Swumsuit Manual

2005/4/16
for Swumsuit version:1.0.0

1 Outline

Swumsuit is a software in which the swimming human simulation model SWUM proposed by Motomu Nakashima et al [1] is implemented. As input, body geometry, joint motion and analysis settings are given and they are passed into the analysis engine part. The analysis engine estimates the fluid force acting on the human body from the body geometry and joint motion, solves the equation of motion for the human body as a rigid body, and compute the absolute motion of the human body. The analysis engine also outputs many quantities from the computation, such as swimming speed, power efficiency, thrust, joint torque.

By using Swumsuit, the user can perform all tasks in the simulation, such as, editing input data, starting analysis, and displaying results of many quantities by graph and animation, with GUI operation without paying attention to inside of the simulation program.

Due to this easiness of operation, Swumsuit provides for everyone a pleasant environment to simulate the dynamics of swimming, which have been thought to be very difficult with respect to human motion and formulation of the fluid force.

Swumsuit is a Free Software based on GPL (GNU General Public License).

2 Location of Distribution

You can get Swumsuit at the website http://www.swum.org/swumsuit/.

3 Environment

Swumsuit runs on Windows 2000 Professional, Windows XP or higher, and Linux. It does NOT run on Windows 95, 98, Me. For Linux, ActiveTcl (http://www.activestate.com/Products/ActiveTcl/) and BLT package (http://sourceforge.net/projects/blt/) must be necessary.

4 Installation and How to Startup

The installation of Swumsuit is very easy, however, you have to do it manually, not automatically with self extracting installer program.

1. Extract the downloaded swumsuitX_X_X.zip with some extracting software.
2. Copy the folder “Swumsuit” into your desired location. Please do NOT locate the folder on a network drive.

   This is basically all you have to do for installation.
3. To startup on Windows, double-click the file “swumsuit_en.exe”, which is represented by an icon of “SWUM”. The file “swumsuit_jp.exe” is the Japanese version. If you feel troublesome to open the Swumsuit folder every time, making a shortcut to the EXE file on the desktop might be help.

   To startup on Linux, enter swumsuit_en.tcl on Xterm at the Swumsuit folder. It will NOT run if the wish command is not the one of ActiveTcl. To check this, enter “which wish” and it is ok if the return message is /usr/local/ActiveTcl/bin/wish, or similar. If the message is not something like that, please check your “path” configuration.

   It might be troublesome to move directory every time on Linux. If so, making a shell-script as below and copying it as /usr/bin/swumsuit_en will be help.

```
#!/bin/sh
cd /usr/local/lib/Swumsuit
wish swumsuit_en.tcl
```

Do not forget that you have to set the file /usr/bin/swumsuit_en executable (chmod 755 swumsuit_en).

5 Operation

5.1 Main Window

The main window is the window which you see first after the startup.

5.1.1 Project Folder Tab

In Swumsuit, a data set of three input files, that is, body geometry, joint motion and analysis settings, and many output data files (and comment file, optionally) is called a "Project". This set is located in a folder, which is called "Project folder". That is, the project folder includes all the conditions and the results of the analysis.

At the project folder tab, the operation related with the project folder is conducted.

Create Use this when you create a new project folder. In this case, loading separately data files of body geometry, joint motion, analysis settings are necessary. Actually, this function might not be used often.

Open Open an existing project folder. You will be warned if there is not even one data file among the body geometry, joint motion and analysis settings.

Save As Use this when you save a project folder as another name after opening the project folder. At this function, only three input data files are copied and saved in the project folder of another name. The output data are NOT copied. This function will be typically used in the case of analysis with changed parameters. That is, first open an existing folder, next change the parameters, and save it as another name using this function.

You will be asked whether the comment is copied or not, when the project folder has its comment and comment file exists.

Info Display the location and comment of the project folder. You also can edit the comment and save it.

Note that the location of the project folder is displayed in the window title bar of the main window.

5.1.2 Input Tab

Edit Body Geometry Invoke the edit body geometry window. Please see 5.2 for details.

Edit Joint Motion Invoke the edit joint motion window. Please see 5.3 for details.

Load Body Geometry Load body geometry file. Although body geometry file is always saved as "body_geometry.dat" in the project folder, any file with a name "∼.dat" can be loaded with this function. For example, you can store body geometry data of averaged male and female as geometry_male.dat and geometry_female.dat, respectively, and load whichever you need for analysis. The data file is automatically renamed as body_geometry.dat when it is located in the project folder.

Load Joint Motion Load joint motion file. Although joint motion file is always saved as "joint_motion.dat" in the project folder, any file with a name "∼.dat" can be loaded with this function. For example, you can store joint motion data of crawl and breast stroke as crawl.dat and breast.dat, respectively, and load whichever you need for analysis. The data file is automatically renamed as joint_motion.dat when it is located in the project folder.

