DigiGraph

User Manual

beta 1.0 : January 5, 2007

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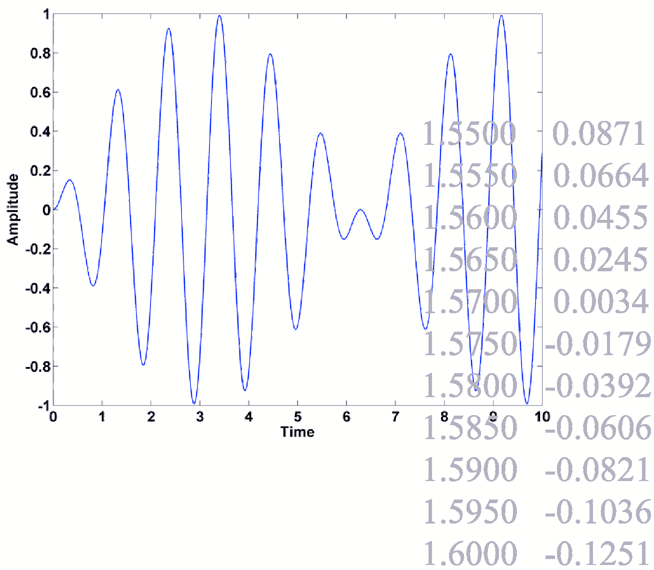

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Contents

Introduction

DigiGraph is a digitizer. Most of us have had to read data off a plot. It is alright if we need one or two points. But it gets tedious and sometimes downright impractical when we need the entire plot to be digitized. DigiGraph makes it easy to digitize entire plots. It is designed to extract line plots. However, it is possible to extract fine detail from a digital (or scanned) photograph as well. How and why this can be done will be made clear in the methodology section.

Quick Start

If you are impatient like me, you can jump right in and start using DigiGraph. Go ahead, open the image file that came with DigiGraph or any image that you have. Let me assume you are using the sample image sample.tif. It is a color image and DigiGraph warns you that it has to be converted to gray-scale before proceeding. Once you have chosen one of the two options, you will see the modified image panel. You can always see the original image from `View` → `Original Image` and switch to the modified image using `View` → `Modified Image`. If you want to meddle with the image, go right ahead. But let me jump as is the theme of this section and show you the works. Extract data by using `Run` → `Extract`. With a little patience you should see the plot of the extracted data. Provided you are satisfied, you can save the extracted data. Otherwise you can go back and tweak the parameters until you are satisfied.

The digital image

The beauty of the digital world is its simplicity. Everything, and absolutely everything is just ones and zeros, no matter what fancy name they are given. Numbers, fractions, pictures, video, software . . . , the list goes on, are finally stored only as a collection of zeros and ones. The digital image is no exception. The digital image is broken down into pixels, let us say p number of pixels along the horizontal direction and q along the vertical direction. The image hence has a resolution of $p \times q$. This image is stored in a file as a

$p \times q$ matrix, with each element being the intensity value of that pixel* The intensity values range from 0 (black/low) to 255 (white/high) (can also be normalized to range between 0 and 1). In color images, there are three or four (rgb or cmyk encoding) sets of intensities corresponding to each color component. These intensity values in (decimal number system) are finally stored as zeros and ones (binary number system) in the computer. Matlab® has an image processing toolbox with some nifty features, that we can use to play with figures. Using the toolbox, reading in a gray-scale image with a resolution of $p \times q$ results in a matrix of size $p \times q$. A color image (rgb encoding) with the same resolution would be read in as a $p \times q \times 3$ matrix.

Methodology

DigiGraph digitizes the image by selecting points with intensity between a specified range. For example, if we have a black line plot with a white background, the points containing (or comprising) the line have an intensity of 0 and the background has an intensity of 255. So we can get all the points containing the line by simply scanning for zero intensity points. However, when we convert a color line plot with white background to gray-scale, we have intensities below 255 for the line but not necessarily zero. So we can scan between an upper and lower intensity limit to digitize the line plot.

