Comparing salience detection algorithms applied to mammograms

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Rationale

Salience in imaging is defined as the extent to which an object in an image catches the eye of the viewer. Currently, several software packages exist which calculate salience using a wide range of models and implementations. For example, in several of the models examined here, the software creates a series of maps for individual salience features like orientation and intensity, and then combines those individual feature maps into an overall map of salience for the entire picture. Differences exist between these models in the way feature maps are calculated, in the way they are integrated into a single map, and in the ways that various types of noise are minimized. Differences also exist in the use of mid-level and high-level features like horizon line detection and facial and person recognition software. In some algorithms, the extent to which any one feature affected the final salience map was dependent, through the use of covariance, on the other features. While in other algorithms, features contributed independently while in others they behaved additively or competitively. In yet other models, neural networks are used to create a series of layers, each of which transforms the data and finds the most salient points in an image. Those models focus on finding semantic objects, or objects defined by a set of attributes, as well as low-level features. In total, this paper compares 15 models, including our own algorithm, and compares the models' accuracies when applied to a common database of images. Additionally, previous work has shown a correlation between the salient points in a mammogram and presence of a mass, and the inverse relationship between salience and time-to-first detection of a mass by a human observer. Here we apply several state-of-the-art software packages to a database of mammograms and compare their accuracies in detecting masses in mammograms.

Methods

Each method was tested on a set of 322 mammograms to assess its capability to detect masses in breast tissue. Additionally, all models were tested against MIT's training set of images and eye-track data to verify previous results. To understand the significance of the results, we used the Kullback-Leibler divergence, Pearson correlation coefficient, and several other measures including area under the receiver operating characteristic curve (AUC) to compare the salience maps created by the software packages to a baseline map created by Gaussian smoothing of eye-track data.

Results

We will present the results of this work, rank the various algorithms, and comment on the ability of different salience approaches to be successful when identifying masses in mammograms. We found that software packages, which were most capable of detecting salience as defined by eye-tracking data, were capable of detecting masses.

Conclusions

The results of our study show that salience software can potentially be a useful tool when attempting to identify masses in breast tissue. In addition, the software studied here may also be expanded to video, allowing for salience detection of motion features in medical video.