5.1.3 Analysis Tab

Start Analysis Start analysis. The analysis engine runs on a command prompt window on Windows, or Xterm on Linux. The analysis takes generally a few to tens minutes, although the calculation time depends on the analysis condition. During the analysis, several quantities are displayed, such as, cycle, direction, x, y, stroke length, stroke length deviation. These respectively are stroke cycle, direction in the horizontal plane (x-y plane), x and y coordinates of the mass center, nondimensional stroke length, and a ratio between two values at the present and previous cycle of the nondimensional stroke length, which can be a criterion whether the calculation reaches a steady condition or not.

Edit Analisys Settings In the edit analysis settings, number of time step, the fluid force coefficients and so on can be changed.

At the "Initial condition", the initial position, direction, velocity and angular velocity can be changed. And at the "Initial direction in x-y plane", you can correct the direction of propulsion. That is, in the case of asymmetrical motion, such as the crawl swimming, the human body propels obliquely even if the initial direction faces toward -x direction. In this case, check the calculation results of "direction" at the steady state, and if the value is 34 degree, you can obtain the results of straight swimming toward -x direction by substituting -34 into the "Initial direction in x-y plane".

At the "Output settings", you can choose which data are outputted. Outputting all the calculation results for all cycles results in heavy load to the system and increase of calculation time. You can save the disk space and time if you do not output unnecessary data.

Load Analysis Settings Load analysis settings file. Although analysis settings file is always saved as "analysis_settings.dat" in the project folder, any file with a name "∼.dat" can be loaded with this function. The data file is automatically renamed as analysis_settings.dat when it is located in the project folder.

5.1.4 Output Tab

Animation Invoke animation window. Please see 5.5 for details.

Graph Invoke graph window. Please see 5.6 for details.

5.1.5 Other Tab

Preferences Configure preferences. At the present version, you can select the OS of the analysis engine. Default is "Auto detect". That is, the present OS, on which Swumsuit is running, is automatically judged as the OS for analysis engine. However, in some case, you might would like to share files between Windows and Linux through network, configure the analysis condition on Windows, and run the analysis engine on Linux. In this case, release automatic judgement, and select the OS you would like. Actually, the execute file of the analysis engine is copied into the project folder for each time of analysis. The file names are SWUM_ENGINE_WINDOWS for Windows and SWUM_ENGINE_LINUX for Linux, respectively. Therefore, if the OS of the analysis engine is set as Linux on Windows, SWUM_ENGINE_LINUX is copied into the project folder when the analysis starts. (Of course, the execute file for Linux does not run on Windows.) And if you login to the Linux box with some terminal software, move into the project folder, and execute SWUM_ENGINE_LINUX, then the analysis will start normally on Linux.

Manual Display how to obtain the manual.

About Display version information and so on.

Exit Exit the software.

5.2 Edit Body Geometry Window

You can edit the body geometry on this window. If you click "Figure", the modeled human body is displayed in three-dimensional form. On the figure window, by dragging up and down, right and left with keeping left clicking, you can rotate the human body about horizontal and vertical axes in the screen plane. By dragging up and down with keeping right clicking, you can rotate it about normal axis to the screen plane.

You can change the size and density ratio to the water on this window. When you change the value in an entry, it will be reflected on the figure by clicking "Apply".

After changing values, click "Save" and close the window.

5.3 Edit Joint Motion Window

You can edit the joint motion on this window. Please load some project first, then invoke this window. The number of frame for one cycle is displayed at the upper left. At the right side, plural lines, whose each line consists of rotated body segment, rotating axis and angles of all frames, are displayed.

In SWUM, the joint motions are represented as rotation of each body segment about joint. The axes of rotations are one of the body base coordinate xb, yb and zb. The rotation angle is not relative but absolute. That is, even if you rotate the thigh for certain angle, the rotation does not affect the shank. In order to rotate the shank for same angle, you have to give same rotation angle for the shank. The rotation is IN ORDER which is displayed in the right side of the window. Therefore, in the case of rotation for a certain body segment, the results becomes DIFFERENT between the rotations of xb-yb and of yb-xb.

At this window, you can copy, cut, paste of each rotation, and also create a new rotation. In order to select a rotation, click line of the rotation in the right side. With keeping pressing shift key, you can select the range of lines. With keeping pressing ctrl key, you can select multiple lines. By "Paste", the copied line(s) is(are) pasted under the selected line.

At "Animation", the joint motion is displayed with three-dimensional animation. On this animation window, by dragging up and down, right and left with keeping left clicking, you can rotate the human body about horizontal and vertical axes in the screen plane. By dragging up and down with keeping right clicking, you can rotate it about normal axis to the screen plane. You can also change the displaying speed and can move to an arbitrary frame with scale after pausing.

