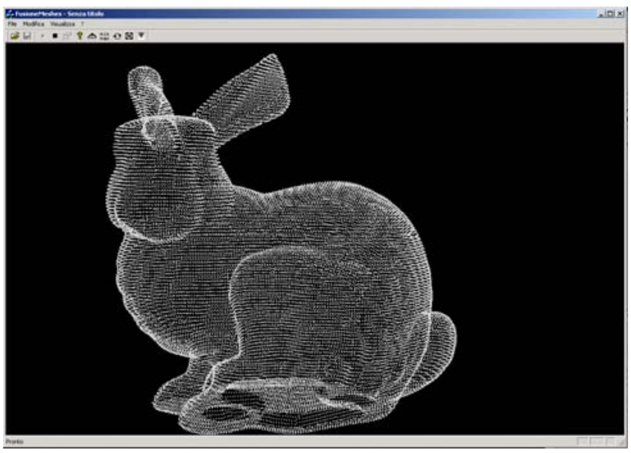
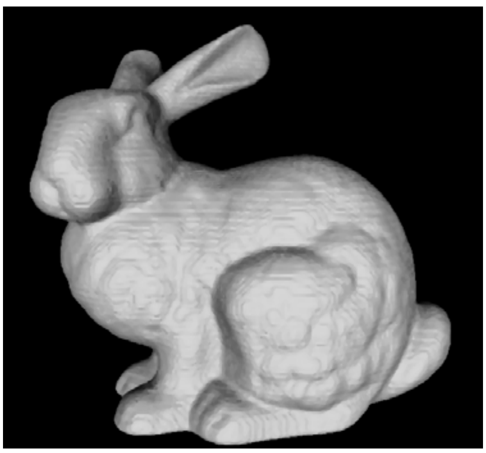
3D L-S Recon: A Fast Level-set Approach to Surface Modeling from Unorganized Sample Points

Marco Marcon, Luca Piccarreta, Augusto Sarti, Stefano Tubaro.
Dip. di Elettronica e Informazione – Politecnico di Milano
Piazza L. Da Vinci 32 – 20133 Milano – Italy
marcon/piccarre/sarti/tubaro@elet.polimi.it
tel: +39-0223992657 / +39-0223993444

The demonstration shows the functionalities of our novel algorithm developed for a fast reconstruction of smooth surfaces from unorganized clouds of points; it's based on the temporal evolution of a volumetric function's level-set.
The algorithm that we developed has been submitted ad accepted at the poster session of the ICCV workshop on level-sets.
One remarkable feature of our approach is its ability to model complex topologies thanks to a novel strategy that allows us to steer the front evolution using Voronoi surfaces in 3D space. Another remarkable feature of this algorithm is its computational efficiency, which proved to be between one and two orders of magnitude better than traditional level-set approaches.
The evolving front, described from the zero level set of the implicit function, is thought of as the surface that separates two different immiscible fluids that obey specific laws of fluid dynamics. In particular we steer the level-set evolution by a Navier-Stokes equation instead of the classical Hamilton-Jacobi PDE proposed by Sethian and Osher.
Thanks to this innovative description we can control the evolution of the level-set using a complete fluid-dynamics model: fluids features, like viscosity and turbulence, have been used to improve the quality of the reconstructed surface allowing the level set to flow inside deep grooves.
The program performs an initial analysis of the points positions calculating the best orientation of the voxel-set grid. Besides of this the grid can also support non-uniform dimensions of the voxels in different directions allowing different resolutions along different axes.
The key-factor in the speed of our algorithm consists in a single computation of the distance function at the beginning of the evolution. The vector field representing the oriented distances towards the nearest point will then steer the fluids motion towards the final convergence.
Here is an example of the reconstruction of Bunny Stanford: at left there is the cloud of points and at the right there is the reconstructed surface.

