RealFlow 0.24 beta

by
Victor Gonzalez
&
Ignacio Vargas

INTRODUCTION

RealFlow is a new particle system algorithm which simulates real fluids (gases, liquids, etc.) by means of a mathematically reliable engine based on Computational Fluid Dynamics schemes. Due to this fact, it is CPU intensive but it achieves a high degree of realism.

The calculus engine was developed in the beginning of 1997 by Victor Gonzalez and Ignacio Vargas and some outstanding animations (showing the dynamic of particles interacting with moving triangle mesh objects) were produced. Those interesting initial animations and some new ones from our testers can be found in:

```
http://www.3dspot.com/~realflow
http://www.arrakis.es/~otowen
```

Because of the great success of this algorithm, and the amount of people who showed interest in this project while it was shown at Siggraph 97 in L.A., we are now developing a fully functional interface for Windows NT and 95 which brings the possibility of beta testing. You should check for new versions of **RealFlow** at the following URL:

```
http://www.etsin.upm.es/victor
```

Please we need your feedback! Feel free to mail us and tell us your opinion, comments, suggestions and bugs. Are you interested in this technology? Licensing? Plug-ins? Let us know!

e-mail:

victor@etsin.upm.es
otowen@arrakis.es
mfajardo@freenet.hut.fi

Note: this version expires in December. After that, you will have to download a new version from the www site.

COMMANDS

1. Fluid Panel

This panel shows all the physical parameters which establish the general conditions of fluid motion in the simulation.

Gravity:	Gravity vector. Earth gravity is about (0, -10, 0) (note negative sign).
Origin:	Origin coordinates of the cube. Initially, the fluid has a cubical shape.
Length:	Length of initial cube edges in each axis.
Velocity:	Initial velocity of particles when they are created.
Distance:	Initial distance between particles in the cube.
Mass:	Mass of each particle (please don't set it to values greater than 1.0).
Load:	Load fluid parameters from file (FLU format)
Save:	Save fluid parameters to file (FLU format)
Viscosity:	Viscosity factor (it's like friction between particles).
Full viscosity:	Viscosity affects not only in particle attraction, but in both directions.
Pressure:	Pressure factor (affects repulsion/attraction between particles).
Friction:	Friction factor between particles and objects.
K:	Elasticity factor in particle-object collision, in [0, 1] (1 = perfectly elastic)
Rate:	Amount of particles created per second.
Max:	Maximum number of particles when creating.
Fluid type:	Switches between gas, liquid or other viscous things.
Tag:	Any comments or annotations for this fluid can be made here.
Link:	Links the creation of particles to the specified object

Extended Parameters:
This command shows up a new dialog window which lets you set new options for the particles:

Destruction > Age: A particle dies when its internal time reaches this age.
(New features under development)

2. Object Panel

This panel shows the controls which let you import up to 10 objects in **RealFlow**. Each object is referenced with the combo box that shows "Object n" where n is the current object. The V (vertices) and F (faces) numbers inform you about the characteristics of the current object.

Warning!! only triangular faces are valid for **RealFlow**, others are ignored. You should check that your LWO object has the appropriate triangular faces.

Import object: Loads an ASCII mesh object exported from 3D Studio (ASC file format) or a Lightwave object exported from LightWave (LWO file format).

Clean:	Removes the object from the scene.
Clean All:	Removes all objects from the scene.
X+ X- Y+ Y- Z+ Z-:	Shifts the object coordinates in view window.
Velocity:	Object´s vector velocity.
Rotation:	Object´s vector rotation (around its mass center).
Update:	Updates object´s velocity and rotation vector with the above values.
Face Test:	if enabled, **RealFlow** checks for faces holding up between pairs of particles. This option will make the process slower and should be only enabled if necessary. For example, the fluid inside a sphere should have this option disabled, but a thin wall separating different parts of the fluid will need the Face Test enabled.

3. Options Panel

This panel manages several controls related to the view window and the possibility of saving image files for each frame.

Save Targa: Saves the view window as a TGA file each 1/FPS of a second.

