Can you draw a sinewave by hand?

Detlef Amberg 01/19

Sure you can.

But what is the resulting SNR, i.e. the difference between your curve and the 'correct' sinewave?

Let's have a try. This is the sinewave drawn by Harald, the best analog electronics engineer of whole Berlin:

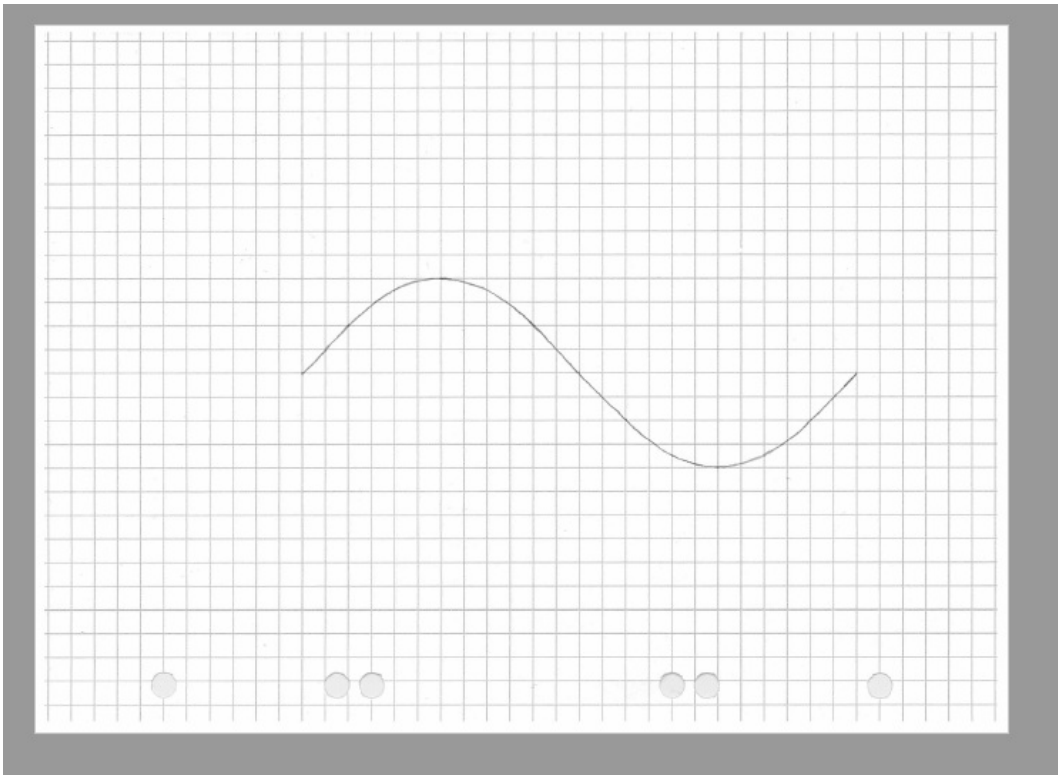

fig.: The sinewave, pencil on squared paper

We import the image to Matlab, it is cropped and we find the darkest spot in each column. After some artifact removal it looks like this:

