USING PARTICLE SYSTEMS TO MODULATE CELEBRATIONS WITH FIREWORKS

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Schedule

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- Basic concepts
- Proposed model
- Results
- Conclusions

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Goal

- Simulate all kind of celebrations using fireworks (with different shapes, sizes and colors).

- Construct a model that we can add:
  - wind conditions (ideal or real)
  - lightness conditions (ideal and real
  - smoke
  - sound
  - distance between fireworks
  - lime-light
  - possible obstacles and any other influences that the fireworks may suffer

Basic concepts

- The use of particle systems on computers began on 1983 with William T. Reeves on a project of special effects of the film “Star Trek II: The Wrath of Khan”.

- Using laws of the mechanics of Newton he shows the possibility of creating elements by a collection of particles.

- Particle systems are a way to model objects like fire, clouds, smoke and water.

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Particle systems

- An object isn't represented by an set of elements of primitive surface like polygons, but like clouds of primitive particles that defines its volume.
- A particle system is not a static entity, its particles can change their forms and move themselves.
- New particles are created and old ones are destroyed.
- An object represented by a particle system is not deterministic, its form is not completely specified.

Particle systems

- A particle is an object that has:
  - Mass
  - Position
  - Velocity
  - Color

- And could be affected by other forces, like: gravity
  - Air resistance
  - Wind.

Proposed model

> We used, as inspiration, past year celebrations taped on some Brazilian beaches.

> Different types of fireworks were formulated to simulate situations like:

New Year's Day

opening events of:

- olympics games
- and world championships.

> The initial position components (x, y, z), like the color (r,g,b) of each firework are taking randomly.

Particle characteristics

> Each new particle has as attributes:

Initial position (x, y and z);

Initial speed (x, y and z);

Size;

Color;

Initial transparency;

Shape;

Life time;

Speed that the live goes away (by frame);

Acceleration (x, y and z).

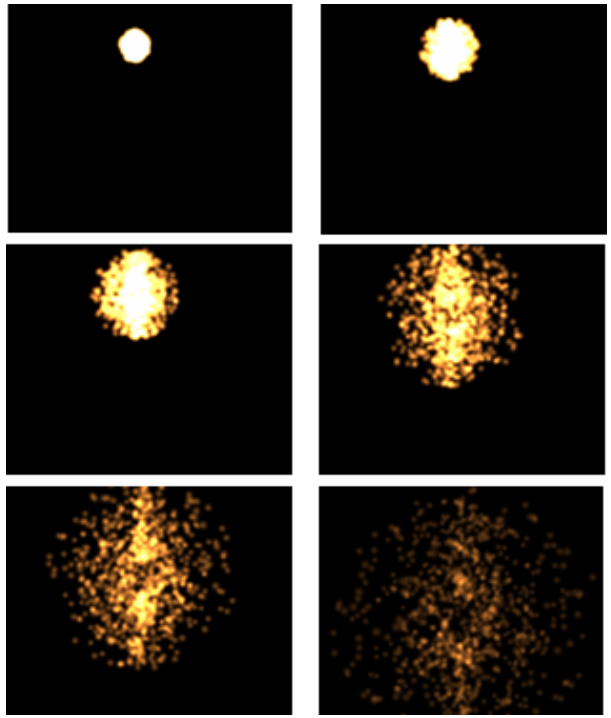
Particle characteristics

- The position of each particle on each frame could be found by knowing its velocity.
- This can be modified by the acceleration.
- The color, the opacity and size of the particle can be modified by parameters.
- This parameters can be the same to all the particles or stochastic for each particle.

Particle characteristics

- When each particle is created a life time is associated to it.
- After each frame, the life time is reduced by the speed that the live goes away (by frame), when the life time is zero the particle is destroyed.
- When a particle is outside an interest region (the screen of the computer, for example) it could be destroyed.

Fireworks modeled (circle)



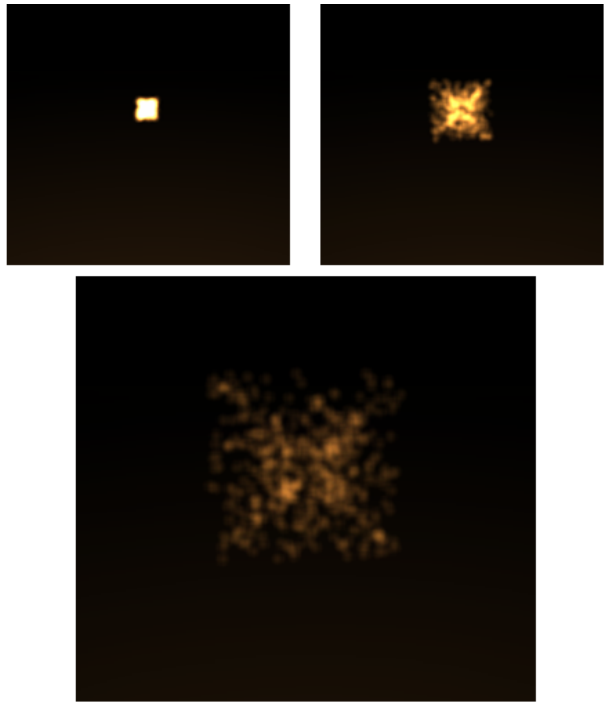
$$v_x = v \times \cos(\theta) \times \sin(\phi)$$