Since the points are digitized based on their intensity, any kind of digital image can be digitized. Suppose you want to attach your signature to some plots by plotting it (like an artist!). Let us say you have a photograph of your signature. Then, you can extract the points with intensity corresponding to your signature and show off your nerdiness! Play aside, a practical example would be tracking a set of points in an experimental setup for post-experimental data analysis. For example, in a simple tension test, the strain can be calculated based on the relative motion of two points on the specimen. DigiGraph can be used to find the position of the two points in several successive images. A more sophisticated application would be in a digital image correlation setup to study the relative motion of several hundreds (or even thousands) of points on a specimen†.

*Depending on the type of the file (*e.g.* jpeg, tiff, eps, ...), the intensity data is compressed differently. Reading the various formats is taken care by the image processing toolbox in Matlab® .

†Forgive me for the structural engineering applications. They just came to my mind

Walk Through

I will try to explain the components of DigiGraph here. Since DigiGraph is GUI driven, it is easier for me to explain with pictures and probably easier for you to refer as well. Keeping with the spirit of the the title, let me walk you through all the components.

DigiGraph can be started by executing the DigiGraph_GUI.m file in Matlab® or the DigiGraph_GUI.fig file from "guide" in Matlab®. The opening screen looks like Figure 1 .

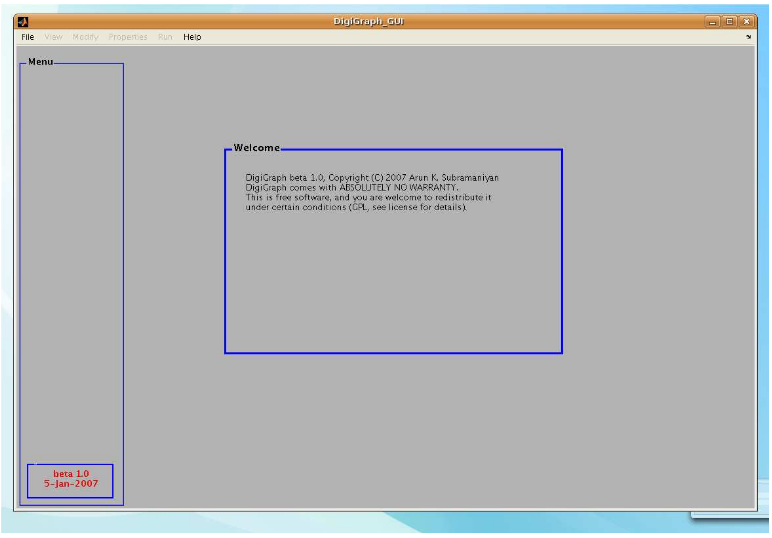

Figure 1: DigiGraph opening screen.

Loading an image

You can open an image file from the `File` → `Open` menu. If the image is a color image, DigiGraph will warn you that the image has to be converted to gray-scale as shown in Figure 2 .

There are two options as seen in Figure 2 . As of this writing, I have used the built in rgb2gray function in Matlab® to convert a color image to gray-scale, because, I could not find a function to convert cmyk encoded color images to gray-scale. I also did not find the need to use cmyk images

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and I listed them for want of better ones.

