A shape prior-based MRF model for 3D masseter muscle segmentation

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Medical image segmentation is generally an ill-posed problem that can only be solved by incorporating prior knowledge. The ambiguities arise due to the presence of noise, weak edges, imaging artifacts, inhomogeneous interior and adjacent anatomical structures having similar intensity profile as the target structure. In this paper we propose a novel approach to segment the masseter muscle using the graph-cut incorporating additional 3D shape priors in CT datasets, which is robust to noise; artifacts; and shape deformations. The main contribution of this paper is in translating the 3D shape knowledge into both unary and pairwise potentials of the Markov Random Field (MRF). The segmentation task is casted as a Maximum-A-Posteriori (MAP) estimation of the MRF. Graph-cut is then used to obtain the global minimum which results in the segmentation of the masseter muscle. The method is tested on 21 CT datasets of the masseter muscle, which are noisy with almost all possessing mild to severe imaging artifacts such as high-density artifacts caused by e.g. the very common dental fillings and dental implants. We show that the proposed technique produces clinically acceptable results to the challenging problem of muscle segmentation, and further provide a quantitative and qualitative comparison with other methods. We statistically show that adding additional shape prior into both unary and pairwise potentials can increase the robustness of the proposed method in noisy datasets.
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