Particle System Report submitted

for 3D Modelling and Animation (UCS636)

by

Darshneet Juneja 101903115

Submitted to

Dr. Shailendra Tiwari

DEPARTMENT OF COMPUTER SCIENCE ENGINEERING

THAPAR INSTITUTE OF ENGINEERING AND TECHNOLOGY, (A DEEMED TO BE UNIVERSITY), PATIALA, PUNJAB

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Particle System Assignment

Aim: Implement a particle system (roughly based on Siggraph 2001 course notes by Baraff, Witkin and Kass)

Compulsory requirements:

1. Animate at-least 1000 particles
2. Include at least two forces
3. Implement Particle-Plane Collision Handling
4. Implement evolution* / recycling** OR ensure particles stay in the scene
5. For rendering, you should use Blender, OpenGL, DirectX or XNA

Optional Requirements:

1. Implement a meaningful demo that recreates real-world or aesthetic effects e.g. implement effects based on Karl Sims paper
2. Implement an alternative to forward-Euler integration

* Evolution: particles appearance parameters other than physics state changes over time

** Recycling: particles “die” and are destroyed and regenerated

Theory: A particle system is a technique in game physics, motion graphics, and computer graphics that uses many minute sprites, 3D models, or other graphic objects to simulate certain kinds of "fuzzy" phenomena, which are otherwise very hard to reproduce with conventional rendering techniques – usually highly chaotic systems, natural phenomena, or processes caused by chemical reactions. Particle systems are defined as a group of points in space, guiding by a collection of rules defining behavior and appearance. Particle systems model phenomena as a cloud of particles, using stochastic processes to simplify the definition of dynamical system and fluid mechanics with that are difficult to represent with affine transformations.

Software Used: Blender 3.0.1

Project Explanation:

I have made a **Sci-Fi Magic Ball** for this assignment. In this project, the particles emit in a glass ball and move around a specific area under various forces. Number of particles used for this project are 125000. I have applied 4 different forces: Turbulence, Vortex, Drag, and Magnetic Field. The figure given below is a frame of the final product.

