SURFEX V. 0.89.02 FOR WINDOWS
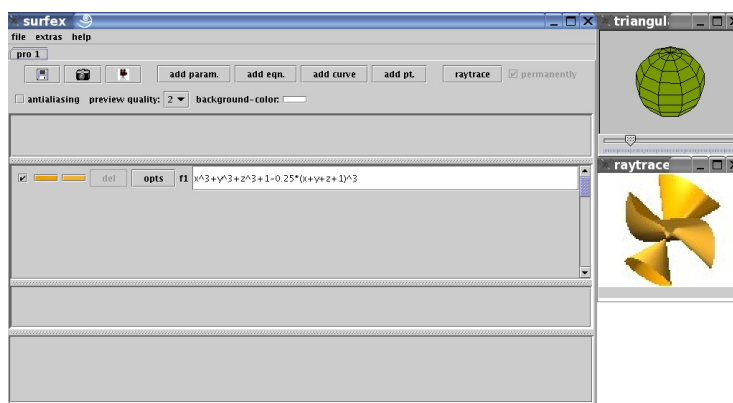## — A Short Documentation —

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Abstract

SURFEX is a tool for interactive high quality real algebraic surface visualization. It is a meta-software which combines the strenghts of several visualization tools such as SURF, JAVAVIEW.

We also implemented a SINGULAR library called SURFEX.LIB which enhances the quality of the visualization of SURFEX using pre-computation of the singular locus etc.

The latest version and information on SURFEX and SURFEX.LIB is available from our website: `www.surfex.AlgebraicSurface.net`.

1 Getting Started

1.1 Download

You can download the version 0.89.02 of our visualization software SURFEX as one file called `surfex_0_89_02.tar.gz` from our website:

`www.surfex.AlgebraicSurface.net`

1.2   Prerequisites

The current version of SURFEX uses the raytracer SURF as a back-end for computing the beautiful images. This software has to be installed on your system if you want to use SURFEX. If you want to produce movies using SURFEX, then you will also need to have the image conversion tool CONVERT installed which is part of the IMAGEMAGICK package.

1.2.1   JAVA (required)

SURFEX is a JAVA program. This has the advantage that it is not much work to provide the software for many operating systems and also that it can easily be adapted to work over the internet.

The current version of SURFEX requires the Java Runtime Environment (JRE), version 1.4.2 or later. You can download it from www.java.sun.com.

1.2.2   SURF (required)

Thanks to the SINGULAR Team, the raytracer SURF is now also available for Windows. This enables us to provide SURFEX for Windows:

The most convenient way to install SURF is to install the **full version** of SINGULAR FOR WINDOWS (which includes in particular SURF). It uses the Linux emulation CYGWIN. The SINGULAR team provides their great software on their website: `www.singular.uni-kl.de`. It is very easy to install; just follow the instructions.

Please, remember the directory to which SINGULAR installed the CYGWIN for later use; at the moment, the standard seems to be `c:\cygwin`.

1.2.3   CONVERT (optional, for producing movies)

For producing movies of algebraic surfaces, SURFEX uses the great image conversion tool CONVERT which is part of the IMAGEMAGICK package. You can download it from: `www.imagemagick.org`.

The easiest way is to download and install a Windows binary release (do NOT use the cygwin binary!). Please, use the Q16-verion. At the time of the writing of this documentation, the current version is 6.2.7-6 and the corresponding file is: ImageMagick-6.2.7-6-Q16-windows-static.exe

Its installation is very easy; just double-click the downloaded file.

1.3   Install

If you have JAVA and SURF (and, optionally, CONVERT) installed on your system as described above, the installation of SURFEX should be very easy. Just follow the steps below:

- Copy the downloaded file `surfex_0_89_02.tar.gz` to the directory for the temporary files of your CYGWIN (if the CYGWIN directory is `c:\cygwin`, then the temporary directory will be `c:\cygwin\tmp`).

- Open a bash shell: It is available from the Windows Start Menu via the SINGULAR sub-menu: Programs → Singular CAS → Cygwin → Bash.

- Uncompress the downloaded file by typing the following command into the shell:
  `tar -xzvf /tmp/surfex_0_89_02.tar.gz`

- This should have created a directory called `surfex_0_89_02`. Change to this directory by typing the following into the shell:
  `cd surfex_0_89_02`

- Run the `INSTALL_WINDOWS` script by typing the following into the shell:
  `./INSTALL_WINDOWS`
  If `INSTALL_WINDOWS` works well, it will produce a script called `surfex` in the current directory, and it will copy this script to a directory which is contained in your bash path.

- You can now start surfex by typing:
  `surfex`

1.4 Start

If you have installed SURFEX correctly then you can start it by typing
`surfex`
into a shell. Three windows will show up (see e.g., fig. 1 on the following page), and a default surface will be shown. You can also invoke SURFEX directly with an equation:
`surfex -e x^3+y^2-z^2`
If this equation contains parenthesis then you might have to enclose the equation in quotes:
`surfex -e "(x+y)*(x-y)+z^3"`
If you already have a SURFEX-file, say `example.sux`, then you can open this file by typing:
`surfex example.sux`

1.5 Examples

The directory `0_89_02` which was made during the installation process should contain a sub-folder called `examples`.

Furthermore, we will give many more examples on our website in the future, see `www.surfex.AlgebraicSurface.net`.

