Multi-spectral recordings and analysis of psoriasis lesions

Line H. Clemmensen
Informatics and Mathematical Modelling
Technical University of Denmark
Email: lhc@imm.dtu.dk

Bjarne K. Ersbøll
Informatics and Mathematical Modelling
Technical University of Denmark
Email: be@imm.dtu.dk

Abstract

An objective method to evaluate the severity of psoriasis lesions is proposed.

Introduction

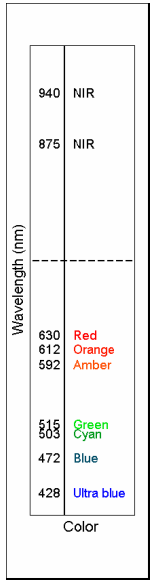
Psoriasis is a disorder of excessive growth and reproduction of skin cells which may be caused by a immune-mediated disorder, see fig. B.1. The lesions caused by the excessive skin growth are red and often inflammatory. 1/3 of people with psoriasis report a family history of the disease. It affects both sexes and can occur at any age. The prevalence is estimated at 2-3% of Western populations.

The diagnosis of the severity of the psoriasis is important with regards to choice of treatment.
A diagnosis cannot be performed by blood tests and the standard is to perform a visual diagnosis which requires trained staff. In some cases a biopsy is performed in order to rule out other disorders.
An objective method for diagnosis would be less time consuming and less expensive. In addition to this, inter-observer variability can be avoided.

In order to obtain objectivity, multi-spectral digital imaging was used with 9 spectral bands; 2 in the NIR range, and 5 in the visible range; cf. fig. A.1. The very accurate camera used is a Videometer Lab[3]; cf.fig.B.2.

Multi-spectral bands

A.1 The wavelengths and colors of the 9 spectral bands



Example of lesion and camera

B.1 Psoriasis lesion on hands

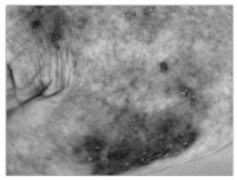
B.2 Videometer Lab

The psoriasis lesions are evaluated by trained staff according to PASI (psoriasis area and severity index)[1]. Erythema is the redness of the skin caused by dilatation and congestion of the capillaries. This is often a sign of inflammation or infection. Infiltration refers to the thickness of the psoriasis lesion. They are evaluated on a scale from 0 (none) to 4 (maximum).

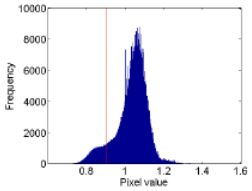
ROI based on inflammation

C.1 RGB

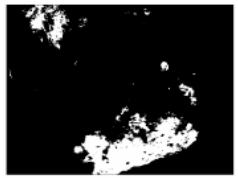
C.2 Amber -/ Red



C.3 Histogram of C.2



C.4 Inflammation ROI

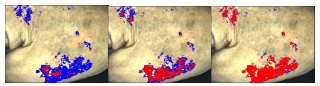


Method

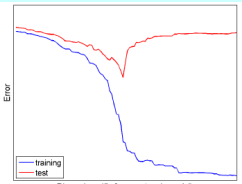
A region of interest (ROI) was computed for each image, cf. fig. C.1-C.4, based on the pairwise ratio between the amber and red spectral bands which enhance the areas with inflammation. To sum up the information in the images, the 1st, 5th, 10th, 30th, 50th, 70th, 90th, 95th, and 99th percentiles were extracted from the ROI of each spectral image as well as each pairwise differences and ratios between spectral images, cf. fig. D.1. There were 3 patients; and 2 lesions were imaged for each. Two to five images were acquired of each lesion area. In total: 1458 features *(p*=1458*)*, and 20 observations *(n*=20*)*.
In order not to over fit the samples in training data, cf. fig.D.2 , a dimension reduction was required. Furthermore, selection of a few features improves the interpretability. The LARS-EN (Least Angle Regression Selection - Elastic Net)[2] method was used to obtain linear models including only few of the features, more precisely two features for each of the two severity indices: Erythema and infiltration.

Percentile features and large *p*, small *n* problem

D.1 10th, 50th, and 90th percentiles for one of the spectral images. The red color illustrates the pixels which have values smaller than the given percentile, and the blue color illustrates the ROI.

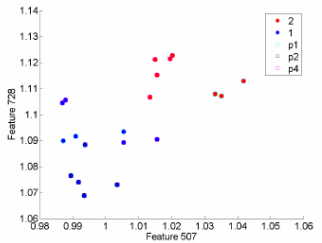


D.2 Large *p*, small *n* problem



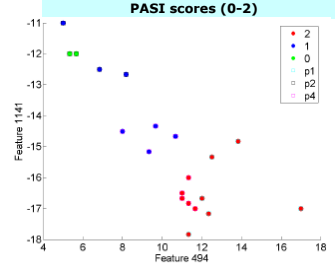
Classification results

E.1 Erythema. The colors represent the PASI scores (1-2)



Feature	Description
507	10th percentile of the inflammation ROI in the ratio of the blue (472 nm) and green (515 nm) bands
728	95th percentile of the inflammation ROI in the ratio of the cyan (503 nm) and green (515 nm) bands

E.2 Infiltration. The colors represent the PASI scores (0-2)



Feature	Description
494	95th percentile of the inflammation ROI in the difference of the blue (472 nm) and green (515 nm) bands
1141	90th percentile of the inflammation ROI in the difference between the amber (592 nm) and red (630 nm) bands

Conclusions

An objective method to evaluate the severity of psoriasis lesions was proposed. Segmentation of ROIs of inflammation in multi-spectral images of psoriasis lesions was illustrated. Features that describe the severity of the lesions were calculated and selected; see fig. E.1 and E.2.
The results were promising as only two variables selected via the elastic net give models with good ordering of the severity indices: Erythema and infiltration; see fig. E.1 and E.2. Future research involves: A larger data set with larger variance in severity scores, and a scale severity index should be included as well as a psoriasis area index.

Thanks to:
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References

1. Frederiksson and Petterson, Dermatologica **157**: 283-44 (1978)
2. Zou et al, J. R. Stat. Soc. B **67**(Part 2): 301-320 (2005)
3. Videometer A/S: www.videometer.com.

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