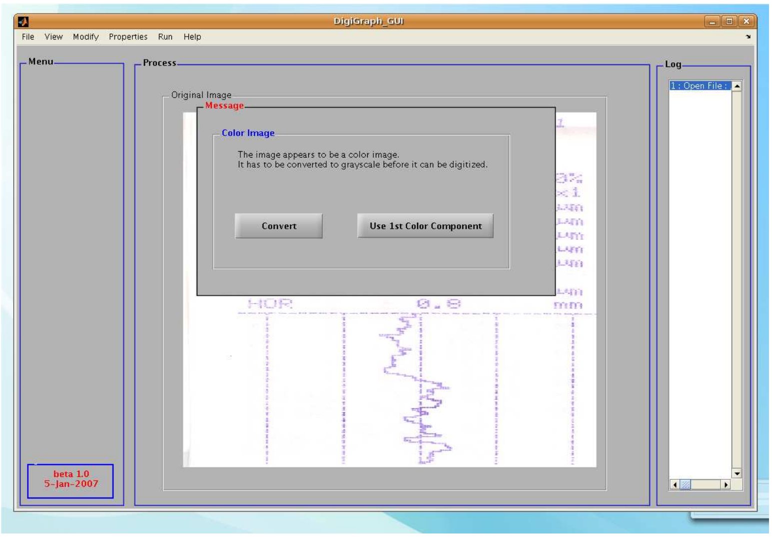

Figure 2: Color image warning.

and hence left it at that. In case you have a cmyk image and do not want to convert it to rgb or gray-scale, then you can use the second option and ask DigiGraph to just consider the first color component in the figure. This may not alter the results as long as you only have a simple line plot. But do be careful to check whether the digitized plot looks something similar to your original image. As soon as you select one of the options, the modified image panel will be activated and you can see the modified image (see Figure 3).

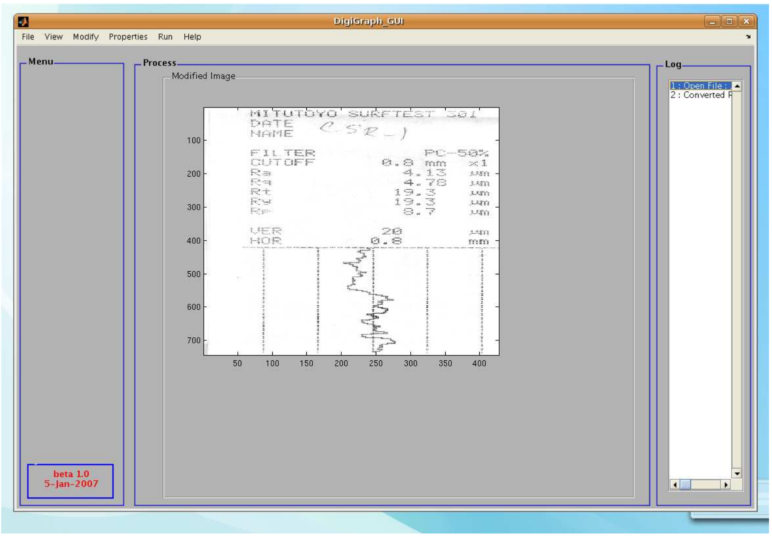

Figure 3: Original image converted to gray-scale and shown in modified image panel.

Modifying the image

The image is now loaded into Matlab® memory, i.e., the intensity values have been stored in a 2D array. Note that although the heading says we are modifying the original image, we are only going to modify the copy of that image in Matlab® 's internal memory. The original image file does not get modified.

The two possible modifications apart from gray-scale conversion are *rotation* and *cropping*. You can rotate and crop the image as many times as you please. Initiate the rotation by selecting `Modify` → `Rotate` to get the rotate dialog box shown in Figure 4 . The angles are in degrees and both clockwise (cw) and counter clockwise (ccw) rotations are possible. Figure 5 shows a rotated image.

Choose `Modify` → `Crop` to start cropping the image. A cross-hair appears on the screen to help you select the crop limits (Figure 6). You should choose the upper left corner followed by the lower right corner (in that order). Right after you choose the lower right corner, the image is cropped and the cropped image is displayed in the modified image panel. The cropped area becomes the active area from which the data can be extracted (digitized). You can crop multiple times, however you can only reduce the area by crop-

