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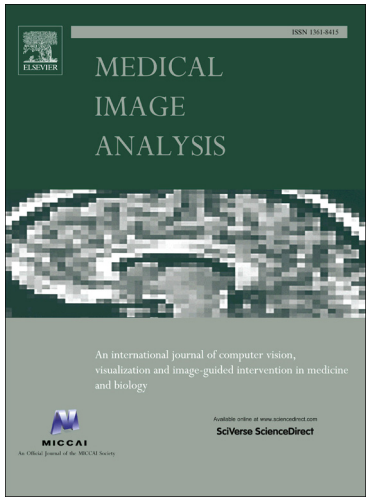

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On combining image-based and ontological semantic dissimilarities for medical image retrieval applications

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Abstract

Computer-assisted image retrieval applications can assist radiologists by identifying similar images in archives as a means to providing decision support. In the classical case, images are described using low-level features extracted from their contents, and an appropriate distance is used to find the best matches in the feature space. However, using low-level image features to fully capture the visual appearance of diseases is challenging and the semantic gap between these features and the high-level visual concepts in radiology may impair the system performance. To deal with this issue, the use of semantic terms to provide high-level descriptions of radiological image contents has recently been advocated. Nevertheless, most of the existing semantic image retrieval strategies are limited by two factors: they require manual annotation of the images using semantic terms and they ignore the intrinsic visual and semantic relationships between these annotations during the comparison of the images. Based on these considerations, we propose an image retrieval framework based on semantic features that relies on two main strategies: (1) automatic "soft" prediction of ontological terms that describe the image contents from multi-scale Riesz wavelets and (2) retrieval of similar images by evaluating the similarity between their annotations using a new term dissimilarity measure, which takes into account both image-based and ontological term relations. The combination of these strategies provides a means of accurately retrieving similar images in databases based on image annotations and can be considered as a potential solution to the semantic gap problem. We validated this approach in the context of the retrieval of liver lesions from computed tomographic (CT) images and annotated with semantic terms of the RadLex ontology. The relevance of the retrieval results was assessed using two protocols: evaluation relative to a dissimilarity reference standard defined for pairs of images on a 25-images dataset, and evaluation relative to the diagnoses of the retrieved images on a 72-images dataset. A normalized discounted cumulative gain (NDCG) score of more than 0.92 was obtained with the first protocol, while AUC scores of more than 0.77 were obtained with the second protocol. This automatical approach could provide real-time decision support to radiologists by showing them similar images with associated diagnoses and, where available, responses to therapies.

Keywords: Image retrieval, Riesz wavelets, image annotation, ontologies, image-based dissimilarities, semantic dissimilarities, vector distances, computed tomographic (CT) images, RadLex, liver lesions.

1. Introduction

Diagnostic radiologists need to maintain high interpretation accuracy while maximizing efficiency with increasing volumes of images. They are now confronted with the challenge of efficiently and accurately interpreting cross-sectional studies that often contain thousands of images (Rubin, 2000). Currently, this is largely an unassisted process (except for image visualization, volume measurement and for specific image analysis tasks such as lung nodule detection, mammography screening, etc.), and a radiologist's accuracy is established through training and experience. Despite this training, there is variation in interpretation among radiologists, and accuracy varies widely (Robinson,

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