FFT for Electron Microscope Image [II]

$1 Introduction

This application software has following features:

1. Able to select one of four FFT filters (*) to process an electron microscope image (8 bits grayscale bitmap).
   (*): high-pass filter, low-pass filter, band-pass filter, or band-cut filter.
2. Able to make a special FFT filter to process an electron microscope image (8 bits grayscale bitmap).
   Please refer to “$4 Making a special FFT filter. ”

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Note: The original image size is N x M pixels ($96 \le N, M \le 4096$).

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$2 Functions

Opens a bitmap (8 bit grayscale) file.

Applies modes for the FFT display.

Executes the FFT.

Applies modes for the inverse FFT display.

Executes the inverse FFT.

Copies an image to the Clipboard.

Saves an image or an FFT pattern with a filename.

Saves line profile data of FFT pattern with a filename.

Changes the brightness and/or contrast of image.

Shows the version information.

(This file.)

Closes this application software.

$3 How to Use

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1. Open an EM image (256 grayscale bitmap file) by button.
2. Set modes for the FFT display by button.
3. Execute the FFT by button.
4. Set modes for the inverse FFT display by button.
5. Execute the inverse FFT by button.
6. Change the brightness and/or the contrast of the image by button, if necessary.
7. Save the image by button.
8. Copy the image to the Clipboard by button, if necessary.

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Note: The image is not automatically saved. Please use the “save button” for saving the processed image.

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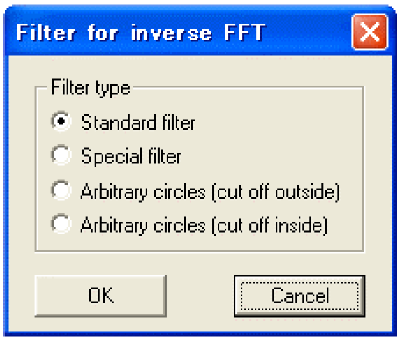
$4 Making a special FFT filter

When pressing the "Mode for the inverse FFT" button, i.e. the procedure "$3 – 4," you can get a small dialog-box for selecting a filter that is applied to the execution of the inverse FFT, as shown below. If selecting "Standard filer," you can get a dialog-box for setting the standard filter for the inverse FFT.

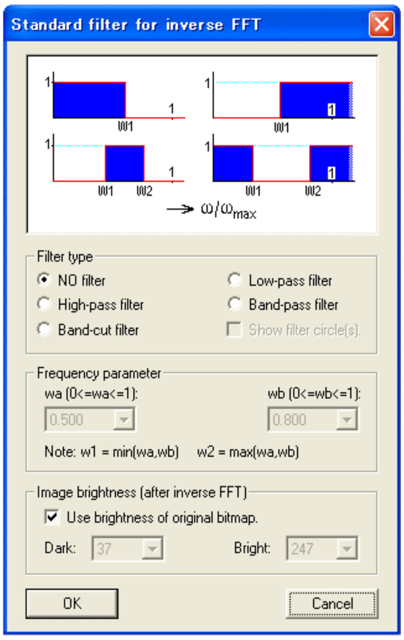
Or, if selecting "Special filer," you can get a dialog-box for setting the special filter for the inverse FFT. On the dialog-box (for making a special filter), horizontally move a "Red mark point" by two horizontal movement buttons, and then vertically move the "Red mark point" by four vertical movement buttons. The obtained filter curve is smoothed as much as possible by using the "spline approximation. "
Of course, the origin (0, 0) of the coordinate is the lower-left corner of the graph.

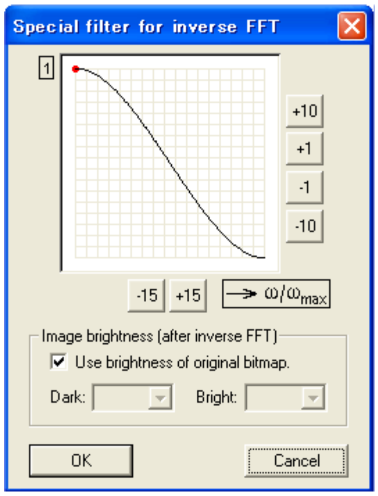
When selecting "Arbitrary circles (cut off outside)" or "Arbitrary circles (cut off inside)," you can get an annular shape cursor. Then, press down the left-button of the Mouse on the FFT pattern, and drag the Mouse by keeping the left-button down. You can get a circle on the FFT pattern. If necessary, make several circles on the FFT pattern. Inside areas or outside areas of the circles (on the FFT pattern) are used as a cut-off filter region for executing the inverse FFT. Please see the following picture.

