Morphological features extraction from multispectral skin images in cosmetology

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Keywords

In-vivo multispectral skin imaging, image normalisation, dimensionality reduction, morphological texture, LIP model.

Introduction

Classically used in dermatology, multispectral in-vivo imaging of skin is nowadays applied in cosmetology to precisely characterize skin visual aspect. The main purpose is to analyse both colour and texture of the skin with a quantitative and reproducible tool and thus be able to model and to predict the effect of cosmetic products, such as foundation make-up or anti-aging lotion. Some inherent difficulties of in-vivo imaging are the great variability of the data, the device stabilisation and repositioning, etc. Moreover, multispectral imaging often requires dealing with a high redundancy level of the data.

Materials and Methods

We achieved a study of the effect of a foundation make-up on skin based on multispectral imaging. A panel of 31 people applied the product to one half of the face. Measurements were taken on both left and right cheek, with time tracking of the product degradation. The acquisition device used was the ASCLEPIOS system. It has been developed by the Le2i Laboratory (France) and it acquires a multispectral reflectance cube of skin surface between 450nm and 850nm, with a spatial resolution of 913ppi (360px/cm).

To exploit these cubes, several preprocessing steps were necessary. We designed a LIP-based artefact removing algorithm and a classical lightning correction technique. Then, thanks to a morphological filter, a texture enhancement of the spectral images is obtained.

Dimensionality reduction of preprocessed images into a common space of representation is then done. This space is defined by the principal component analysis (PCA) of the average covariance matrix from the different multispectral images. Using the eigenimages of this reduced space, a multispectral texture description is computed by means of the granulometry and the covariogram on the most significant PCA axes.

These morphological texture descriptors are used to predict the make-up effect using supervised machine-learning techniques, in particular logistic regression and SVM.