Save LWO files: Saves the particles as a LWO (Lightwave) object each 1/FPS of a second. You just need to load the first LWO in Lightwave and apply the **ObjectSequence** plug-in.

File prefix: The file prefix for Targa and LWO files.

FPS: Frames per second.

Point size: Updates the point size in the view window.

Particle color: Switch between velocity or pressure color encoding.

4. Control window (lower right corner)

Restart particles: Initialize fluid parameters in the view window. **You must click it to refresh any changes made to the fluid parameters.**

BUZZ: Begin/Stop the calculation.

Time: Shows the total time elapsed.

Step: Shows the (adaptive) time step in the simulation.

5. View controls window (lower area)

View axes: Shows axes in the view window.

Solid: Shows a solid representation of objects.

Grid: Shows the reference floor grid.

Bounding Box: Shows the bounding box of the objects.

PAN: If enabled the mouse will pan the view window instead of rotating it.

Center: Centers the view on the particle system.

Top: Display a orthogonal view of the scene from top.

Side: Display a orthogonal view of the scene from side.

Reset view: Restore initial view parameters (perspective mode).

6. Menu options

FILE menu

File > Load workspace: Loads fluid and object data from disk (FLW format).

File > Save workspace: Saves fluid and object data to disk (FLW format).

File > Import LWS scene: Import a Lightwave scene (LWS format). Only up to 10 objects are imported (as in the *Import Object* command). Only first keyframe is loaded.

File > Preferences: Set the base directory for the objects to be imported from the Lightwave scene. By default it is set to C:\NEWTEK (as in Lightwave) but you should change it if necessary. You can choose the background color too!

LINK with Lightwave

Our strategy consists on keeping this standalone as the final product if possible. Therefore we are developing a set of little plug-in servers for the most important 3D packages (such as LightWave or 3D Studio MAX). **RealFlow** acts as the client, asking for data to the servers. Here we present the first version of the Lightwave server.

RealFlow server for Lightwave (5.0 & 5.5 compatible)
First of all you have to install the file realflow.p as a layout generic plug-in in LightWave. Then you must load the same scene in both Lightwave and *RealFlow* programs. Now LightWave and *RealFlow* should show the same objects in the same positions. Then follow the next steps:

1. Edit the Lightwave scene (move, rotate or scale objects).
2. Enable realflow server plug-in (located in the general plugins section). A dialog window will pop-up and the plug-in will switch to listening mode. At this point you can continue using Lightwave while the plug-in is active.
3. In *RealFlow* select **Link > RealFlow** and then click connect to server. Then the *RealFlow* scene will be updated with the information passed from Lightwave.

Only information of keyframe 0 is transmitted when you click Connect to Server button. When *BUZZ* is activated the server will pass the information in each time interval so *RealFlow* will be able to see the complete animation of Lightwave.

TUTORIAL

When the program begins, the view window shows the cube for the default values. Change some parameters and remember to click *Restart particles* in order to refresh the view window and internal variables. Load some ASCII or LWO object with *Insert Object* button in the Object panel. Enable *Save Targa* by clicking on the check button. Change the point of view by dragging the mouse over the view window with the left button pushed. Change zoom by dragging the mouse with the right button pushed.

After you have modified all parameters push *BUZZ* and see how the calculation process begins. Particle color represents relative speed or pressure (red is high, and green is low). Some internal information is shown in the text box. After a few minutes you might stop the process by clicking the *BUZZ* button again.

In the default directory you will find TGA files with names "???XXXX.TGA" where XXXX is the frame number (remember each file represents 1/FPS of a second). There are several utilities which can build an animation file (AVI, FLC, etc.) from TGA files. We have used DTA (Dave's TGA animation program) and VFD (Video for DOS).

TIPS & TRICKS

• Too many particles will result in heavy memory usage and a very slow process. But the results might be analogous if less particles are used.
• Don't change the point of view when saving TGA or the animation will show strange jumps (but maybe you want to stop the animation, change to other interesting point of view and continue the animation…)
• Most parameters have a restricted range of sensible values. Don't set them too far from the default values or you'll get your particles blowing up.
• If time step is too low (0.0001 or lower) that is because the process is stuck. Usually it is caused by particles enclosed inside a diminishing space.

