our automated analysis allows radiologists to access optimal views of each organ at a click of a button, for greater productivity. Content-based image retrieval is also enabled by our technique.

FIGURE (OPTIONAL)

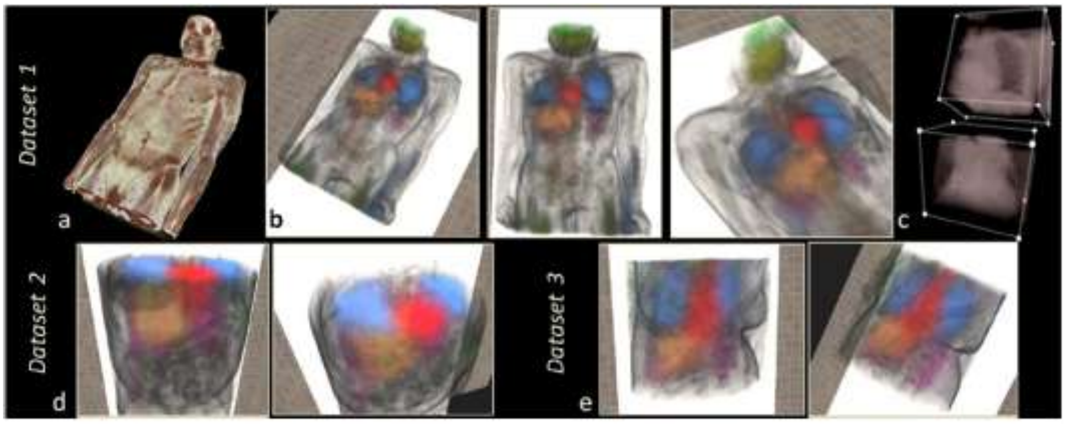

Figure **Results on automatic organ detection and localization.** (**a**) The original 3D CT data rendered using a manually-designed colour transfer function. (**b**) Three views of the 3D organ posterior probabilities computed by our algorithm for the localization problem. Different colours indicate different organs. Larger opacities indicate larger probability of a voxel being the organ centre. Notice how well eyes (green), head (yellow), heart, lungs, liver and even kidneys (purple) have been localized. A faint body outline here is shown to aid visualization. (**c**) 3D views of the automatically detected bounding boxes including the heart and left lung. (**d,e**) Results on two more test datasets. The different datasets (related to different patients) are cropped differently and have different resolutions.