By pressing button,



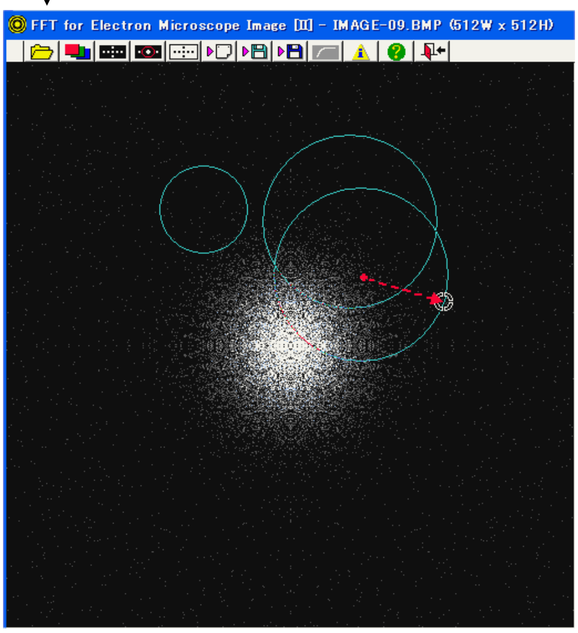
By pressing OK button,





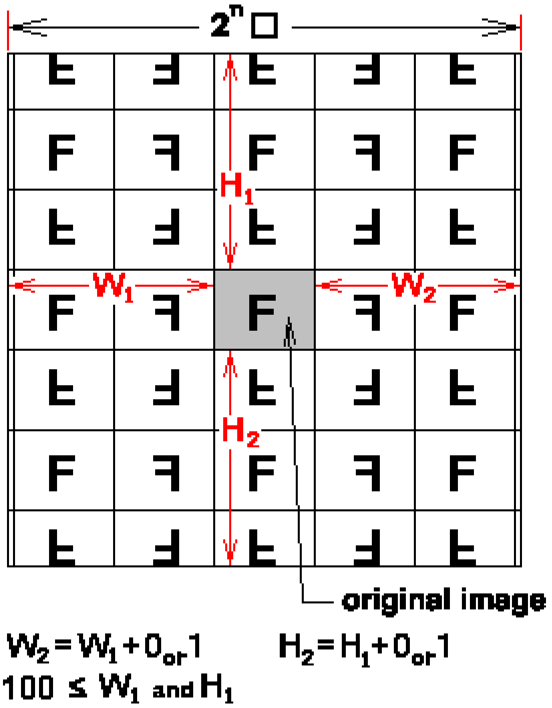
When making a special filter, you can save the numerical values of the filter curve to an "INI file" by pressing OK button. Therefore, you can automatically use the saved values, next time.

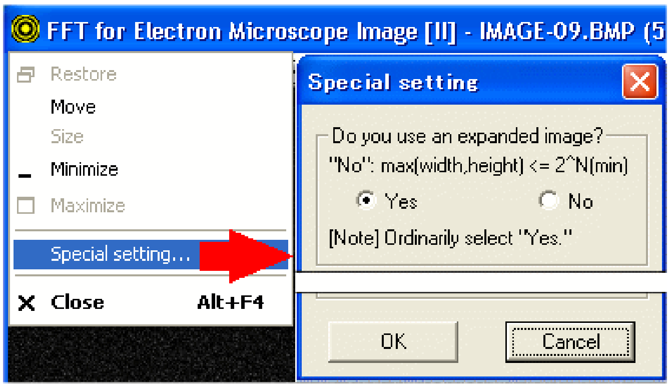
Press down the left-button of the Mouse on the FFT pattern, and drag the Mouse by keeping the left-button down. You can get a circle on the FFT pattern. If necessary, make several circles on the FFT pattern. Inside areas or outside areas of the circles (on the FFT pattern) are used as a cut-off filter region for executing the inverse FFT.



$5 For your reference

A point for developing FFT application software is as follows:





1. Make a mirror image, a flip image, and a mirror + flip image.
2. Then, combine these images to the original image as illustrated above.
3. Develop the FFT application software that can process the above image.
4. When executing the FFT, display only the area corresponding to the original image size.
5. If applying a frequency filter to the FFT pattern, process all of the area illustrated above.
6. When executing the inverse FFT, process all of the area illustrated above.
7. Then, display only the area corresponding to the original image.

Note: "100 $\leq$ W1 and H1" is a minimum requirement. The larger off-set value (e.g. 200) is better.

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Note:

(1) As you know, the DFT and the inverse DFT can be executed to an image having the size N x M (N $\neq 2^n$, M $\neq 2^m$, where n, m = positive integers).

(2) However, it takes a lot of time to execute the DFT and the inverse DFT.

(3) If an image size is 2^n square (n = positive integer), we can use the FFT and the inverse FFT by Cooley and Tukey.

(4) Their method can save a lot of time when executing Fourier transform.

(5) However, when executing "FFT → high-pass filter → inverse FFT," you can easily see artifacts - brighter areas - near the edges of the image .

Note: If executing "FFT → low-pass filter → inverse FFT," you can hardly see artifacts - brighter areas - near the edges of the image.

(6) For avoiding these artifacts (brighter areas near the edges of the image), the expanding image method (illustrated above) seems to be good.

(7) A minimum requirement - "100 $\leq$ W1 and H1" - means that you can see minimum artifacts (near the edges of the image), when executing "FFT → high-pass filter → inverse FFT."

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