Threshold-Generated Markers for Visualization of Thyroid Nodules

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Hypothesis

We hypothesized that it would be possible to use a thresholding method to predict markers that highlight both hyper- and hypofunctioning thyroid nodules.

Introduction

Planar iodine-123 (I123) scans provide functional information that can complement anatomic information on ultrasounds showing thyroid nodules. They are often used as part of the work-up of clinical hyper- or hypothyroidism. Hyperfunctioning "hot" nodules are more metabolically/synthetically active than background normal thyroid tissue. Hypofunctioning "cold" nodules exhibit decreased synthetic function and are more concerning for malignancy. Subjective interpretation by radiologists involves judging regions within the thyroid gland that are denser than normal parenchyma to be hot nodules. Hypodense regions may be judged as cold nodules. Given that these lesions are sometimes subtle and may be missed on occasion, an automated second reader-like tool that highlights candidate hot and cold nodules would be a useful method for reducing false negatives.

Methods

We analyzed I-123 scans of 11 patients with expert consensus-judged hot nodules and another set of 11 patients with similarly-determined cold nodules. Our algorithm computes the scaled average count (pixel intensity) of 5 x 5 pixel "superpixels" and applies various threshold values above which the corresponding pixels are displayed in red for visual contrast.

Results

For each patient image analyzed, an appropriate threshold exists for which the expert consensus-drawn nodule region-of-interest (ROI) has nonzero overlap with algorithm-generated markers. Average distances between centers-of-mass of expert consensus and marker is computed to be roughly 1.5 cm, but this is felt to be adequate since the overlap of these ROIs is nonzero in all cases and ours is a qualitative tool which is meant to serve as a visual aid/second reader.
Discussion

Our method successfully highlights candidate hot and cold nodules. This approach can be used by a radiologist to aid in image interpretation by alerting to candidate nodules. Extensions to whole-body thyroid scans post-treatment for recurrence is one obvious extension for further work.

Conclusion

Using a threshold-based marker-generation we are able to localize and highlight candidate hot and cold thyroid nodules, in good agreement with expert consensus-drawn nodules.

References


Keywords

Thyroid Nodules, Automated, Threshold, Computer-Aided Detection