Analysing with PSD the images of an experiment

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Abstract

The aim of this document is to provide a description of the creation of the Power Spectral Density (PSD) from a real experimental image. This tool is essential for the image processing and latter evaluation, as well as for the posterior simulations.
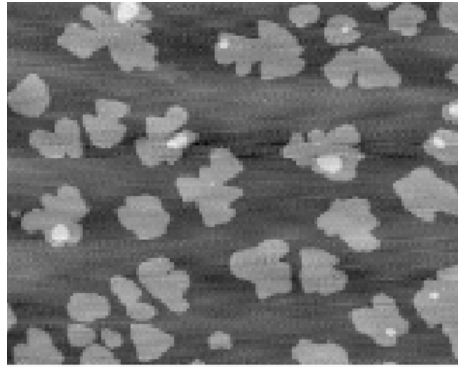
Figure 1: original experiment image

Power Spectral Density (PSD) [4, 3, 2] is a tool to evaluate the structure of a figure.

We have structured the document in two main sections that are coming next; the "Experiments", doing different PSD analysis of the original Figure 1 image, and the "Conclusions".

Contents

1 Experiments

1.1 All the islands together (OuterTogether)

We selected an image (Figure 2a) from an experiment [1] to evaluate the tool of PSD. The image has 500×500 pixels. The tool of segmentation has been applied to the original image. The output of this segmentation is a matrix of the same size, which its values are either -1 (the surface) or 0 (the island). Before creating the PSD the sampled surface is modified from the original -1, 0 values, to tents. This latter matrix has been used to create the PSD (Figure 2b).
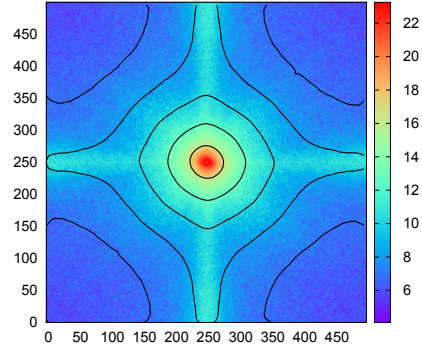

(a) The sampled surface.   (b) Corresponding PSD.

1.2 All the island minus the border ones (InnerTogether)

In this second case we have eliminated the islands that they were touching the borders (Figure 3a), we want to evaluate only the islands that are complete. The resulting PSD (Figure 3b) has roughly the same shape, but clearly, are not the same.


(a) The sampled surface.   (b) Corresponding PSD.

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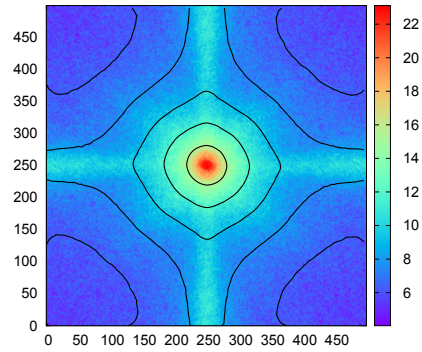
1.3 All the islands isolated (OuterIsolated)

We have also analysed one by one all the islands and do an average PSD of all of them (Figure 4a). We have placed the island in the middle of a figure of 130 × 130 pixels matrix, assuming the rest is the surface. In this case, the PSD is different from the previous two ones. This might suggest that the islands are different each from the others, and they might not have the same properties. This is also supported by the fact that visually islands look different (Figure 4a).

(a) The sampled surfaces, 45 islands in total.

(b) Corresponding PSD.
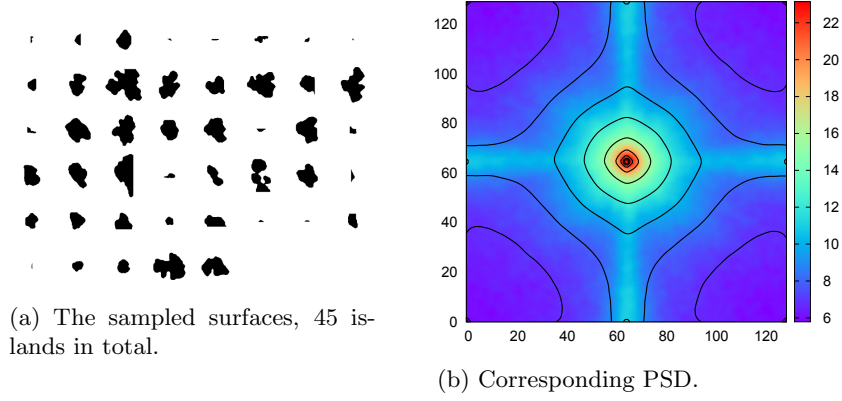
1.4 Inner islands isolated (InnerIsolated)

For this analysis we have selected again all the islands individually, but, we have excluded the islands that they are touching the border. Therefore, we have done a PSD analysis of 26 images of size 130 × 130. The current averaged PSD (Figure 5b) has a similar shape of the previous Figure 4b one, yet different. Nevertheless, this similarity supports the idea that the different islands grow in the same manner all over the surface.