1.6 Documentation

The latest version of the documentation which you are currently reading is available from our website: `www.surfex.AlgebraicSurface.net`
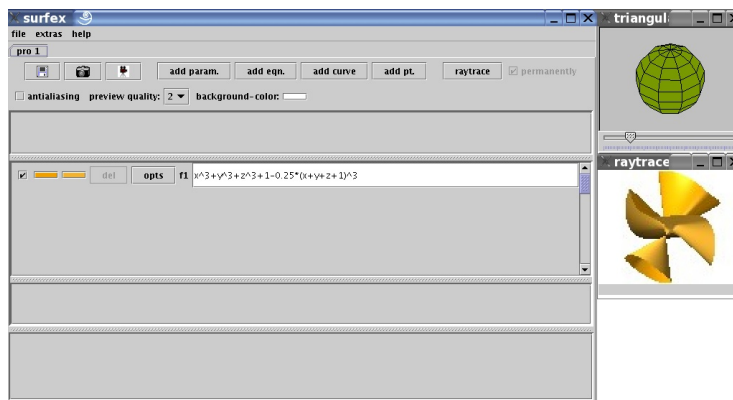
2   The Interface

2.1   Three Windows

Figure 1: The SURFEX interface.

After having started SURFEX, you see three windows, entitled `surfex`, `triangulation`, `raytraced surface`.

The `raytraced surface` window shows a raytraced view of the surfaces (produced using SURF).

The `triangulation` window currently only shows a sphere. By dragging the mouse on this window you can rotate the surface which is shown in the `raytraced surface` window.

The main window is the `surfex` window: here, you specify the equations and most of the other data. We describe this in detail in the next subsection.

2.2   The `surfex` Window

2.2.1   The Menu

In the current version, the menu does not have much functionality. Only the `file` menu contains some important items: for opening SURFEX files, and for saving raytraced images and movies.

2.2.2   The Project Title

2.2.3   The Actions Bar

The main actions are performed using the actions bar. From left to right, the buttons have the following functionalities:

- save the current project,
- save the current raytraced image (in a higher resolution, if you whish),
- save a movie, based on the current image (in a higher resolution, if you whish),
- add a parameter to the project,
- add an equation to the project,
- add a curve to the project,
- add an isolated point to the project,
- raytrace the image once,
- raytrace permanently; i.e., always produce new raytraced images whenever you have changed anything.

2.2.4   The General Properties Bar

Using the general properties bar you can perform actions which do not only have an effect on one single object, but on all varieties simultaneously. From left to right:

- antialiasing: after the computation of the raytraced image, perform an antialiasing (which enhances the quality, but which takes time).
- preview-quality: 1 (best quality), ..., 8 (lowest quality).
- background-color: set the background color of the raytraced image.
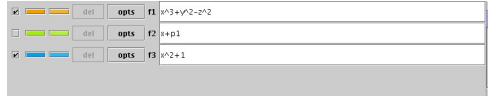
2.2.5   The Parameters Window

The name of the parameter (here `p1`) is the leftmost information given for each parameter. It cannot be changed in the current version.

But you may specify the range of the parameter, and, of course, the value of the parameter itself. In the current version, the parameter can only be changed using the slider and not via the keyboard.

Attention! Once you have changed the lower or upper bound for a parameter by typing in some decimal number, you have to press RETURN (while the cursor is still in the text field in which you entered the new number).

2.2.6 The Equations Window

A checkbox is the leftmost element for each equation. Using this one, you can decide wether the surface should be shown in the picture or not.

By clicking on one of the two colored buttons one can specify the inside (i.e. looking towards the points on which the equation takes positive values) and the outside color of the surface.

The `del` button is currently disabled.

The `opts` button opens an options dialogue box. At the moment, one can only specify the transparency there (in %). If this is set to 100 % then the surface is not visible at all in the picture.

At the right of this button you can see the name of the equation.

Equation Syntax The equation itself may be entered into the big text field. You have to give all operators explicitly: `+`, `-`, `*`, `^` (i.e., e.g., `3xy` is not allowed). As parenthesis you may use `(` and `)`.

Furthermore, you may include the names of the parameters (in the numerator or denominator) and of the other equations (in the numerator).

You may even apply trigonometric functions (`sin`, `cos`, `tan`, `arccos`, `arcsin`, `arctan`) or `sqrt` to decimal numbers or parameters (these are actually those supported by SURF).
E.g., if you have two parameters `p1` and `p2`, and two equations `f1` and `f2`, then the equation of the third equation may e.g. look as follows: `cos(p1)*f1 + (sqrt(p2)+1)*f2`.

SURF also allows the usage of some functions which yield a polynomial:

- `hesse` (produces the Hessian of a surface),
- `diff(p,x)`, `diff(p,y)`, `diff(p,z)` (the partial differentials, where `p` is some polynomial),
- `rotate(p,v,xAxis)`, `rotate(p,v,yAxis)`, `rotate(p,v,zAxis)`, where `p` is some polynomial and `v` is some decimal number (or parameter!); in this way, you can produce your own non-standard rotation movie.

E.g., `diff(f1,x)*p1 + diff(f1,y)*p2 + diff(f1,z)*p3` is the equation of the polar of the surface `f1` with respect to the point with coordinates `p1`, `p2`, `p3` (which can be specified using the parameter sliders).

2.2.7 The Curves Window

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Similar to the equations, you can specify if you want to see the curve or not by using the checkbox at the left.

There is also a color button.

Each curve is then specified by giving the numbers of some equations.

Attention! It is important to note that the curve will be drawn on the first of the surfaces specified. This means in particular that the curve will only be shown if the checkbox of this surface is checked, although its transparency can be 100 %. This last feature can be used to draw space curves without showing the surface.

2.2.8   The Solitary Points Window

Solitary points can be shown as small spheres in the picture. At the moment, their properties have to be the same as those of one of the surfaces. You have to select its number from the drop down list at the left. The coordinates of the points can contain polynomials in the parameters.

The slider can be used to give the radius of the small sphere representing the solitary point. At the moment, all solitary points have to be represented by spheres which have the same radius.