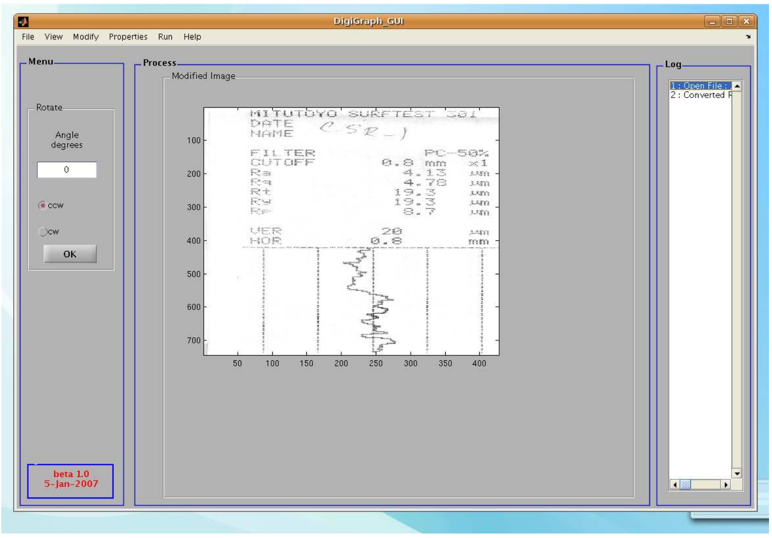

Figure 4: Rotate dialog box.

ping. A sample cropped image is shown in Figure 7 . The horizontal and vertical grid lines have been intentionally included.

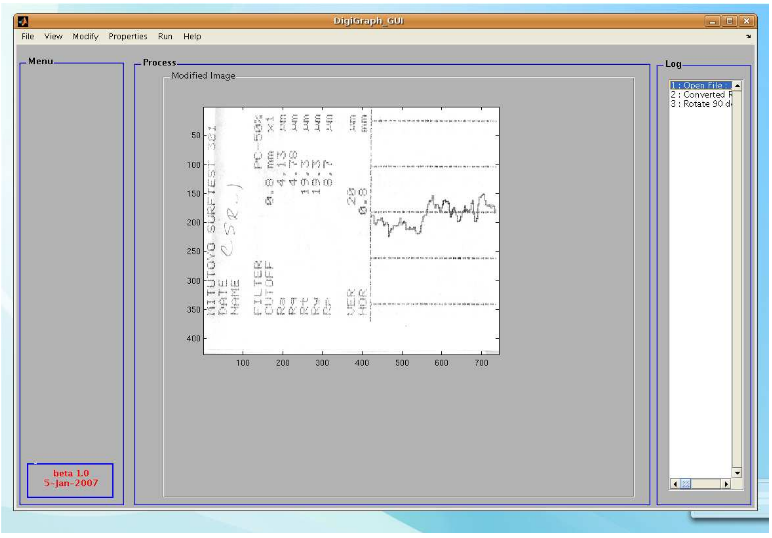

Figure 5: Original image rotated by 90 degrees counter clockwise.

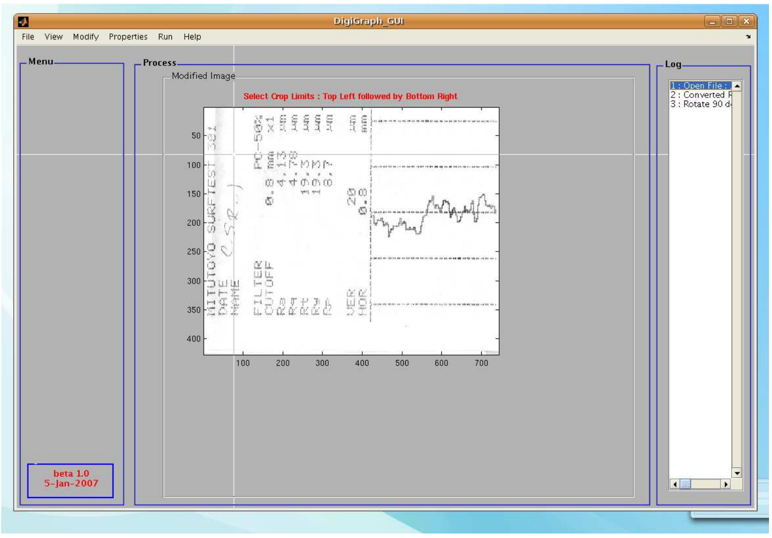

Figure 6: Cross-hair to select the crop limits.