On this window, you can not edit the body segment to be rotated, the rotation axis, and each value of the rotating angle, although you can change the order of the rotations and can copy them. In order to edit them, you have to double click the line to be edited or click "Edit motion" with selecting the line, and invoke "Edit each joint motion" window explained in the next section.

5.4 Edit Each Motion Window

On this window, you can edit body segment, rotation axis, and angle at each frame for each rotation. The values of angles at all frames are displayed on the left side in numerals, and on the right side with a graph. Note that, in SWUM, gaps between frames are interpolated with Spline function as shown in the graph on the window. By clicking "Apply" after changing numerals on the left side, the graph on the right side will be also changed. On the lower right side, you can perform operation for all frames. You can move in X and Y directions, magnify, and invert all the angles.

This window works together with the animation which is invoked at the edit joint motion window. That is, by pausing the animation at a frame, background color of the numeral entry for the frame on the left side is changed into yellow. And a large yellow point appears on the graph, too. Therefore, if you find a joint angle to be changed at a frame watching the animation, you can easily find the corresponding angle of the frame.

5.5 Animation Window

At this window, you can see three-dimensional animation of the analysis results. On this window, by dragging up and down, right and left with keeping left clicking, you can rotate the human body about horizontal and vertical axes in the screen plane. By dragging up and down with keeping right clicking, you can rotate it about normal axis to the screen plane. You can also change the display speed and can move to an arbitrary frame with scale after pausing.

The red lines from each part of the body represent the direction and magnitude of the fluid force. The length of the lines also can be changed by clicking the arrow mark at the side of "Force". The propulsive distance in one cycle is divided into two kinds of areas with different depth of colors on the water surface.

In "Output Settings" of "Edit Analysis Settings", if you choose "All cycles" for animation, you can select whether all cycles are displayed or only the last cycle is displayed, by clicking "All" or "Last" on the lower right side of the window. In the case of 'All", the animation stops for a moment at each end of cycle. This is not a bug but the normal behavior. In the case of "Last", the last cycle is animated without the stop.

At the lower left "Rotation angle" part, the rotation angle of the animation can be inputted with numerals. Please click "Apply" after inputting.

By clicking "Output", you can output snapshot of the animation for each moment as an EPS file. You can select to output whether whole cycle or this moment only. If you choose "All", you have to wait for much time to be completed.

5.6 Graph Window

The Graph window is invoked by clicking firstly "Graph" at the "Output" tab in the main window, and selecting quantities to be displayed. The graph title is shown at the upper part of the window. You can dimenionalize/nondimensinalize the graph by clicking "dimension". You can configure graph range by clicking "Range". If you leave the range as blank, the graph range is automatically determined.

If you bring the mouse pointer close to line of the graph, the values of abscissa and ordinate at the nearest data point are displayed, and you can easily read numeral values from the graph.

The "Output" part supports many kinds of format. For Window, you can output into formats of Clipboard, Windows meta file (WMF), Extended meta file (EMF), and EPS. For Linux, EPS format only.

6 Developping Environment

Below environments and softwares are used for developing this software. We greatly appreciate the author of these softwares, especially noncommercial softwares.

Windows

- Windows XP Professional
- ActiveTcl 8.4.6 (http://www.activestate.com/Products/ActiveTcl/)
- BLT 2.4z (http://sourceforge.net/projects/blt/)
- Togl 1.6 (http://togl.sourceforge.net/)
- freeWrapPLUS 6.0 (http://freewrap.sourceforge.net/) (The executable file "wish_windows.exe" in the Swumsuit package is created by merely renaming "freewrapPLUS.exe" in the package.)
- freeWrap 5.61 Japanese version (http://reddog.s35.xrea.com/wiki/index.php)
- Intel Visual Fortran Compiler 8.1 (http://www.intel.com/software/products/compilers/fwin/)
- SLATEC numerical calculation library (http://www.netlib.org/)

Linux

- Vine Linux 2.6r1 (http://www.vinelinux.org/)
- ActiveTcl 8.4.6 (http://www.activestate.com/Products/ActiveTcl/)
- BLT 2.4z (http://sourceforge.net/projects/blt/)
- Togl 1.6 (http://togl.sourceforge.net/)
- g77 0.5.24 (http://www.gnu.org/software/fortran/fortran.html)
- SLATEC numerical calculation library (http://www.netlib.org/)

7 Contact

Please send any quastions, requests, bug reports and opinions to swum-admin_at_swum.org (please change _at_ into @). Any information is welcomed.

References

[1] Motomu Nakashima, Yasufumi Miura and Ken Satou, Swimming Human Model SWUM to Analyze Swimming Dynanical Problems, The Engineering of Sport 5 (Proceedings of the fifth international conference in engineering of sport), Vol.1, 594-600 (2004).