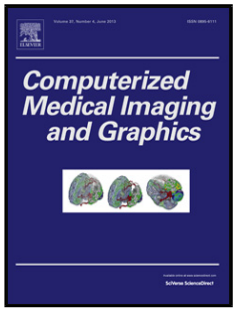

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Psoriasis Image Representation using Patch-based Dictionary Learning for Erythema Severity Scoring

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Abstract

Psoriasis is a chronic skin disease which can be life-threatening. Accurate severity scoring helps dermatologists to decide on the treatment. In this paper, we present a semi-supervised computer-aided system for automatic erythema severity scoring in psoriasis images. Firstly, the unsupervised stage includes a novel image representation method. We construct a dictionary, which is then used in the sparse representation for local feature extraction. To acquire the final image representation vector, an aggregation method is exploited over the local features. Secondly, the supervised phase is where various multi-class machine learning (ML) classifiers are trained for erythema severity scoring. Finally, we compare the proposed system with two popular unsupervised feature extractor methods, namely: bag of visual words model (BoVWs) and AlexNet pretrained model. Root mean square error (RMSE) and F1 score are used as performance measures for the learned dictionaries and the trained ML models, respectively. A psoriasis image set consisting of 676 images, is used in this study. Experimental results demonstrate that the use of the proposed procedure can provide a setup where erythema scoring is accurate and consistent. Also, it is revealed that dictionaries with large number of atoms and small patch sizes yield the best representative erythema severity features. Further, random forest (RF) outperforms other classifiers with F1 score 0.71, followed by support vector machine (SVM) and boosting with 0.66 and 0.64 scores, respectively. Furthermore, the conducted comparative studies confirm the effectiveness of the proposed approach with improvement of 9% and 12% over BoVWs and AlexNet based features, respectively.

Keywords: Psoriasis erythema severity scoring, computer-aided system, unsupervised dictionary learning, multi-class classifier, patch-based feature extraction, sparse representation

1. Introduction

Psoriasis is a common, chronic, and immune-mediated skin disease. Stated by National Psoriasis Foundation (NPF) [1], about 7.5 million people in the United States; approximately 2.2 percent of the population, have psoriasis. The most common form is plaque psoriasis, which appears as red patches covered with a silvery white build-up of dead skin cells [2]. There is no specific medical test for psoriasis [3]. A dermatologist usually makes visual examination by looking at the skin lesion. In some few cases, a physician examines a skin biopsy under a microscope to ascertain if the psoriasis skin looks thicker and inflamed when compared to the normal skin. There are different topical medication options to help control the disease, but it usually takes some time before the right treatment is found for an individual. Photo therapy is another treatment for advanced severe cases [4, 5].

Currently, psoriasis is assessed visually through a measure called "Psoriasis Area Severity Index (PASI)" [6]. Dermatologist scores PASI based on four measures: erythema (redness), thickness, scale, and area [7]. Each measure is scored in four different body regions: the head, trunk, upper- and lower-limbs. The intensity of erythema, scaling, and thickness are assessed as none (0), mild (1), moderate (2), severe (3) or very severe (4), as shown in Figure 1. The percentage area affected by psoriasis is expressed to be either nil (0), 1-9% (1), 10-29% (2), 30-49% (3), 50-69% (4), 70-89% (5) or 90-100% (6). The scores from the four regions are weighted and summed to give the final PASI score,

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