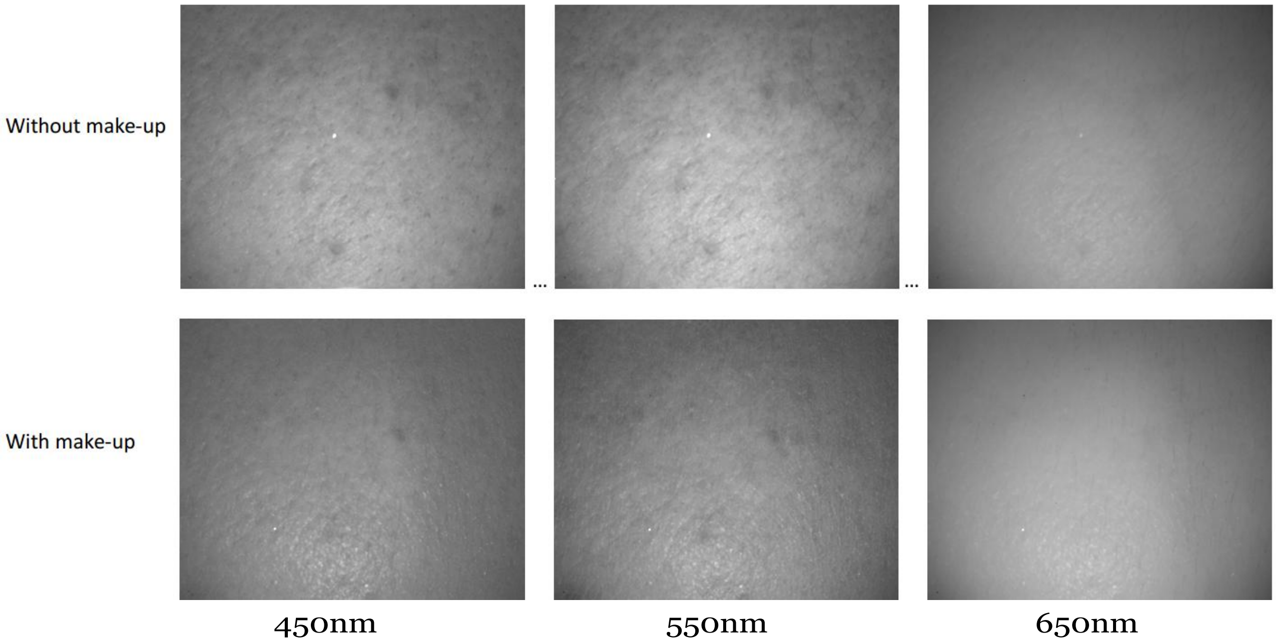

Figure 1. Raw spectral images with and without make-up

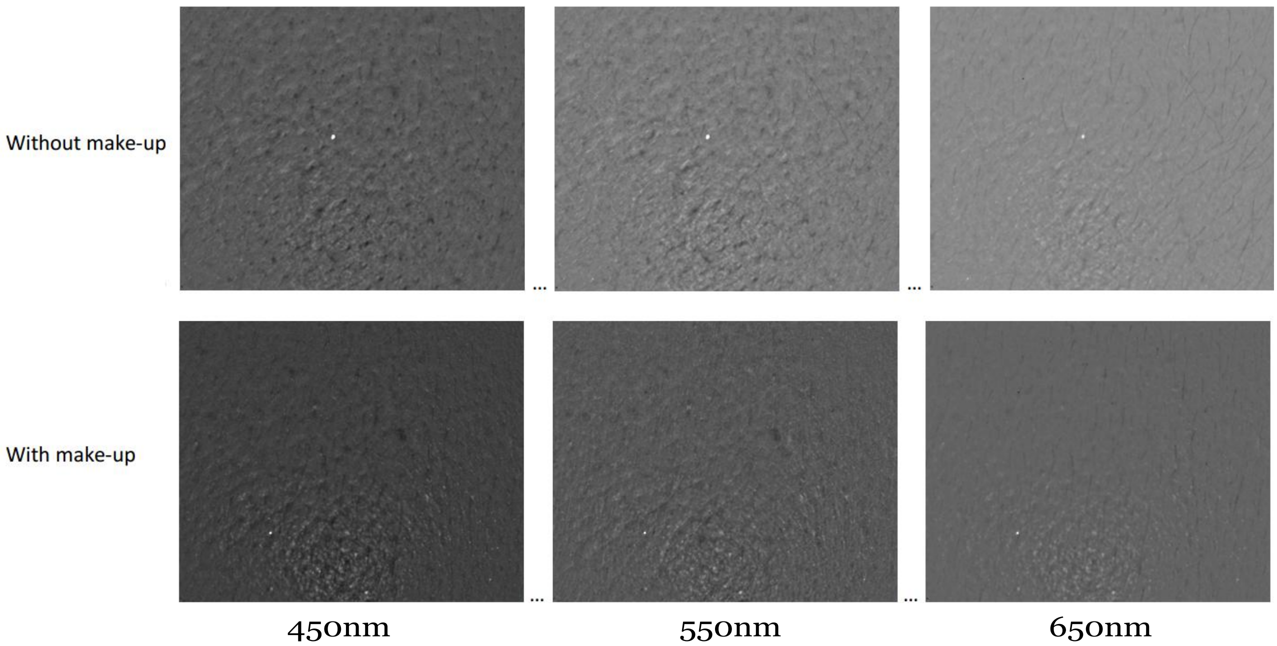

Figure 2. Pre-processed spectral images with and without make-up

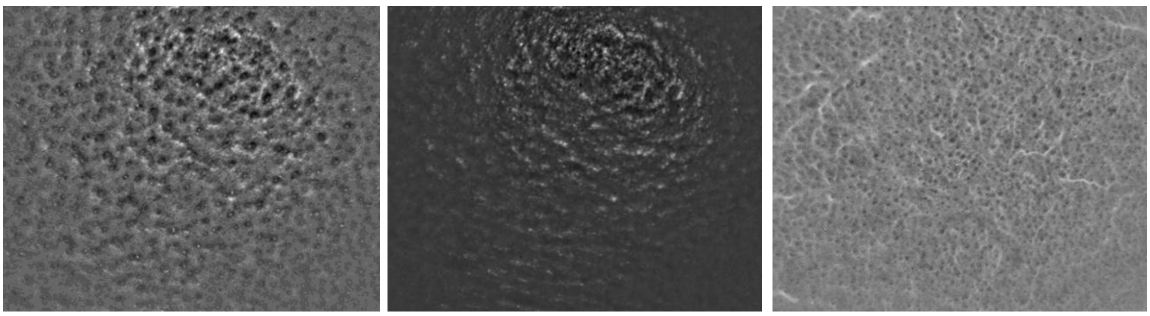

Figure 3. 3 Significant PCA axes (pores, radiance, vessels)

Results and Discussion

The different preprocessing steps allow a good stabilization of the images which is essential to perform the PCA on a barycentre covariance matrix. Most significant PCA axis generated in this way enhance different skin component (pores, radiance, vessels…).

Some texture data from these PCA axes are correlated to the ground truth, hence we can predict their value with or without make-up. Best parameters even allow following the evolution in time of the make-up. For those parameters, we had encouraging prediction score.

Conclusion

The obtained score of prediction validates our pre-processing and dimensionality reduction methods. We are able to describe the effect of foundation make-up on skin using multispectral imaging system. In order to address other problems in cosmetology related to multispectral texture, additional preprocessing should be considered. In particular, one of the skin components that influences texture description is the hairiness. Unfortunately, this component which appears on several PCA axes, is very variable from a person to another and would require more complex algorithms.

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