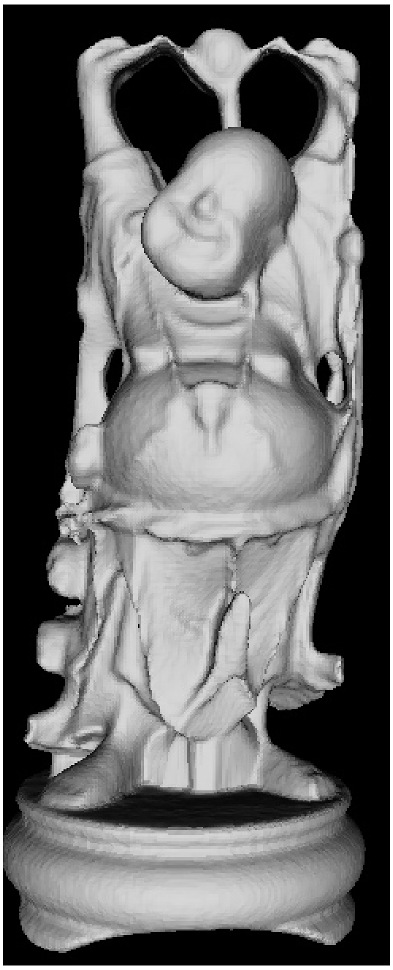
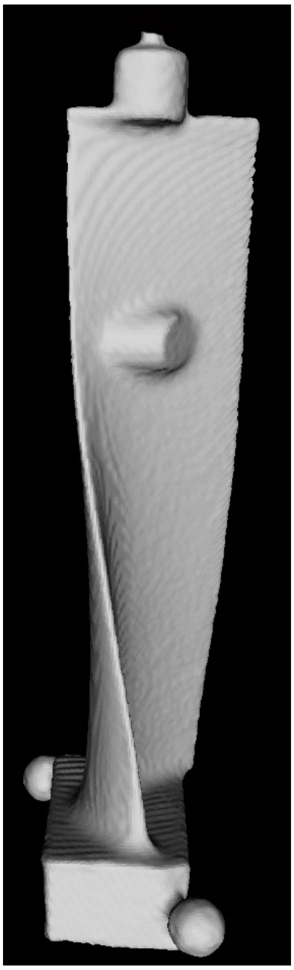


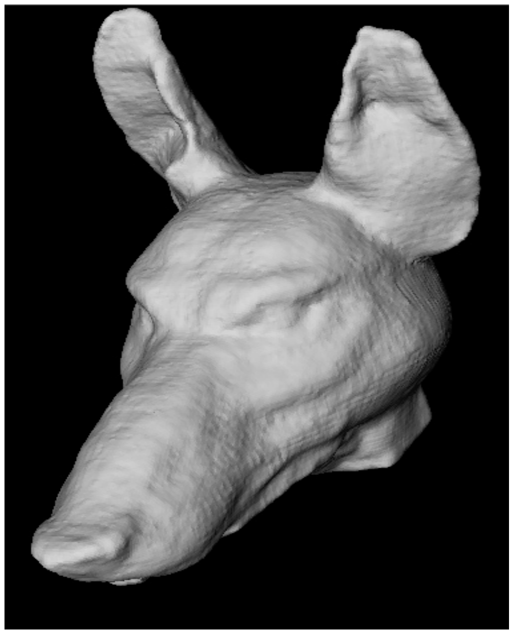


The surface is obtained from the implicit function using the marching cubes algorithm and the rendering is obtained in an interactive window using the OpenGL rendering engine. During the evolution phase it's possible to see the motion of the level-set towards the sample points.

In the table below there is the rendering time for the following figures at different resolutions of the Voxel-set. The rendering was performed on a standard Dekstop computer absed on an AMD Athlon™ XP at 2.1 GHz with 512 MB RAM under Windows™ 2000.

Set	Resolution	Points	Time (s)
Bunny	180	35780	40
Bunny	100	35780	4
Happy buddha	350	3836	105
Teapot	256	33061	110
Airscrew	300	1550316	120
The Wolf	300	20860	230



The equipment that I will provide will me only my note-book PC, I don't need any other special equipment.
The size of the space that I need is only one desk, if you think that may be useful for big affluence to the demonstrations session I can also bring with me a video-projector to show the screen of my PC on a wall.