uFlow v0.1 Documentation

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ABOUT

 uFlow is a graphical tool for the rational design of inertial microfluidic

 devices that utilize pillar geometries to deform the laminar flow field.

 uFlow assembles pre-computed advection maps to enable fast, real-time feedback

 of flow deformation without requiring an online Navier-Stokes solver. Find

 out more about the inner workings of the program in an upcoming publication.

 uFlow is provided as-is without guarantee of stable operation or accuracy

 of results. Please bear in mind that uFlow is beta software; as such,

 it is expected to contain show-stopping bugs. We have, to the best of our

 ability, tested the program on a range of hardware and determined it to be

 usably stable and accurate for a limited set of use-cases. If you have

 questions about the accuracy of the program output, or find an error in

 the program's operation, or wish to speak with us for any other reason,

 please feel free to contact us as detailed in the CONTACT section of this

 document.

 Simulation results provided by the Yu Xie and Baskar Ganapathysubramanian

 of Iowa State University.

DOWNLOAD

 The latest release version of uFlow can be downloaded from:

 http://biomicrofluidics.com/software.php

 If you obtained this software from a different source, we cannot guarantee

 the safety of the program's execution. Please be sure that you have

 downloaded the software from a trustworthy source.

INSTALLATION

 Presently, the software is shipped in a self-contained ZIP or TAR.GZ archive

 depending on your platform. Once this archive is extracted, no further

 installation steps are required. However, some platforms require further

 dependencies to be installed to ensure full range of software functionality.

 Please find your platform in the list below.

 WINDOWS

 The Windows binary includes all required and optional dependencies. To

 run the program, simply double-click the uFlow.exe executable in the

 extracted folder.

 LINUX/UNIX

 Most linux distributions will include the necessary python interpreter.

 You will need to use your distribution-specific method of installing the

 relevant python libraries; beyond the standard ones, you'll need pyglet,

 Tkinter (optional) and PIL (optional). On Ubuntu and its derivatives,

 these may be installed from the command line as follows:

 sudo apt-get install python-pyglet python-imaging python-tk

 You may also consider using python's library installation if you do not

 have administrator priveleges:

 pip install PIL

 pip install pyglet

 You will need to make sure that libjpeg, libz, and libfreetype are

 available on your system.

 Once the relevant dependencies have been installed, you can run the

 software by executing the uflow.py script from the unzipped directory.

 Please ensure that the working directory matches the location of the

 uflow.py script; this is required to allow the software to locate the

 data used to compute the transformations.

 cd uFlow/

 python uflow.py

USAGE NOTES

 Upon first run of the software, you will be greeted with a device consisting

 of a single empty channel and three parallel inlet flows, represented with

 three colored dyes. The screen is divided into three parts. From left to

 right, they are: (1) the tool pane, (2) the device pane, and (3) the output

 visualization pane.

 THE TOOL PANE

 At the top of the tool pane, the user may adjust the inlet flow conditions.

 This is done by sliding the triangular handles marking the boundaries

 between fluid streams. To add a new handle, double-click somewhere within

 the fluid stream. To remove a handle, drag a handle all the way to the

 left or right edge of the fluid stream. To change the color of a fluid

 stream, right-click that stream to bring up the color palette, and select

 a color from the options presented. Note that adjustments to the inlet

 flow conditions are reflected instantaneously at the output and at all

 points in the flow. Click on any stream to highlight it in the device

 schematic.

 In the middle of the tool pane are controls for adjusting the parameters of

 the currently-selected pillar in the schematic. To use these controls,

 click on an already-placed pillar in the schematic and drag the handles.

 Note that the controls snap to a number of discrete points rather than

 having continuous operation; this is because the results have been pre-

 computed and cached for a finite number of pillar geometries and

 locations. In some cases, some tick marks will be inaccessible; this is

 because there is no data store for that particular geometry configuration.

 At the bottom of the tool pane are buttons for standard operation of the

 software. uFlow supports unlimited UNDO and REDO. These commands may also

 be accessed using the Ctrl+Z and Ctrl+Y hotkeys, respectively. The NEW,

 SAVE, and LOAD buttons can be used to store devices in the software's

 native format. This allows the devices to be reloaded at a later date for

 further work. This functionality is also bound to the Ctrl+N, Ctrl+S, and

 Ctrl+O hotkeys, respectively. The EXPORT DXF option exports a version of

 the device suitable for interoperability with other computer-aided design

 programs, such as AutoCAD, as well as vector graphics programs such as

 Illustrator.

