A programmable software framework for the generation of simulated surface topography

Luke Todhunter[1], Nicola Senin[1,2], Richard Leach[1], Simon Lawes[1], François Blateyron[3], Peter Harris[4]

[1]Manufacturing Metrology Team, University of Nottingham, UK [2]Department of Engineering, University of Perugia, Italy [3]Digital Surf, Besançon, France
[4]National Physical Laboratory, Teddington, UK

Email: luke.todhunter@nottingham.ac.uk

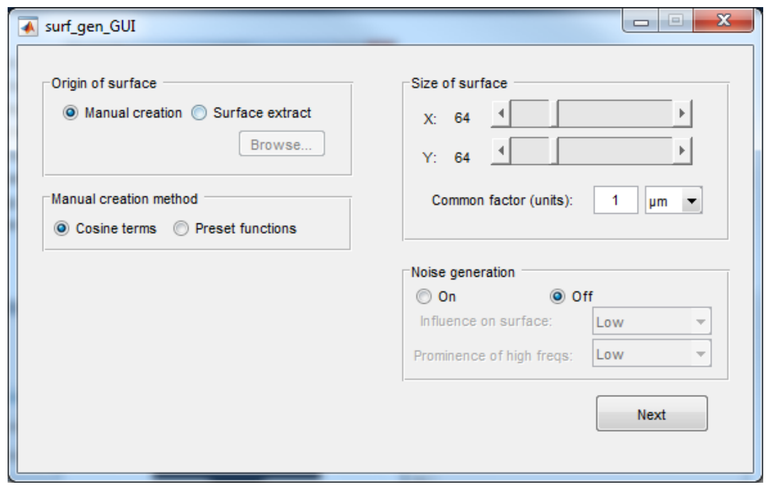
Software purpose

New software has been developed that enables the creation of areal surface topography representations. The goal of this software package is to utilise analytical continuous surface representations in the development of surface texture parameter reference values. These surface texture parameter reference values will be compared against parameter values obtained by third-parties to assess the performance of their software. The reference values will be obtained from the calculation of parameters for a continuous analytical surface, to reduce some of the uncertainty associated with current reference standards, which are calculated from numerical dataset surface representations.

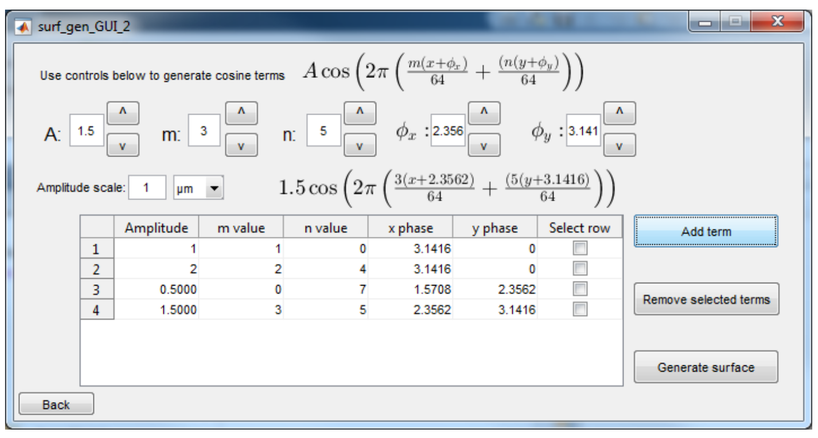
Software details

Step one: Initial settings

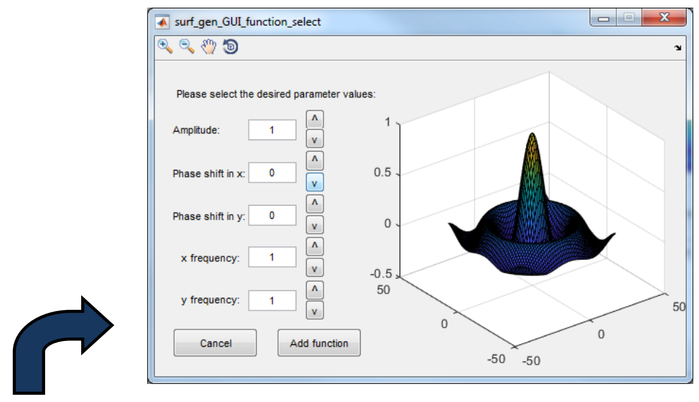
The software features a graphical user interface (GUI) that enables easy navigation, and allows users to customise the surface to create the topography they require. The GUI allows users to specify the size and fundamental period of the areal surface, and create the surface through one of two methods (see below). The user can also choose to recreate an existing areal surface .SDF file, via a DFT approximation, in the form of a continuous analytical equation.

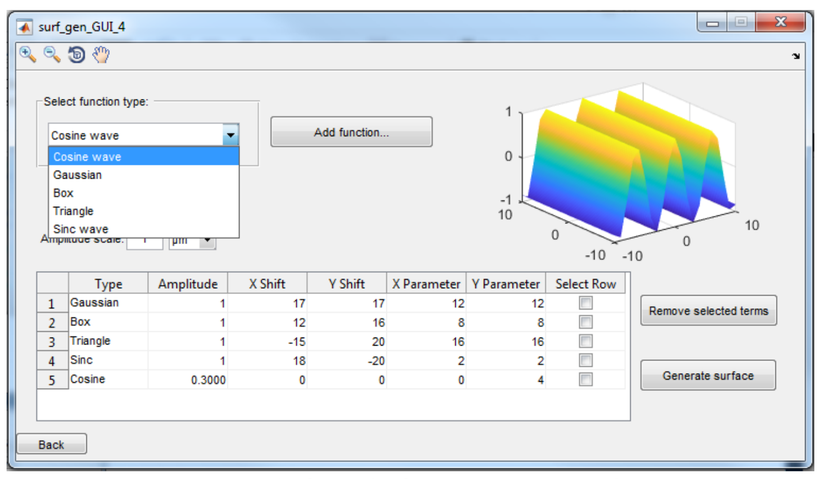


Step two: Surface creation



Option one: Combinations of cosine terms can be selected, specifying amplitude, *x*/*y* frequency and phase.

