

# Computer Game Scene-Generation Projects Using “Particle Methods”

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Particle methods are used in generating physically correct appearing behaviour of various material and scene components **in movie special effects and in computer games**. The key concept is to use Newtonian or **classical physics models to compute realistic trajectories of particles in a system**. Particles can be used directly to model flow of fluids such as water or lava. A visually realistic-appearing surface can be generated by use of texture-mapping or some other mapping of image data to the plausible-appearing surface generated by the particle paths. More detail can be added if more individual particles are included.

Other materials such as **cloth can be modelled by draping a suitable texture map across a surface mesh** with particles at each node. The appearance of movement of the material, as would occur from flow in air or water currents, is simulated by applying suitable physical models to the particles. The integrity or layout of the surface mesh is maintained if the nodes are constrained in their spatial relationship to one another. Such as structure is known as a tethered-membrane and is simulated using a set of particles held in a fixed graph or network relationship to one another. Once again, more folds or substructural details can be modelled if more particles are used in the simulation.

This project is to investigate the use of integrated simulation and graphics techniques, and also high performance computing technology, to create **near real-time rendering of particle systems** with as many particles simulated as possible. An **interactive simulation framework** will allow **control parameters** relating to the model physics to be **tuned directly by the user** to obtain the right flow properties such as weight, viscosity or pliability.

The project involves development of Java or C/C++/OpenGL software to construct an interactive test-bed. Small numbers of particles will be attainable within a single processor program, but a distributed framework that can access multi-threading capabilities or remote high performance computer clusters will be required for systems of more than a few hundred particles.

Parts of this project could be carried out at **undergraduate, honours or masters level** with obviously more work required to implement more of the aspects of the system at higher levels of study. There is scope for software engineering a suitable framework as well as model development and investigation of different physics details. There is also scope for learning to integrate programs with distributed computing and parallel processing software tools and libraries.

The project can be based on some **existing Java code** and algorithms for simulating particle systems. Key developments in the project will involve design of suitable data structures and file specifications to manage suitable simulations. These can be integrated with existing or integrated 3D rendering software. An ideal system would integrate particle trajectory calculations with a built-in visualisation system.

It will be helpful if student(s) working on this project have some OO and graphics experiences. It would be best to have taken and passed 159.234 and 159.235 and their pre-requisite courses. Some software is already available from the demonstrator examples of both those papers to help construct a software prototype for this project. This project might also appeal to students interested in the underpinning physical models and the approximations that are commonly used.

A simple “flag moving in the wind” can be simulated by a simple tethered-membrane. This approach is the basis for many of the clothes effects you may have seen in computer-generated effects in movies or in modern games. The recent *Star Wars* movie *Attack of the Clones* makes use of particle methods in generating the realistic water effects in the large waterfall. This approach is obviously attractive in generating visuals for other impractical photo-shootable effects such as lava rivers. There **are possible extensions to this project** in considering how **other materials or shapes would interact with simulated**