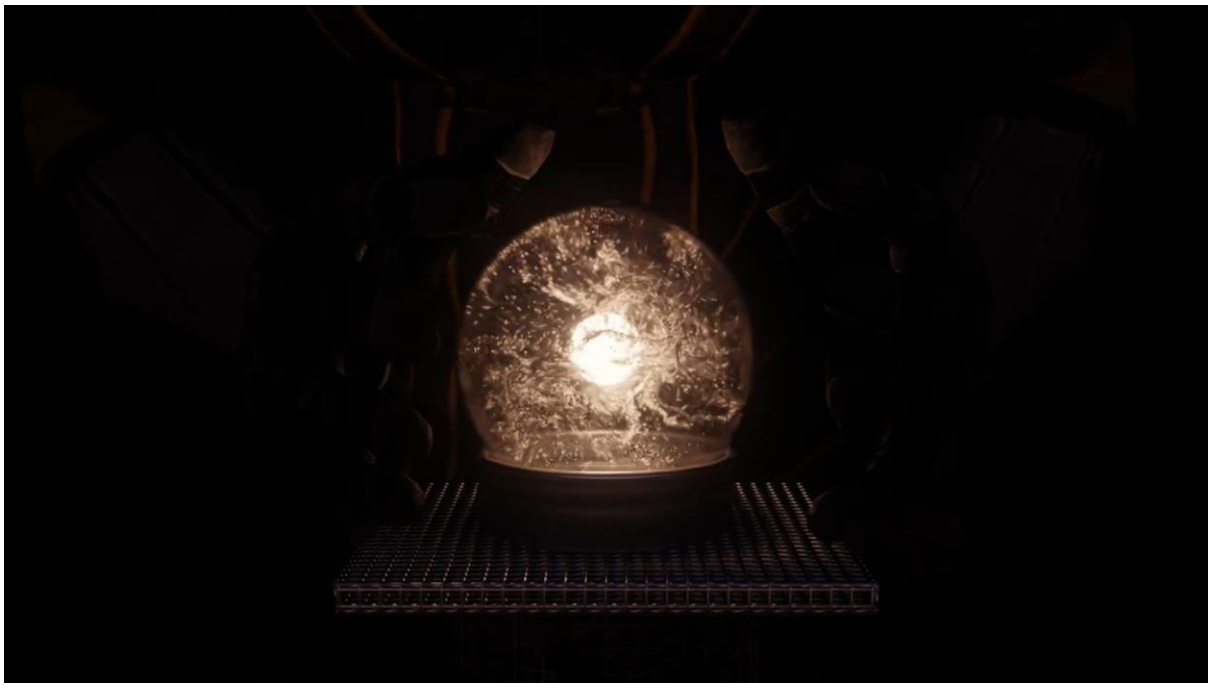

Figure 1: Screenshot of rendered video

Step by Step Procedure:

- First open a new project in blender and delete the default objects on the screen.
- We will then click shift+A to add a new object. Select Mesh and then UV Sphere. Then right click and shade smooth.
- Proceed to the right side and click on modifier properties. Add solidify modifier and set thickness to 0.02 m. Then add subdivision surface modifier and set the render to 1.
- Then head over to the physics properties and select collision and leave them to default settings.
- Then duplicate the sphere by holding shift+D. We have to remove the settings we have applied on the original sphere, so click on collision in physics properties again to disable it. Similarly remove the modifier properties as well. Further scale the sphere to 0.92.
- Then click on the particle properties and click on + to add a new particle

system. Set the emission number to 125000. Set the Frame start and end to 1 and 250 respectively. Also set the lifetime to 250. Open the source tab and change the distribution to random. Scroll down till the Rotation and enable it. Change the parameters (Randomize, Phase and Randomize phase) randomly. Scroll down till the Physics tab and leave the Physics type as Newtonian. Type 10 for Brownian, 1 for drag and 1 for damp. Further move to Render and select Render As Object. Change the scale to 0.008 and 0.5 for the randomness. Then disable the Show Emitter button.

- Then add an icosphere using shift+A and reduce the subdivisions to 1. Move the icosphere out of the camera perspective. Select the duplicate sphere (renaming it to Emitter and other sphere to Glass) and select particle properties. Select the instance object as icosphere. Scroll down to viewport display and uncheck the show emitter button. Now we will change the field weights, set the gravity to 0. Renaming this icosphere to Particle.
- Now we will add one more icosphere and increase the subdivisions to 2. Hit s to scale and type 0.25. Then head over to the modifier properties and add subdivision surface and increase the render to 2. Right click on this icosphere and shade smooth. Then go to the physics properties add collision and set damping and friction to 1.
- Make sure you are on frame 1, click on the center icosphere and head over to the rotation and insert a keyframe for the rotation values. Then head over to the final frame and set the rotation values roughly to x=350, y=-300 and z=250. Then right click on the rotation and insert a keyframe.
- Hover over the timeline and press t. Then select Linear.
- Next press shift A and Force field and select Turbulence. Head over to the physics properties and increase the strength to 250, size to 0.5 and flow to 5. We will then go to the falloff tab and set minimum distance to 0.6 and maximum distance to 2.
- Make sure you are on frame 1 and then hover over the location and insert a keyframe. Similarly insert a keyframe for rotation. Then head over to the last frame. Now set the rotation as x=250, y=300 and z=-100 and insert another keyframe.
- Going back to frame 1, head up to the left of the screen till you see a plus symbol and drag it till half of the screen space. Change the view to graph editor in the second screen. Make sure to click Normalize.
- Then expand the Object Transform tab and click on x location. Hover to the right side of this graph screen and hit N. Open the modifiers, add noise, set size to 11.5 and strength to 0.5. Do the same steps for y and z location and some random phase values to them. Then close the graph window by joining the two screens.
- Press shift A, force field and add Vortex. Set the strength to -6, inflow to 3, power to 2 and add a minimum and maximum distance. Set those

distances to 0.8 and 1.07 respectively. This is done so that particles don't stick a lot to the outside glass surface. Next insert a rotation keyframe for frame 1, then head to the final frame, set the rotation values as x=-125, y=150, z=100 and insert a keyframe again.