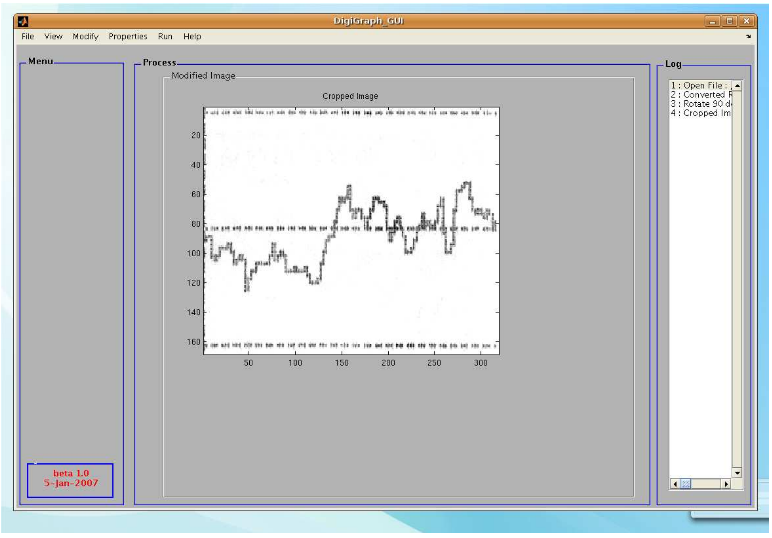

Figure 7: Cropped image.

Intensity Distribution

Once we have loaded the image and cleaned it up with rotations and crops, we can view its intensity distribution. `Properties` → `Intensity` brings up the intensity distribution along the horizontal and vertical directions as seen in Figure 8 .

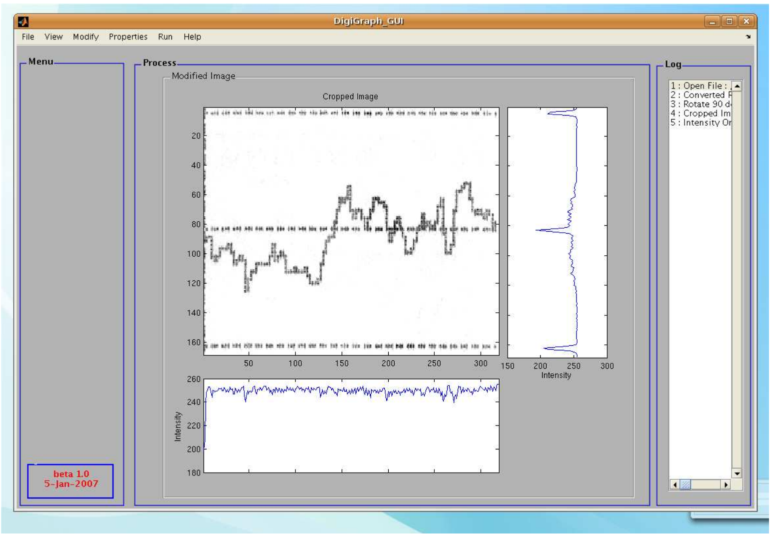

Figure 8: Intensity distribution.

With the knowledge of the intensity (that we need to extract), we can set the intensity limits from `Properties` → `Set Intensity`. The upper and lower intensity cutoff can be selected in the set intensity dialog (Figure 9).

The digital image may contain features that you do not want to digitize. Most common among such features are the grid lines. You can remove the horizontal and vertical grid lines by using the `Properties` → `Remove Horizontal Grid Lines` and `Properties` → `Remove Vertical Grid Lines` options respectively (see Figure 10 and Figure 11).

