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Advanced Correction of Blurred Image on Soft X-ray Projection Microscopy

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Introduction

Blurred Image correction by iteration procedure on a soft X-ray projection microscopy has been continued during a decade.[1] The correction of the blurred images was successful under adequate contrast by using the italation procedure we have developed, while images with too low contrast and too high contrast were found hard to adjust the aplicable correction, especially for cell and chromosome images with high transparency even in the soft X-ray region. In this study we added the procudure of image modification to improve the contrast and to reduce the artifact of additional fringes on our italation procedure. The beam line used was BL11A through this experiment, but the data from BL2C in PF-KEK, and BL20XU in Spring-8 were included for comparison.

Results and Discussion

The former algorism of our burred image correction is the italation procedure to generate the phase distribution of the propagated blurred image under the restriction of diffraction intensity. Both of the intensity and the phase distributions on the blurred image were restructured to the correct one by the inverse Fourier transformation. The physical resolution of this microscope is about 0.2μm at the maximum magnification (x658), and the properly corrected image could achieve the same resolution by this italation procedure.[1]

Our strategy to improve the image contrast is not new in the image processing, but the combination algorism of the italation procedure and the contrast improvement needs the balance of their techniques.

Figure 1 shows a representative result of a latex particle of 10μmϕ. In this observation, 1μm pinhole and soft X-rays with a wavelength of 17.7 angstrom from the beam line BL11A was used and the observation was performed for 3 minutes by a back-illuminated X-ray CCD camera with the pixel pitch of 24.8 μm. The magnification was x219.3. Although it was hard to correct such a high magnification image with low contrast by only the italation procedure, the contrast improvement could correct it clearly and sharply.

Figure 2 shows the result of chromosome. In this image, the frame of a SiN membrane appeared on the right side. The former correction would cause the additional fringes near the frame edge by the itaration procedure, while the new algorism refrained it by introducing the gradual slope on the contrast improvement. On the contrary, the chromosome on the left side disappeared by the procedure because of the lack of balance of image contrast between left and right sides. Figure 3 shows the good correction of low-contrast objects (latex particles of 2μmϕ) surrounded by a high contrast frame (Copper Mesh).

Now the low contrast images of biological specimens are tried to correct by this new iteration procedure.

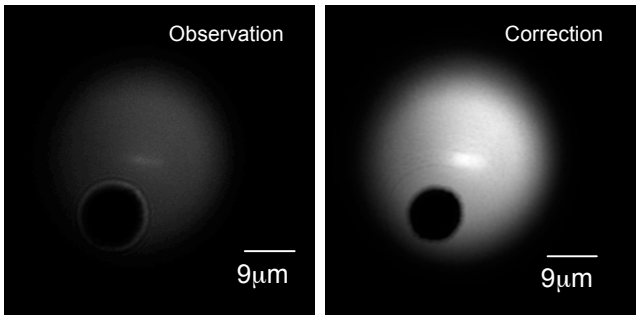

Fig.1 Blur and corrected images of Latex particle of 10μmϕ.

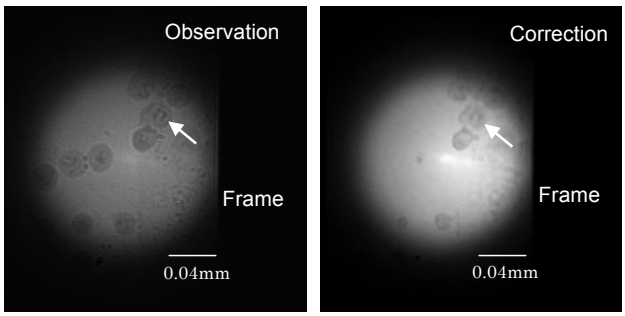

Fig.2 Blur and corrected images of chromosome.

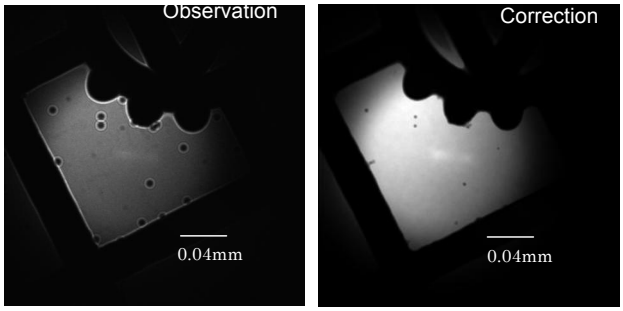

Fig.3 Blur and corrected images of the latex particles of 2μmϕ.

References

[1] T. Shiina et al., PF Activity Report, 2013.

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