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IT-16-P-3434 Super-Resolution applied to Magnetite boundaries images

Bárcena G.[1], Guerrero M.[1], Guerrero E.[1], Kepaptsoglou2 D.[2], Gilks D.[3], Lari L.[3], Lazarov V. K.[3], Galindo P. L.[1]

[1]Department of Computer Science and Engineering, Universidad de Cádiz, 11510 Puerto Real, Spain, [2]SuperSTEM Laboratory, STFC Daresbury Campus, Warrington, WA4 4AD, United Kingdom, [3]Department of Physics, University of York, Heslington, York, United Kingdom

Email of the presenting author: guillermo.barcena@uca.es

High-Angle Annular Dark-Field (HAADF) imaging is a useful tool to understand the nature of the interaction between different materials domain boundaries, but one must overcome the limitations imposed by the characteristics of the microscope that directly affects resolution. An approach to face this problem is to deal with super-resolution techniques. These techniques attempt to obtain high-resolution images from several observed low-resolution images captured from the same scene, thus the resolution of an image can be improved by bringing out details that might otherwise not be seen.
In this work we illustrate the application of super-resolution techniques to a series of 10 low resolution HAADF images of Magnetite (Fe3O4), oriented along the 001 direction.
Since classical super-resolution reconstruction programs running on a standard computer may take up to 6 hours to get the results, a specialized software suite running in GPUs [1] has been developed to speed up this process, and now results can be obtained just in 10 minutes.

Figure 1 show an experimental low resolution image of Magnetite where the presence of noise is noticeable. Three atoms of Fe have been marked in figure 1 and the corresponding intensity profile is plotted in figure 2, but just two intensity peaks can be appreciated.
In the super-resolution approach two steps are applied: alignment and reconstruction. In this work the alignment process is carried out by filtering the image with a Gaussian filter and then applying the Vandewalle’s modification [4]. Then, a variant of the Non Local Mean algorithm [2,3] is used in order to obtain a high-resolution image, where noise has been substantially reduced, so that the three atoms of Fe can be clearly identified, as shown in figure 3. This fact is made apparent in the corresponding intensity profile shown in figure 4.
These results indicate that super-resolution techniques can provide enhanced HAADF images in terms of resolution, quality and details definition.

[1] Bárcena-González, G. M. Sc. Thesis. Study and application of Superresolution's algorithms in electron microscopy images. October, 2013

[2] Binev, P., Blanco-Silva, et al (2012). High-quality image formation by nonlocal means applied to high-angle annular dark-field scanning transmission electron microscopy (HAADF–STEM). Modeling Nanoscale Imaging in Electron Microscopy, 127-145.

[3] Buades, A., Coll, B., & Morel, J. (2005). A non-local algorithm for image denoising. Computer Vision and Pattern Recognition, 2005. CVPR 2005. IEEE Computer Society Conference on, 2 60-65.

[4] Vandewalle, P. et al (2004). Double resolution from a set of aliased images. Proc. SPIE 5301, Sensors and Camera Systems for Scientific, Industrial, and Digital Photography Applications V, 374

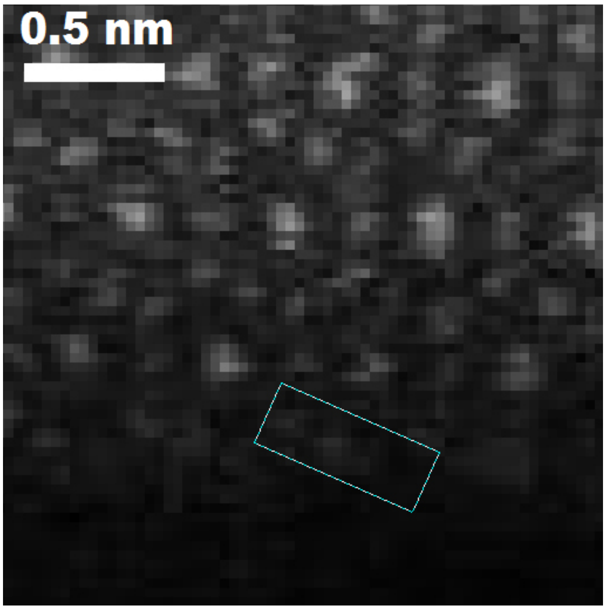

Fig. 1: An experimental low resolution image of Magnetite, three atoms of Fe has been marked with a red circle. The presence of noise is noticeable, in fact, just two atoms can be clearly appreciated.

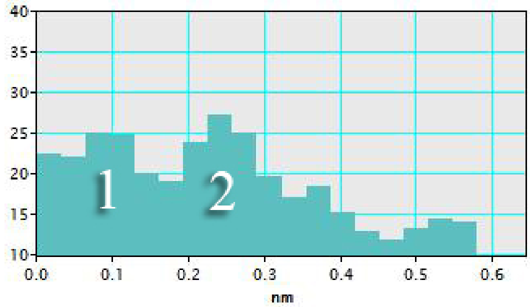

Fig. 2: Intensity profile corresponding to the marked area in figure 1, Two of the three intensity peaks can be observed.

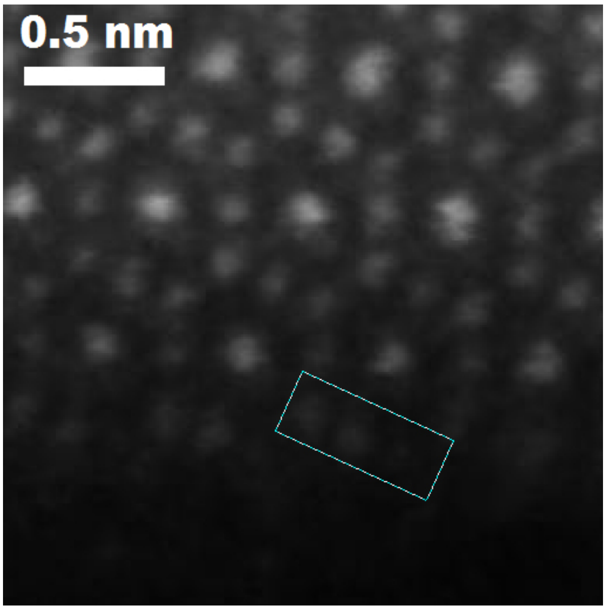

Fig. 3: High-resolution image obtained by super-resolution techniques, noise has been substantially reduced, so that the three atoms of Fe marked with a red circle can be clearly observed.

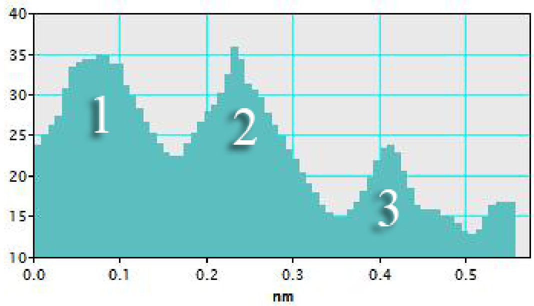

Fig. 4: Intensity profile corresponding to the marked area in figure 3. The three atoms of Fe can be clearly identified.