The actual removal is done based on the number of horizontal and vertical points extracted along a line (horizontal or vertical). In the dialog box that appears (see Figure 10 and Figure 11) when you select `Properties` → `Remove Horizontal Grid Lines` or `Properties` → `Remove Vertical Grid Lines`, you can choose the criterion for a line to be a grid line. The criterion is the minimum number of extracted points along a line. If along

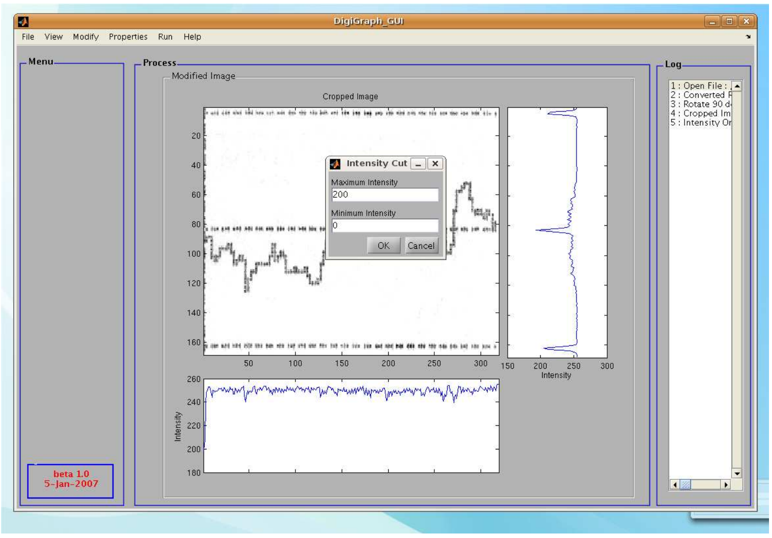

Figure 9: Setting upper and lower intensity cutoff.

any line, the number of points extracted exceeds your threshold, that line will be deleted from the extracted data.

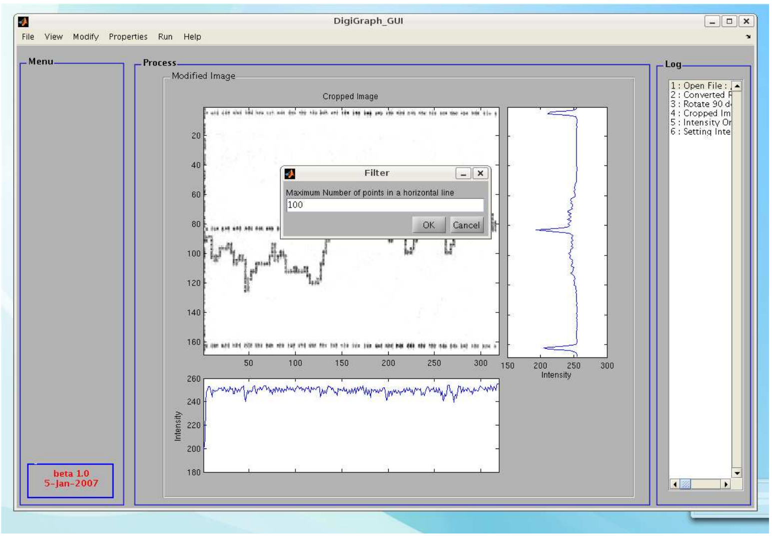

Figure 10: Remove horizontal grids from digitized data.