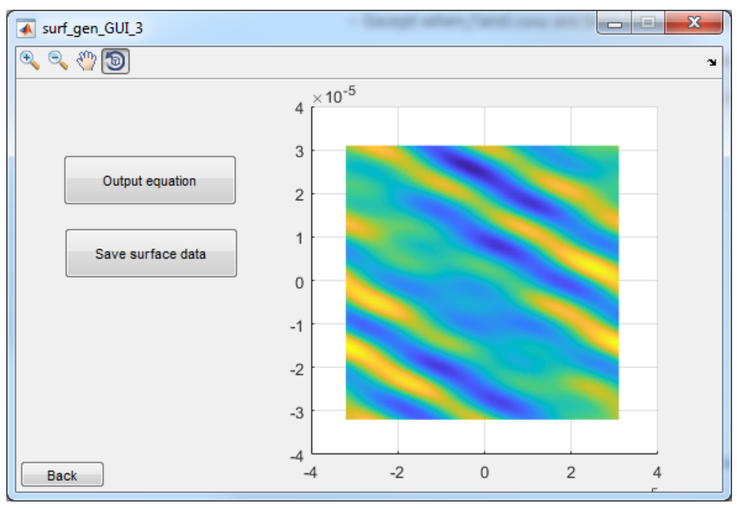




Option two: Pre-defined functions, such as Gaussians and cardinal sine waves, can be selected, edited and combined to create a desired surface.

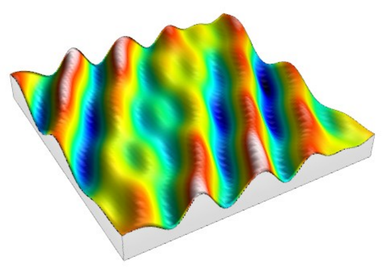
Step three: Surface generation

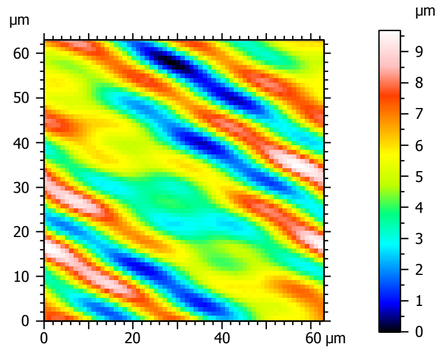
The software utilises a summation of exponential terms and the Fourier series to produce continuous analytical functions that describe a simulated areal surface. The software allows the user to export the resulting surface as an analytical equation written in a .TXT file. The analytical equation can also be sampled to produce a numerical dataset representation in the form of a dataset in the standardised .SDF file-type.



Step four: Surface output

.SDF file

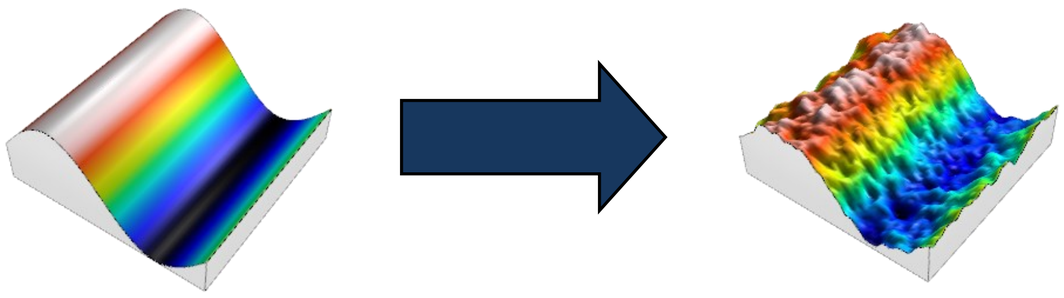




Surface equation

$$Z(x,y) = \frac{e^{31250i\pi(x+3.14159)}}{2000000} + \frac{e^{-31250i\pi(x+3.14159)}}{2000000} + \frac{e^{2000000i\pi\left(\frac{1}{32}(x+3.14159)+\frac{y}{16}\right)}}{1000000} + \frac{e^{-2000000i\pi\left(\frac{1}{32}(x+3.14159)+\frac{y}{16}\right)}}{1000000} + \frac{e^{218750i\pi(y+2.35619)}}{4000000} + \frac{e^{-218750i\pi(y+2.35619)}}{4000000} + \frac{3e^{2000000i\pi\left(\frac{3}{64}(x+2.35619)+\frac{5}{64}(y+3.14159)\right)}}{4000000} + \frac{3e^{-2000000i\pi\left(\frac{3}{64}(x+2.35619)+\frac{5}{64}(y+3.14159)\right)}}{4000000}$$

Optional: Noise generation



Multi-scale Fourier-space Gaussian noise can be incorporated into the continuous analytical expressions to produce more realistic looking surfaces.