Quantitative Discrimination of AFM Images of Human Hair from Different Ethnic Groups: African, Caucasian and Oriental

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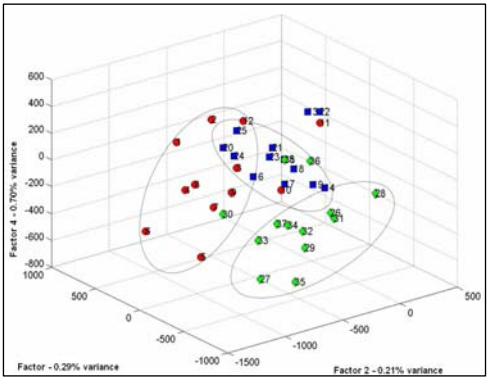
Purpose. The human hair is a complex tissue consisting of several morphological components. The physical integrity of the fiber and the major physical and chemical characteristics are determined mainly by the three most important constituint acting together: cuticles, cortex and intercellular componentes. The ethnic aspects of human hair are resulting from the differences in the constitution of theses three components, and they are reflected in the characteristical aspect of the fiber surface[1]. Quantitative methods to identify and classify such characteriscs could be very useful to cosmetic science, forensic investigations and medical diagnosis.

Method. This work presents a quantitative method to discriminate images of human hair fibers from three ethnic groups: african, caucasian and oriental, based on the utilization of a multi-way partial least squares (NPLS[2]) technique. The samples were colected from the root end area, where the fibers are yonger and most preserved from effects of combing, weathering and cosmetic action. Samples of human hair were obtained from De Meo Brothers, New York, USA. Atomic Force Microscopy (AFM) images were obtained using a Digital Instruments NanoScope IIa instrument, under atmospheric conditions at 25°C and a loading force of 3.6nN.



Results. The data set consists of a 3D array **X** (38 x 256 x 256) where the 38 pixels images (256 x 256) are superimposed, and a bidimensional array $\mathbf{Y}_{ij}$ (38 x 3), where y_{i1} = caucasian fiber, y_{i2} = african fiber, y_{i3} = oriental fiber. Discreet categorical values of 0 and 1 were attributed to each column, in which 0 = samples that don´t belong to that category and 1 = means the opposite. The **X** array was submitted to a logarithmic transformation[3] and it was modeled using NPLS. The best results were obtained without any further preprocessing and 4 latent variables were necessary to describe 88,21% on the total variance of the **X** block and 66,29% on the total variance of the **Y** block. Figure 1 presents the distribution of samples in the LV1 x LV2 x LV3 loading plot, where (○) african, (□) caucasian and (◊) oriental. The hair fibers surface are quite irregular and present very heterogeneous aspects as intrinsic characteristic. The samples are well clustered in specific areas although a few of them occupy the intermediary regions.

Conclusions. The Discriminant NPLS model allowed to discriminate the 3 classes of samples with success, and it can be used succesfully for classification and discrimination of *greyscale* images.

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