- Next, we are going to add a Magnetic force field. Set the strength to -2 and the flow to 1. On frame 1, add a rotation keyframe. Then take it to the final frame, set the values to x=-75, y=100 and insert another rotation keyframe.
- Add one more force field- Drag. Set Linear and Quadratic to 2.
- Press shift+A, empty and select plain axes and drag it above everything. Hit A to select all objects. Hit control+P and object near the empty axes so that everything will be under control of it. Select it hit G+Z and drag it above.
- Head over to frame 1, select the emitter object and head over to particle properties. Click on Bake.
- Head over to the Shading Tab. Select World. Add environment texture to the current page. Then I added an HDRI image in the background which will be linked in the environment texture. (Link- https://polyhaven.com/a/kiara_1_dawn). I further changed the strength to 0.01 in the background box. Click on background box, shift+D to duplicate and change the color to black. Add a mix shader and connect both the background boxes to it on one side and World Output to another. Add a light path, select the Camera Ray and hook it to mix shader.
- Then select object and click on Glass. Click on new to add shading. Set roughness to 0.25, bring transmission to 1. In case you are using eevee, add screen space refraction in material properties and in render properties, set IOR to 1.1 and set refraction depth to 0.1 m in material properties.
- Click on center sphere and then click new to add shading. Change the surface to emission in material properties. We can change the color to a peach shade and set the strength to 250. In case you are using eevee, add bloom but bring down the intensity to 0.004. In render properties, open up film and uncheck transparent box. I was rendering in Cycles and set the device to GPU compute. Add adaptive sampling, render (set to Optix), and viewport (set to Optix).
- Drag the mouse to bottom left till you see a plus sign and add a timeline.
- Next click on Particle and add new. Set metallic to 1 and roughness to 0. Add a little reddish base color and change the value to 5.
- Add a new cube by pressing shift+A. Press s+z and type 0.1. Press s+shift+z and type 2. Go into edit mode. Ctrl+R and hit escape till you get in the middle and set the subdivisions to 25. Now drag the view to side and similarly set the subdivisions to 25 so that we get equal horizontal and vertical divisions.
- Go back to object mode, head over to the modifier properties, Add a

wireframe modifier. Also add a solidify modifier and set the thickness to 0.03. Hit control+A and select all transforms. Then we add a material, so click on new below and set metallic to 1, roughness to 0.2 and base color value to 5.

- Go to the world properties, select HDRI box hold control and hit T to add mapping and texture. Set the z=150 (rotation) in the mapping box.
- Add a camera to the frame. Head back to the Layout mode. Hit Control+Alt+0 to get the camera perspective. Then use location toggles to straighten the view. Head to camera properties, Enable Depth of Field, select the Focus object as the center icosphere. Set the F stop to 0.8.
- Then add a cylinder to the frame, scale it appropriately so that it fits between the wireframe cube and the glass surface. Go into the edit mode and add subdivisions to it by pressing i. Add about 5-6 subdivisions to the upper surface. Turn on proportional editing, select connected only, then press g+z to move the surface and create a hole type shape so that the two objects do not clash anymore. Scroll in the mouse key to bend the frames as we want. Add random new cuts vertically to this cylinder by pressing control+R so that the object becomes more defined. Also add some subdivisions to the bottom surface. Go back into object mode and shade smooth. Go to modifier properties and add a subdivision surface of 2.
- Go to the Shading tab and select the cylinder and randomly change the settings according to what you want.
- Add another cylinder and make it into a wireframe by following the same steps as the cube wireframe. Add around 25 vertical subdivisions. Add the same material as the cube in the shading tab.
- Then I added a blender object in the background which I downloaded from the internet and set it according to the scene.
- Furthermore, I added a zoom in and zoom out effect to give it a final touch. After that I rendered my final video.

Link to the blender file:
https://drive.google.com/file/d/1oRan1PzUE520MfITIAbvgUmDLd90cCaa/view?usp=sharing