(a) The sampled surfaces, 26 islands in total.

(b) Corresponding PSD.

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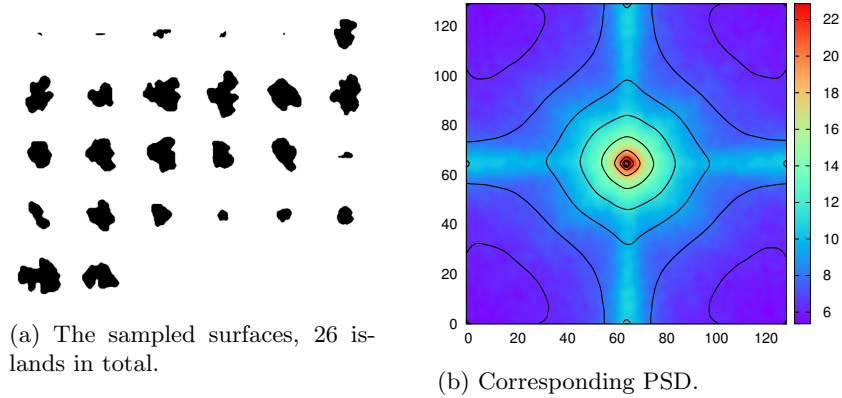
1.5 Comparison of large and small input images (Outer-TogetherSmall and InnerTogetherSmall)

In this section we will compare the PSD of the original 500×500 pixels input image with the scaled 130×130 image. We can see in Figures 6 and 7 that the small PSD differs significantly from the original one in both cases. This fact makes complicate to compare PSD from different input sizes.
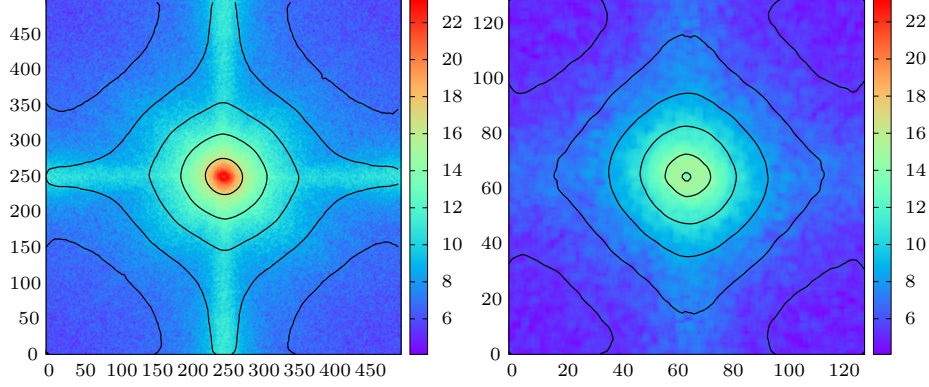

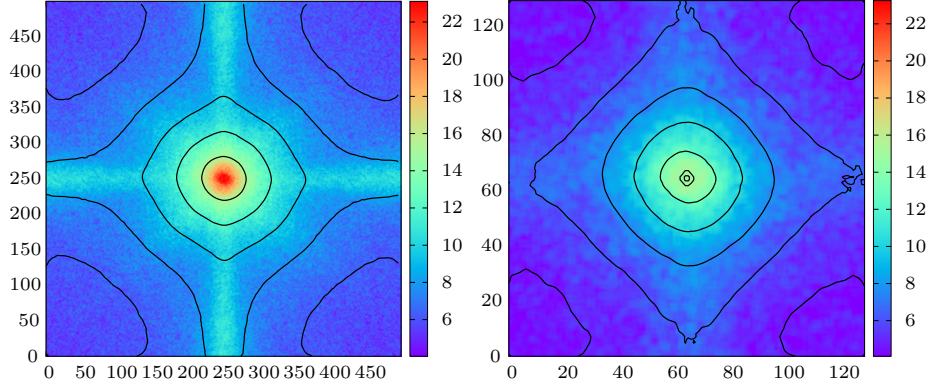Figure 6: The same PSD: left the original 500×500 pixel; right, scaled to 130×130 pixels.

Figure 7: The same PSD: left the original 500×500 pixel; right, scaled to 130×130 pixels.

