The combination of optical microscopy and SEM may improve their analytical capacity. However, the registration of optical and SEM images consists of a complex task, it requires corrections of translation, rotation, and non-linear and local distortions. Gomes & Paciornik [1] developed a method for this purpose that employs a standard sample for calibration. However, although this method is effective, it is not practical.

This work presents a new registration method to automatically combine image sets from optical microscope and SEM without the need of a calibration step. It was compared with different registration methods present in the literature. A set of 81 pairs of images from an iron ore sample was used for tests. The correlation coefficient was employed to evaluate the quality of registration.

The proposed method involves three stages. First, each pair of images is aligned, through cross-correlation, and then cropped to have the same size. Following, the images from SEM are registered using a transformation computed by Local Weighted Mean (LWM) [2]. At final, all images are cropped in order to represent the same field.

All image pairs are used to obtain the control points that define the transformation. They are partitioned in small sub-images, and the moments of translation of each pair are measured, determining control points covering the whole field.

Figure 1 presents the correlation coefficient for the 81 image pairs measured from (i) the acquired images; and the images registered by (ii) the method with calibration [1], (iii) SIFT [3] and Affine [4], and (iv) the new automatic method. Figure 2 shows the same results and the results obtained for the registration with bUnwarpJ [5], using a different scaling to compare them.

The lower results obtained for the original images and for the registration with Affine evidence the need of more complex transformations than a simple alignment or even rigid-body ones. The bUnwarpJ method achieved high results for most image pairs. However, it showed up unstable, it distorted much many images, making them practically unrecognizable.

The results for the registration with calibration and for the new automatic method were similar. In fact, the new method, besides more practical, was capable of providing the best registration results.

References

Acknowledgement: The authors acknowledge the support of Brazilian funding agencies CNPq, CAPES and FAPERJ.
Fig. 1: Correlation coefficient measured from the acquired images; and the images registered by the method with calibration; SIFT and Affine; and the new automatic method.

Fig. 2: Correlation coefficient measured from the acquired images; and the images registered by the method with calibration; SIFT and Affine; the new automatic method; and bUnwarpJ.