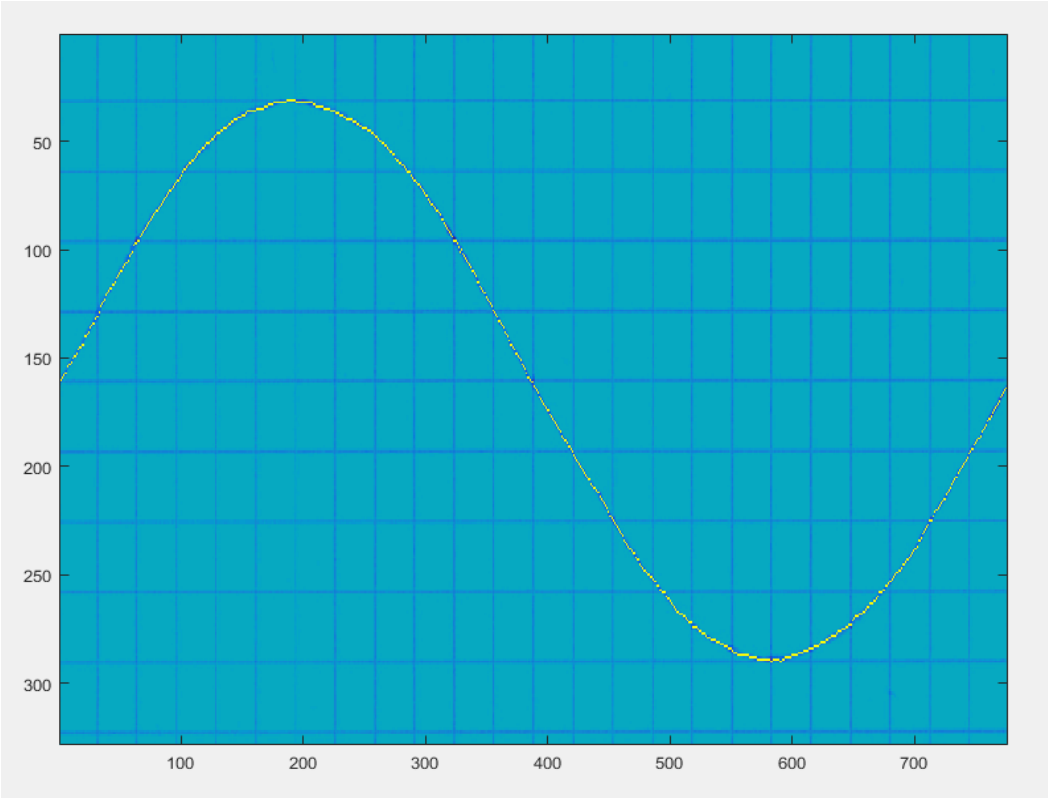

fig: The sinewave, cropped and digitized

The yellow curve in the last figure and the red one in the next figure is the identified sinewave.

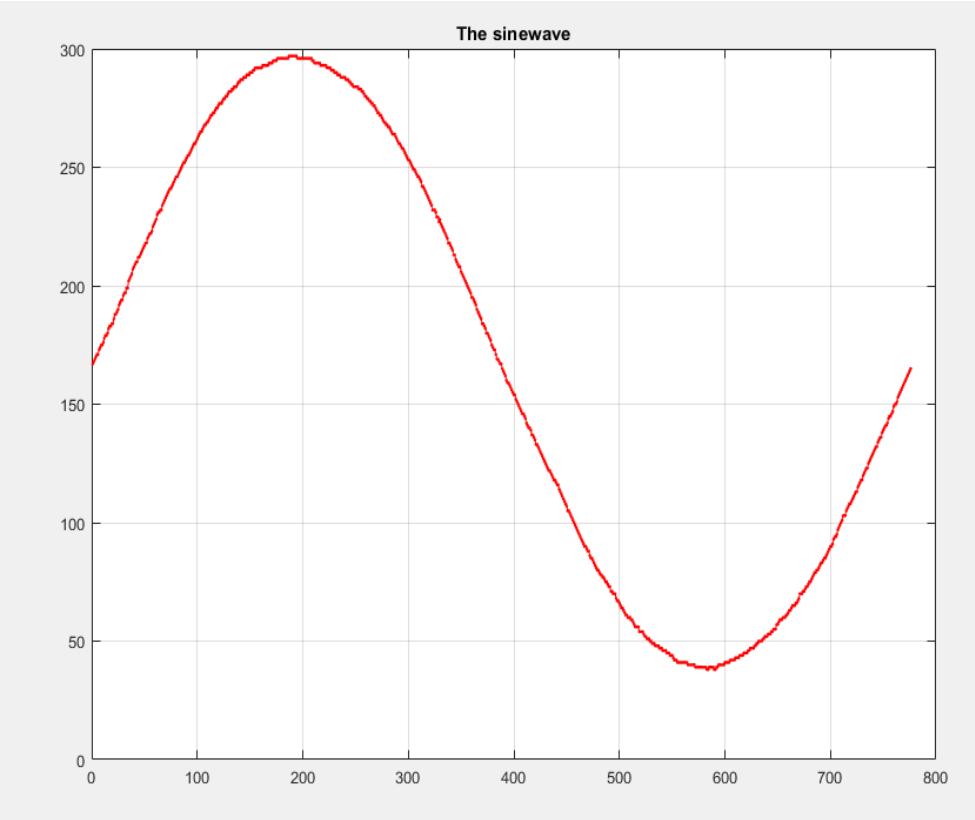

fig: The sinewave, extracted from the image.

Now a 'correct' sinewave is fitted to the extracted sinewave.

Fitting of sinewaves, even with additional damping, is not a nonlinear problem.