1.6 (OuterIsolatedLarge and InnerIsolatedLarge)

For the individual islands analysis, we have included them into a bigger empty area of 500×500 (the same as the original image size). In Figure 8 we can see that both PSDs look pretty similar, and the difference does not have any patron.
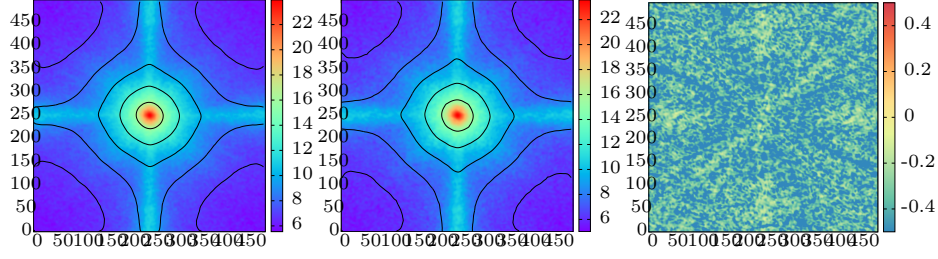
Figure 8: Left: PSD of all the island of size 500 × 500. Center: excluded the border ones. Right: difference between two PSDs.

In Figure 9 we compare isolated islands with the complete image. They are equivalent.
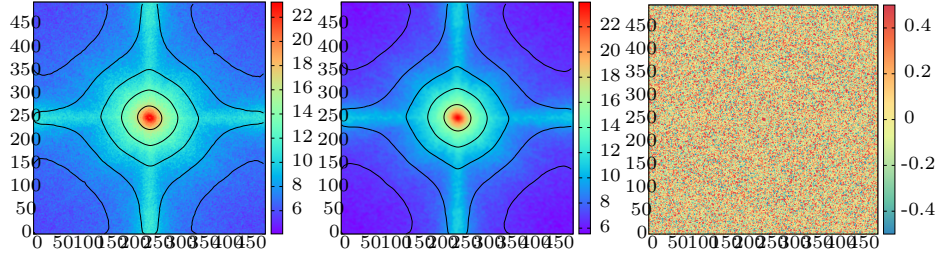

Figure 9: Left: PSD of all the island of size 500 × 500. Center: excluded the border ones. Right: difference between two PSDs.

In Figure 10 we compare isolated islands with the complete image, excluding the islands that touch the border. They are equivalent.
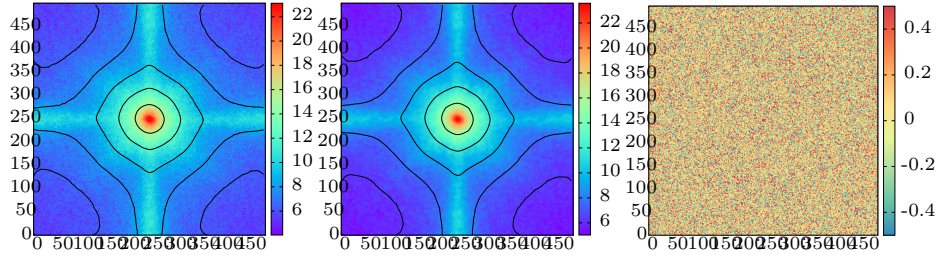

Figure 10: Left: PSD of all the island of size 500 × 500. Center: excluded the border ones. Right: difference between two PSDs.

2   Conclusions

The PSD is an essential tool for the evaluation of the islands characteristics. It is the best way to get an unequivocal measurement on random islands. Here, we provide an analysis of a example image. We evaluate it in a global manner; first, we have completely analysed the image. Second, we have excluded the border islands, which have different shape (due to image cut). Both present

equivalent results. Then, we have analysed individually all the islands and we have done an average PSD of all them, which were placed in a region of 130×130 pixels instead of the original 500×500 pixels. We see that including or not the border islands makes no differences, but we realised that we could not use this PSDs for the comparison with the complete ones; we loose information if we decrease the original image size to 130 pixels, and it is not feasible to compare two PSDs of different sizes. So, we have placed the isolated island in a region of 500×500 pixels. With this new comparison we have seen that all the PSDs are equivalent.

As a main conclusion we can say that whatever is the configuration we choose to do the PSD (complete image/individual islands and including or not the border islands) the results will be the same, as long as we keep the image size as big as possible.

Acknowledgements

References

[1] Erik Cox, Maozhi Li, Po-Wen Chung, C Ghosh, TS Rahman, Cynthia J Jenks, James W Evans, and Patricia A Thiel. Temperature dependence of island growth shapes during submonolayer deposition of ag on ag (111). *Physical Review B*, 71(11):115414, 2005.

[2] Árpád Czifra. Sensitivity of power spectral density (psd) analysis for measuring conditions. In *Towards Intelligent Engineering and Information Technology*, pages 505–517. Springer, 2009.

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[4] BNJ Persson, O Albohr, Ugo Tartaglino, AI Volokitin, and Erio Tosatti. On the nature of surface roughness with application to contact mechanics, sealing, rubber friction and adhesion. *Journal of Physics: Condensed Matter*, 17(1):R1, 2005.