 For certain low-resolution environments, it may be useful to hide the tool

 pane to devote more screen space to the device pane. To do this, press the

 V key on your keyboard. This will toggle the tool pane to the side. To

 restore the tool pane, press the V key again.

 THE DEVICE PANE

 In the center pane, the user can interact with a schematic representation

 of the device. Note that the spacing between pillars in this pane is not

 accurate; it has been reduced to enable easier user interaction. To view

 an accurate physical description of the device, it is recommended to export

 a DXF and view the device in your tool of choice.

 In this pane, green cubes represent candidate pillar positions for pillars

 of the currently-selected diameter. To place a pillar, position the mouse

 cursor over a candidate pillar position, and press the left mouse button.

 Once a pillar has been placed, the software automatically shifts the view

 downstream of the placed pillar, to facilitate placement of additional

 pillars. The user may adjust an already-placed pillar by positioning the

 mouse cursor over that pillar, and clicking on it. This selects the pillar

 for adjustment. That pillar may now be adjusted using the sliders in the

 tool pane, or by left click-dragging the pillar into a new position. The

 user may also change the current selection using the LEFT and RIGHT arrow

 keys on his or her keyboard. The UP and DOWN arrows can be used to change

 the current pillar diameter.

 To remove a pillar, select the pillar and press the DELETE button on your

 keyboard.

 To zoom in on the device, use the mouse scroll wheel. Right-click drag to

 orbit the current view about the device. Left-click drag to pan around the

 device. Use the C hotkey to toggle between the standard view and a top-

 down orthographic view of the device.

 At each boundary between pillars, a representation of the fluid cross-

 section appears. This representation indicates the deformed flow field

 that would be observed if a cross-section were taken following the

 previous pillar.

 THE OUTPUT PREVIEW PANE

 At the top of the rightmost pane of the screen is the realtime output

 preview. This is a low-resolution preview of the transformation at the

 location beneath the mouse cursor. Note that this is simply an

 interpolation of the transformation occuring at each boundary, and does

 NOT represent the actual fluid cross-section at the mouse position.

 Instead, it is intended as a visual tool for understanding the steps in

 the fluid transformation. The actual fluid dynamics are more complex and

 are not captured in this preview.

 Second, in the output preview pane is a high-resolution view of the fluid

 cross-section at end of the device, after all pillars have contributed

 their transformation. The user may click this preview to compute a very

 high-resolution version of the result. If PIL is present on the system,

 a SAVE button will appear below the high-resolution result, allowing the

 user to save a PNG of this image. Note that a number of numerical issues

 at the boundaries of the simulations result in visual artifacts in the

 computed flow field. These are non-physical and unfortunately unavoidable

 at present. We are investigating methods for mitigating these artifacts.

 In the preview versions of the software, a debug window appears at the

 bottom of the output preview pane. This window contains information on the

 state of the program, and can be useful for spotting bugs. For more

 information, please see the TROUBLESHOOTING portion of this document.

TROUBLESHOOTING

 VISUAL ARTIFACTS, NO OUTPUT, AND/OR OPENGL 1286 ERROR

 uFlow requires a modern OpenGL implementation with floating-point

 framebuffer support, in order to perform fast computation with the GPU.

 This feature is supported by the majority of graphics cards manufactured

 since 2004. However, some Windows installations do not ship with the

 drivers necessary to expose this functionality. Please ensure that you have

 complete, up-to-date drivers installed for the graphics hardware in your

 computer, available from the manufacturer's website.

 In certain integrated graphics hardware found in laptops, this

 functionality is (unfortunately) not available. If your graphics drivers

 are up-to-date and you still receive this error, it is possible that you

 have one of these chipsets. In our experience, some hardware drivers will

 support the relevant functionality in one OS but not another (in

 particular, OpenGL support on Intel chipsets appears to be better on

 linux than on Windows). Unfortunately, there is nothing we can do to fix

 this issue, and we recommend switching to another computer or installing a

 new graphics card.

 If you find any bugs, or if your question is not answered here, please do

 not hesitate to contact us using the information described in the CONTACT

 section of this document.

CONTACT

 For general information about the software, please see:

 http://biomicrofluidics.com/software.php

 If you wish to contact the author with questions, comments, bug reports, or

 for any other purpose, please do so at the following address:

 stoeckd AT ucla DOT edu

 This software is being developed as part of an ongoing research effort by

 the Di Carlo lab at UCLA. For more information about the lab and our other

 work, please see our website, at:

 http://biomicrofluidics.com