PhD School of Agri-Food Sciences, Technologies and Biotechnologies
XXXI Cycle
II Year

Development of chemometric methods for fast and non-destructive characterization of complex food matrices:

Graphical User Interface for the standardization of RGB images

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INTRODUCTION

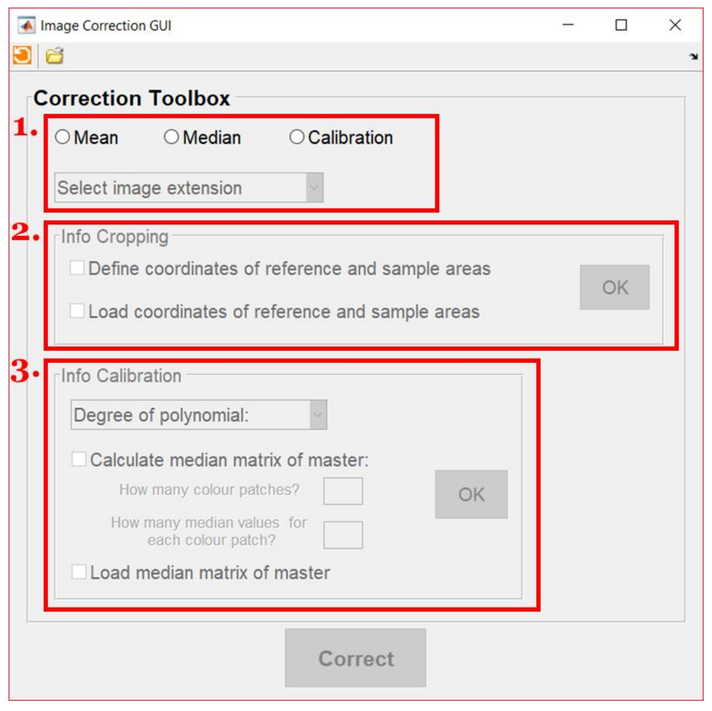
One of the main issues in dealing with digital images results from variations due to instrumental instability or differences in lighting conditions. Therefore, the reduction of these effects is of fundamental importance, since it allows to work with merged images or to apply models calculated on a dataset of images to the others, as well as to transfer a technology developed at a laboratory scale to industrial applications. To this aim, a Graphical User Interface (GUI) has been developed to reduce the extent of undesired variations between RGB images. The GUI, named "Image_correctionGUI", has been designed in order to facilitate the image standardization procedure, including in the same interface the possibility to test different correction methods and then to choose the proper one, according to the problem under consideration.

SOFTWARE PRESENTATION

The GUI written in Matlab language includes three algorithms for the standardization of images:
- "**Mean**" and "**Median**" are basic correction methods useful to quickly reduce slight differences between the images;
- "**Calibration**" is an advanced correction method suitable to standardize the images by computing the appropriate regression model, verified case-by-case. This correction method is derived from an approach that was previously developed for the elaboration of hyperspectral images [1].

All the three methods are based on the following procedure: an image is chosen as "master" image, then each other "slave" image is corrected by comparing the RGB values of standard colour references included in the image scene.
The main window of the GUI has been subdivided in three subsequent sections, reflecting the operating procedure required for computing each one of the correction method:

1. choose the correction method and the image file format;
2. crop the images according to the reference and sample areas;
3. define the information needed for calculating the regression model (section enabled only for the calibration correction method).

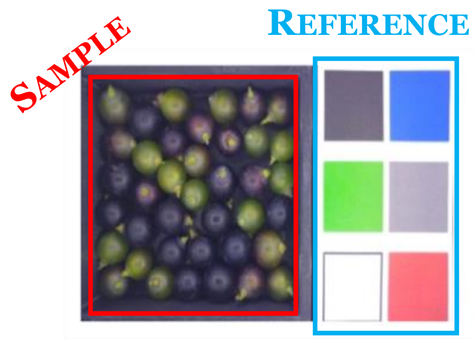


CASE STUDY

The "image_correctionGUI" has been tested on a case study concerning the on-field estimation of grape phenolic ripening by means of a smartphone.
In this study, two different grape varieties were considered:

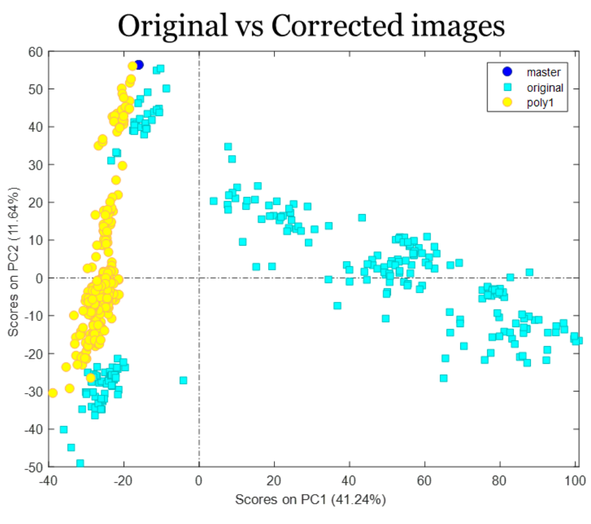
- Ancellotta - grape samples were collected during 7 subsequent harvest times from 05/08 to 14/09/2016;
- Salamino - grape samples were collected during 8 subsequent harvest times from 05/08 to 22/09/2016.