$$v_y = v \times \cos(\phi)$$

$$v_z = v \times \sin(\theta) \times \sin(\phi)$$

Variable	Possible Values
v	[0.2,1]
θ	[0, 2π]
ϕ	[0, π]

Fireworks modeled (square)



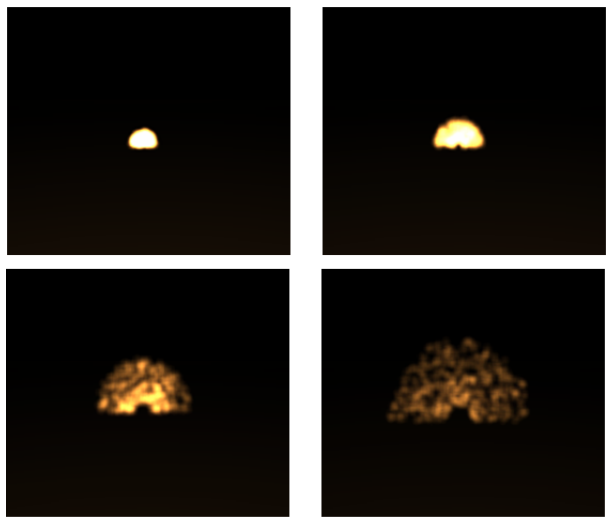
$$v_x = v \times \cos(\theta)$$

$$v_y = v \times \cos(\phi)$$

$$v_z = v \times \sin(\theta) \times \sin(\phi)$$

Variable	Possible Values
v	[0.2,1]
θ	[0, 2π]
ϕ	[0, π]

Fireworks modeled (iglu)



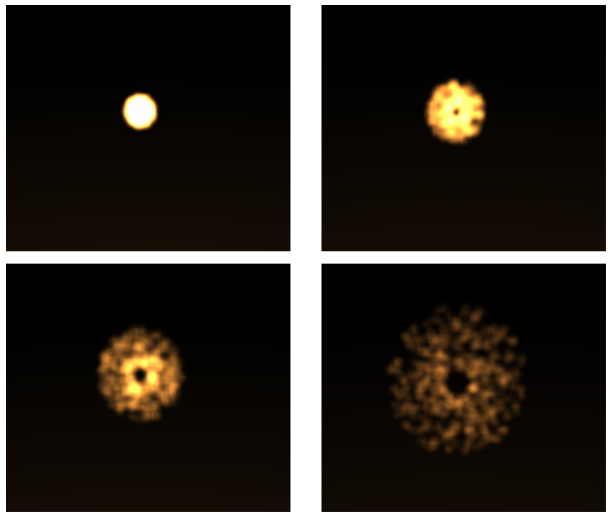
$$v_x = v \times \cos(\theta)$$

$$v_y = v \times \sin(\theta)$$

$$v_z = v \times \sin(\theta) \times \sin(\phi)$$

Variable	Possible Values
v	[0.2,1]
θ	[0, π]
ϕ	[0, π]

Fireworks modeled (disk)



$$v_x = v \times \cos(\theta)$$

$$v_y = v \times \sin(\theta)$$

$$v_z = v \times \sin(\theta) \times \sin(\phi)$$

Variable	Possible Values
v	[0.2,1]
θ	[0, 2π]
ϕ	[0, π]

Real example (inspiration)

Result (instant 1)

Result (instant 2)

Acceleration of examples

- We simulate a little wind through the x (ax) axis.
- The gravity (ay) to have a good estimation of a reality.

Variable	Possible Values
ax	0.01
ay	-0.08
az	0.00

Conclusions

- Particle systems are a very good approach to simulate fireworks.
- With this technique we can easily construct a model to simulate any kind of celebration that use fireworks.
- And this model could be very useful to a great number of situations considering the design of this type of celebration.

Conclusions

- The project was implemented in C++ using OpenGL and paradigms of object orientation.

- In the future, we can also add to this model some things that were not taking into consideration here like the smoke and sound of the fireworks.

- More illustrations can be found at the web address: http://www.ic.uff.br/~rmelo/fogosArtificio.htm.