

FTutor Help Document

The purpose of this software is to provide educational tool for Fourier transform and its application in the field of digital image processing. It aims to explain attractively yet clearly how the Fourier transform works, and uncover the potential that lies behind working with this transformation.

After the application starts, the main window is shown. Its user interface can be split into several parts: Main menu, Tool strip and four Image boxes. Two bottom image boxes contain input and output images, and their size is 256 x 256 pixels. The left one, input, displays image that was loaded. The right one, output, displays modified image that is obtained by Fourier transform of the input image and consequently reversed (inverse) Fourier transform. At the application initialization these images are the same, because there was no change made after the transform, therefore the output image is not modified. If the mouse button is pressed and mouse is moving on either input or output image, zoomed images appear to offer more detail observation of changes.

These changes can be made in top-left image box that is interactive. It displays spectrum (amplitude) of the Fourier transform of the input image. Its size is the same as size of input image, which is 256 x 256 pixels. The spectrum can be modified using various tools, doing that also changes the output image. That is because we modify our image, only instead of working directly with pixels we work with frequencies in the frequency domain. Those frequencies can be seen in top-right image box. Depending on a mouse position in frequency spectrum the appropriate frequency is drawn. In the centre of the spectrum is located zero frequency, farther away from the centre the frequencies are higher. The angles of the frequencies also vary, though the central symmetry applies. Since the frequencies are related to the rate of change, we can associate them with the intensity changes in the image. Closer to the spectrum origin the frequencies correspond to more smooth intensity changes, those are raw characters of the image. Farther away from the origin the frequencies correspond to more rough changes, those are details of the image.

The spectrum illustrates what frequencies and in what amount are present in the image. Brighter color indicates large presence, darker color indicates smaller presence. The spectrum can be modified, therefore the amount of certain frequencies can be changed. Several tools can be used to achieve that, these are located in the Tool strip. First of them is *Brush* tool that draws mask using brush strokes. Its size can be changed in *Size* box by choosing the radius of the brush in pixels. Next tool is *Rectangle* that draws rectangle mask. If the *Shift* key is pressed during the rectangle draw, the square is drawn instead. Last tool is *Ellipse* with elliptic mask, alternatively with the circle mask if the *Shift* key is pressed. There are three ways of applying the mask to the spectrum, this method can be selected in *Mode* box. The mode *Remove* completely removes desired frequencies from the image (selected data are set to 0). Modes *Suppress* and *Amplify* just suppresses or amplifies desired frequencies, the rate of those modes can be selected in *Strength* box. Strength is represented as percentages, and it sets a coefficient the data are multiplied or divided by.

Besides the manual spectrum modification the application also offers filtering with three types of filters located in the *Filters* item menu. Those are *Low-pass*, *High-pass* and *Band-pass* filter. After the filter is chosen, the dialog is shown to select filter properties.

Immediately after the spectrum modification the output image in the bottom-right image box is redrawn and we can compare the difference between this and the input image in the bottom-left image box. In order to undo (or redo) the last step of modification the option *Undo* (or *Redo*) can be selected in the *Edit* item menu. The same can be achieved by pressing shortcut *Ctrl + Z* (or *Ctrl + Shift + Z*). To revert the image's original state, select *Revert to Original* in the *Edit* item menu or click *Reset button* on the *Tool* strip.

Application also offers to select another image for spectrum modification demonstration. It can be selected using *Choose Image* option in *File* item menu and selecting desired image in the following dialog. It is also possible to open own image by

choosing *Open Image* option or by pressing shortcut *Ctrl + O*. However the image will be resized to resolution 256 x 256 pixels before displayed. Fourier transform usually works only with grayscale images, therefore if the desired image is color, an option to convert it to grayscale will be offered.

Another feature of the application is visual tutorial that can be found in the item menu *Help -> Tutorial*. It contains three demonstrations that can be switched between using *Previous* and *Next* buttons. It is possible to work with the application in fullscreen mode. This can be achieved in the item menu *View -> Fullscreen* or by pressing the key *F11*. Perform the same steps to exit the fullscreen mode, or press the key *Esc*. Application also enables to change language to Czech. This option can be found in the item menu *Edit -> Language Setting -> Čeština*.

Application was created as a part of bachelor's thesis and is intended for teaching purposes. Thank you for using this software and I wish you pleasant experience with Fourier transform.

Software author

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