It can be solved with mere good old linear Algebra, see

https://www.dsprelated.com/showarticle/795.php

https://www.mathworks.com/matlabcentral/fileexchange/50756-fit-a-damped-sine-wave

This is the result:

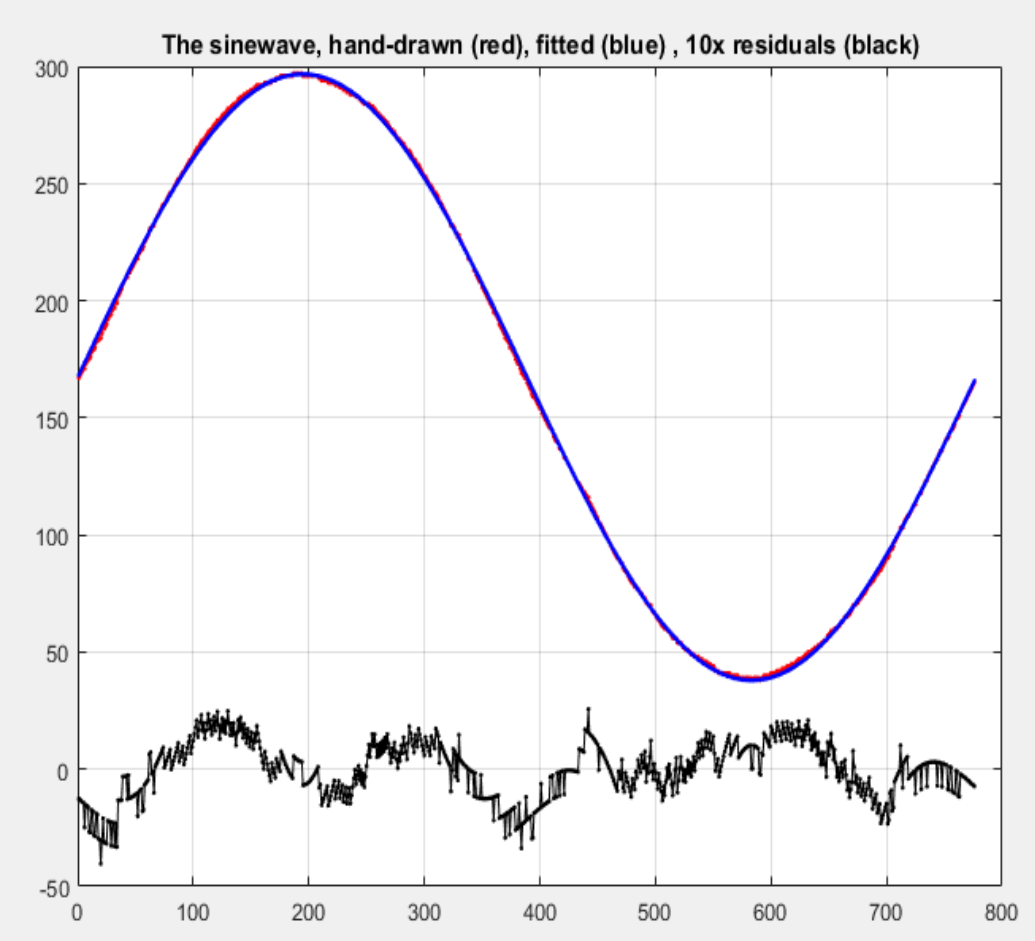

fig: The sinewave, the fit and the residual (10x zoom)

The fitted parameters of the sinewave are:

- amplitude 129.35
- frequency $8.082*10^{-3}$ rad (777.42 samples full sinewave)
- offset 167.33
- energy $6.505*10^{6}$ (sum of squares without the offset)
- energy of residuals $1.097*10^{3}$

The energy of the fitted sinewave in relation to the energy of the residuals results in a Signal-to-Noise ratio SNR of

37.7dB

Not to bad. At the 'zero crossings' the drawn curve is a bit low, at the maximum and the minimum it is a bit high.

The coordinates of the extracted points are integer values because we do no subpixel interpolation. So we get an error for the quantization alone with an

energy of 61.69 in our case, which results in 50.2dB. The sinewave with an amplitude of +/-129.35 gives 8 Bit resolution, which should yield

$$8 * 6dB + 1.7dB = 49.7dB$$

Close enough.
That was big fun.

Math rulez!

Cheers
Detlef