- We have noticed that number of particles and pressure factor are related. A high number of particles should use lower values of pressure factor if you want to keep the same behaviour. For example: 27 particles, 0.1 pressure could be equivalent to 1000 particles, 0.001 pressure.
- When you achieve an interesting set of parameter values, save them (Save option in fluid panel) and try new animations with slight parameter variations.
- We have just added a new kind of fluid named *chof*. It's similar to *viscous* but with a slightly different behavior. We recommend you these values for both *viscous* and *chof* types: *Distance=0.15 mass=0.9 viscosity=300 pressure=5 friction=0.6*
- Try high pressure values (1.0 -- 5.0) and high viscosity values (50 -- 500) combined with full viscosity. You can obtain fluids with a high stiffness behavior.

SUPPORT FOR WINDOWS 95 USERS

This is a 32-bit Windows executable and it has been tested successfully in a Windows 95 environment. Windows 95 supports *OpenGL* but in early Win95 versions the DLL libraries are not included in the installation media. In this case *RealFlow* won't run. The *OpenGL* support for Windows 95 can be found in Microsoft (www.microsoft.com) and many other sites. We have included it in our web page too.

BETA-TESTING PROGRAM

Please contact Marcos Fajardo (beta-testing coordinator) and he will inform you about the way you can cooperate with us to improve *RealFlow*:

Marcos Fajardo
Pico de las Palomas, 11
29004 Malaga
SPAIN

mfajardo@freenet.hut.fi
+34 5 2343738   (phone)
+34 5 2326562   (fax)

REVISION HISTORY

RealFlow 0.1a
- First (and full of bugs!) beta release.

RealFlow 0.1
- Fixed many bugs.
- Multithreading for calculation loop
- Added some other minor changes.

RealFlow 0.16

- Fixed several bugs.
- Handles up to 10 objects.
- Now it saves TGA files ok.
- A single file format (FLW) for saving/loading the entire scene.
- Calculation is a bit faster.
- Can import Lightwave (LWO) objects.

RealFlow 0.19
- Two decimal values are saved in FLW format.
- Solid objects are correctly represented.
- Import Lightwave scenes (keyframe 0).
- Changed axes for LightWave compatibility.
- Included Face Test option.
- Fixed some other minor bugs
- Added some performance improvements.

RealFlow 0.20
- RealFlow server for Lightwave presented.
- **Great improvement in calculation times!**
- New viscous type of fluid.
- Now can choose the background color.
- Fixed some bugs.

RealFlow 0.21
- FLW saves some other parameters.
- Material files implemented (fluid parameters).
- Fixed memory leaks.

RealFlow 0.22
- Exports particles as LWO objects.
- FPS and file prefix parameters.

RealFlow 0.24
- New windows management and interface improvements.
- Fixed various display problems (Matrox Millenium cards, 256 color modes ...)
- You can move to the next field with the TAB key (finally!).
- Mass parameter has been removed
- Added some new features (particle life, link to object).

ACKNOWLEDGEMENTS

The following people have been very helpful and active testers:

Adam Chrystie @ DNA Productions
Alan Chan @ Digital Domain
Alex McLeod
Andrew Bradbury @ Digital Animations
Andy Lesniak @ Digital Domain
Bob Lindabury @ Raven Imaging
Brian Tatosky @ OCS/Freeze Frame/Pixel Magic

Cedar Kraus
Frank Aalbers @ Planet X Studios
Grant Boucher @ Planet X Studios
Kevin Quattro @ Foundation Imaging
Mike Bayona
Oliver Hotz @ Computer Cafe
Saiyad Abdul

Sorry if your name is not included here. Notify us as soon as possible!

Special thanks to:

Jose María Pérez Box for the web pages support. (webmaster@etsin.upm.es)
Miguel Talens Mion for helping us in some tricky Windows artifacts. (bubinga@etsin.upm.es)

Last revised 11 / 24 / 1997 by Victor Gonzalez, Ignacio Vargas.