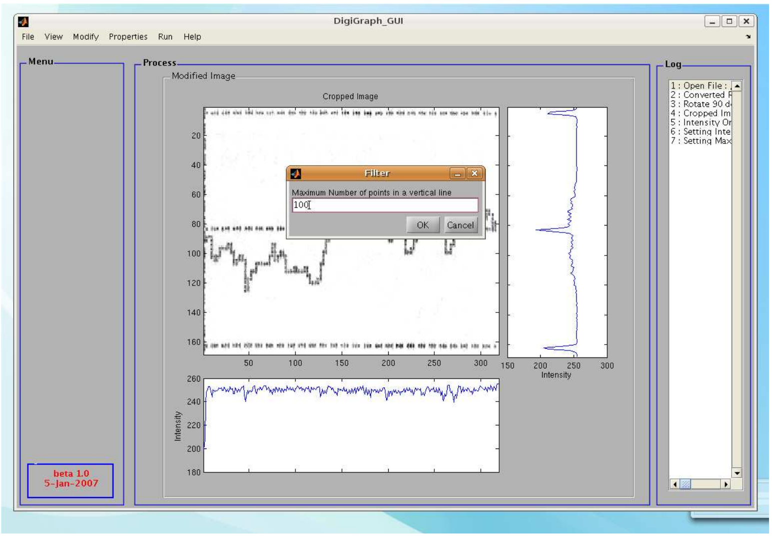

Figure 11: Remove vertical grids from digitized data.

Setting Scale

A graph without scale is meaningless. Scale consists of two parts; the value and the unit. Although the units are equally important to the end user(i.e., you), the only scale DigiGraph is concerned about is the value. Value is the lower and upper limits of the graph's axes. By default, DigiGraph takes the lower left corner to be the origin (0,0) and the top right corner as (1,1). You can change the default by using the options `Properties` → `Set X Scale` and `Properties` → `Set Y Scale`. When you select one of the above two options, the cross-hair appears again. You should select the lower and upper limit points (in that order) using the cross-hair (shown in Figure 12). Once you have selected the points, a dialog block pops up, in which you can enter the lower and upper scale values .

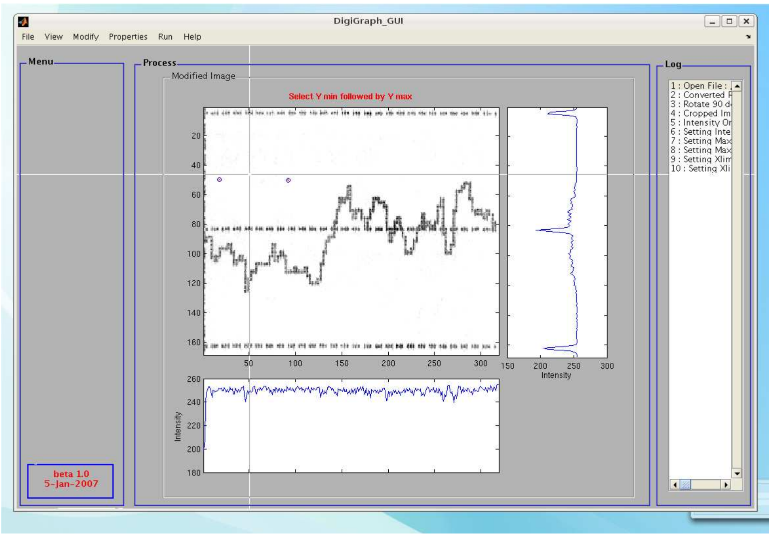

Figure 12: Setting X and Y axis scale.

Note that you do not have to select the lowest and highest points along the axes. You only have to select two points (not necessarily along the axes) and specify the value for those two points. For example, let the x-axis in your plot ranges from -2 to 4 and y-axis ranges from 0 to 10. Let us say you choose the points (1,1) and (2,3) using the cross-hair for the x-scale points. Then you should enter 1 and 2 for lower and upper scale values respectively in the x-scale dialog box. You can go ahead and select the points (-1,0) and (3,5) as the y-scale limits and enter the lower and upper values as 0 and 5 respectively. The entire plot will be scaled based on the distance between the points you chose and the corresponding values you entered. The points you chose for the X limits will be marked in red cross with blue circle and the Y limit points are marked in blue cross and red square as shown in Figure 13 .