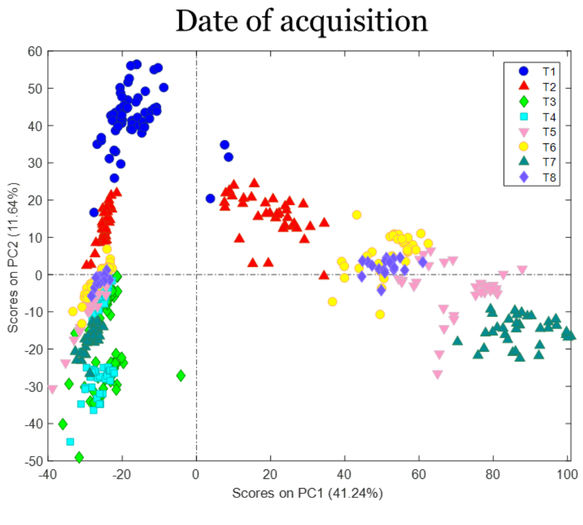
270 images (= 126 for Ancellotta + 144 for Salamino) were acquired using a smartphone mounted on a box and the lighting system consisted in a strip of white light-emitting diode lamps.
A colour reference was included in the image scene for the image standardization.
The extraction of the relevant information from each RGB image was performed with the *colourgrams* approach, which allows to convert each RGB image into a one-dimensional signal including all its colour-related information [2].



Stability evaluation of the image acquisition system:

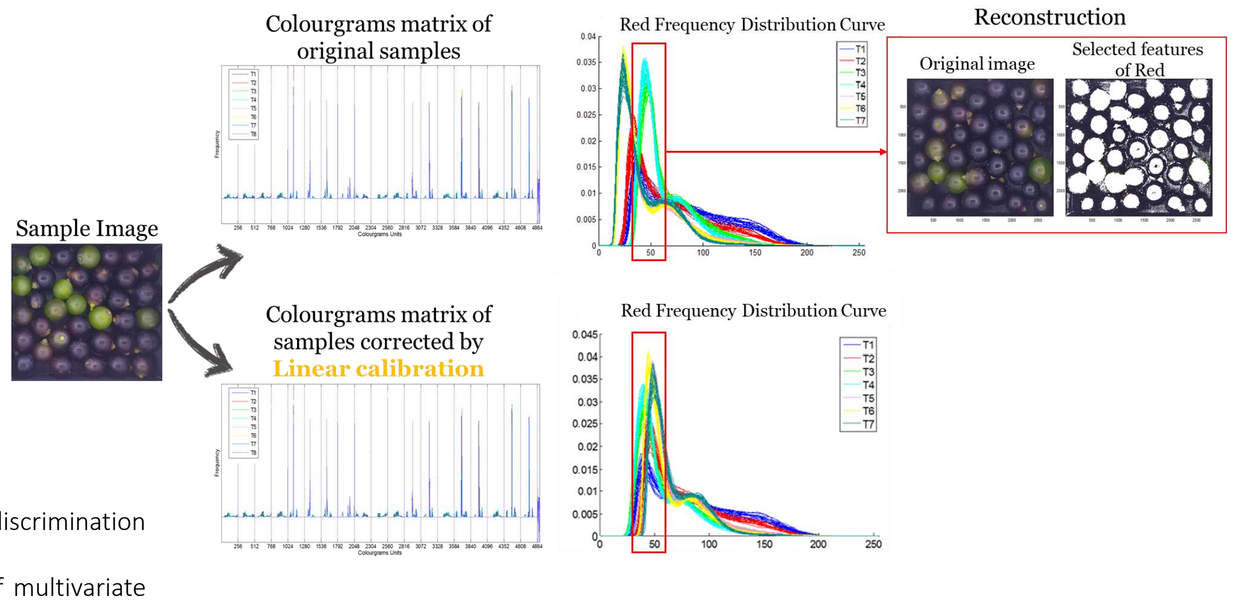
In the PC1 vs PC2 score plot, the original references were clustered according to the date of acquisition.
The application of a linear calibration model has been essential to reduce differences between the reference images due to the variation of lighting conditions.





Analysis of sample images:

The colourgrams matrix of original samples shows a poor overlap between the peaks of the signals acquired at T3-T4 and the other harvest times. By reconstructing the areas of the peaks in the original domain of the RGB image, it was possible to verify that these variables correspond to the darker pixels of the background of the box. Actually, the peaks should be perfectly overlapped.
The colourgrams of the corrected images shows a better overlap between the peaks.



REFERENCES

[1] A. Ulrici, S. Serranti, C. Ferrari, D. Cesare, G. Foca, G. Bonifazi, Efficient chemometric strategies for PET-PLA discrimination in recycling plants using hyperspectral imaging, Chemom. Intell. Lab. Syst. 122 (2013) 31–39.
[2] G. Orlandi, R. Calvini, G. Foca, A. Ulrici, Automated quantification of defective maize kernels by means of multivariate image analysis, Food Control (Article in press).