Markov random field modeling in posteroanterior chest radiograph segmentation

PURPOSE: To develop an image processing algorithm to classify each pixel of a digitized posteroanterior chest radiograph (DCR) as belonging to one of six separate region-types: lung, subdiaphragm, heart, mediastinum, body, or background.

MATERIALS AND METHODS: Denote the set of pixel gray levels in a DCR as $\boldsymbol{y}$, and the set of pixel classifications as $\boldsymbol{x}$. The objective is to obtain the optimal segmentation $\boldsymbol{x}^{OPT}$ given the set of gray level values $\boldsymbol{y}$. A probabilistic approach is used that defines $\boldsymbol{x}^{OPT}$ as the segmentation $\boldsymbol{x}$ that maximizes the conditional distribution $P(\boldsymbol{x}|\boldsymbol{y})$. We model $\boldsymbol{x}$ as a spatially varying Markov random field (MRF) that incorporates spatial and textural information of each possible region-type. MRF modeling provides the form of $P(\boldsymbol{x}|\boldsymbol{y})$, and allows for the use of Iterated Conditional Modes to converge to the distribution maximum of $P(\boldsymbol{x}|\boldsymbol{y})$ thus obtaining the optimal segmentation of a given DCR.

RESULTS: The algorithm correctly classified on average 90.0%±3.4% of the pixels in a DCR as belonging to one of the six possible region-types. Additionally, each region-type was identified with an average accuracy greater than 95.0%.

CONCLUSION: The results suggest promise for the use of Markov random field modeling in DCR segmentation. Such an algorithm should prove useful for anatomically specific computer applications in chest radiography such as computer-aided diagnosis and image processing.