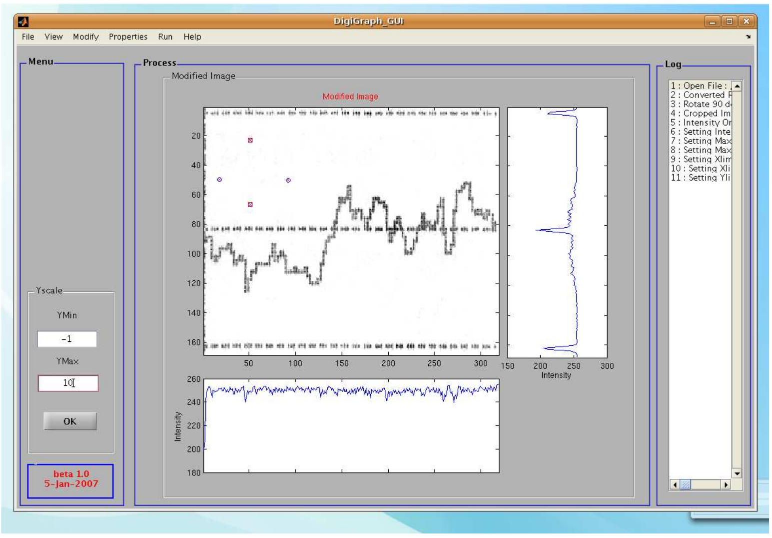

Figure 13: X and Y axis scale limits set.

You can set the scale multiple times. Only the latest selection is valid.

Extracting & Saving Data

Now, after setting all the parameters, we are ready to extract the data from the image. Just select `Run` → `Extract` to start the process. The time taken depends on the detail in your image among other obvious things like your computer's prowess. Wait till the *Patience ...* screen disappears. The digitized plot will now be displayed as shown in Figure 14 . Note that most of the grid lines have been removed.

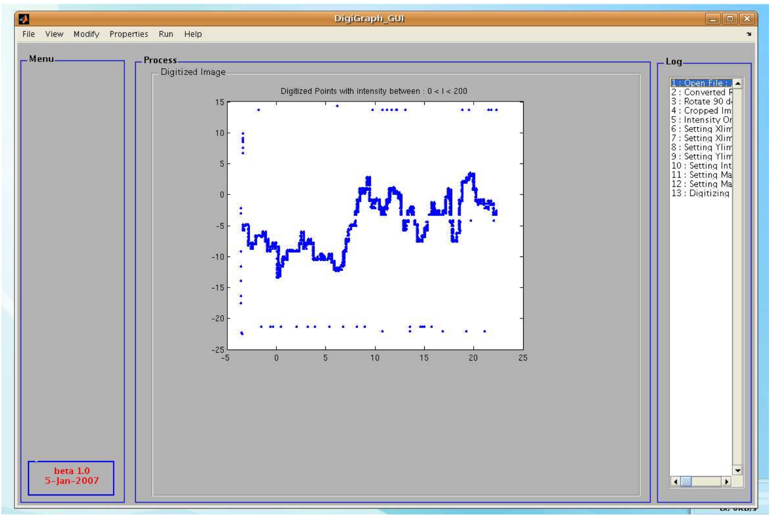

Figure 14: Digitized plot.

If you are satisfied with the result, you can save the points to a file using `Run` → `Save` or tweak the parameters until you are satisfied. The points are saved as two columns corresponding to x and y values (scaled according to the scales previously set). A log file with the following details is also created.

- Intensity Upper Cutoff
- Intensity Lower Cutoff
- Maximum Number of horizontal points
- Maximum Number of vertical points
- X_min selected in pixel
- X_max selected in pixel
- Y_min selected in pixel
- Y_max selected in pixel
- X_min value entered
- X_max value entered
- Y_min value entered
- Y_max value entered
- Data file

Log Panel

The log panel lists (i.e., logs . . .) the operations performed. I originally intended to add an undo function, but did not find any real need for it. This log function was a precursor to the undo function. Since I decided to abandon the undo function (as of now), log panel just lists the functions performed. As mentioned in the previous section, a log file with some relevant data is written for every saved data file.

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