Snow Deformation

To create a snow accumulation and deformation effect along with physical based rendering.

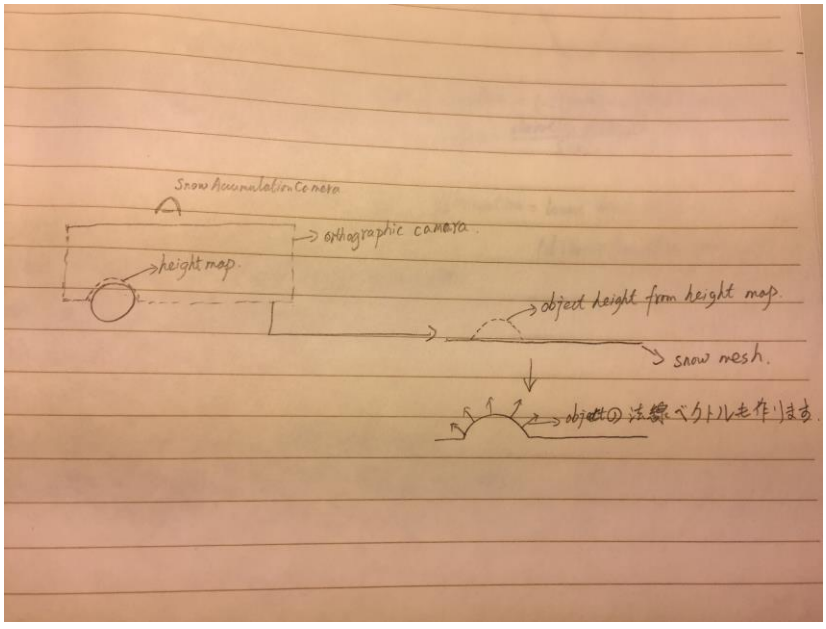
- At first, I researched and observed real snow accumulation and deformation though video and photos. I noticed that accumulation of snow could be divided into two types.
    1. Snow Covered Object: Object that slightly under snow

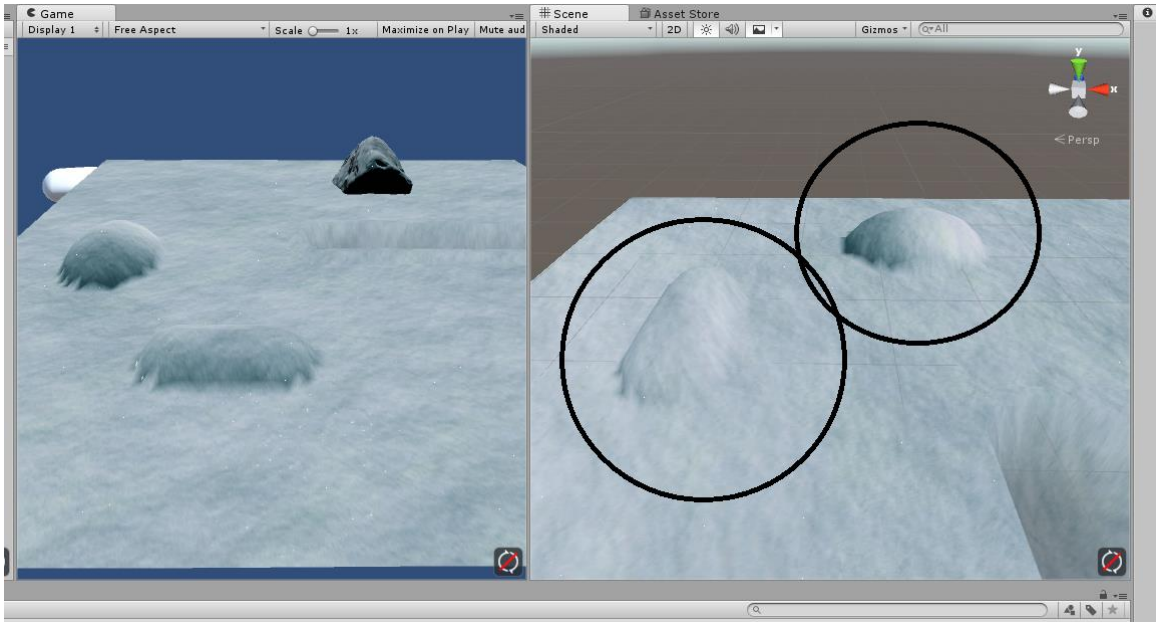
To present this kind of snow accumulation, Snow mesh should be slightly deformed and it should have basic shape of the object it covers.

2. Snow Accumulated Object: Normal Object that has snow accumulated

This kind of accumulation requires snow accumulated on the surface of object and the amount of snow depends on the gravity and the snow falling direction.

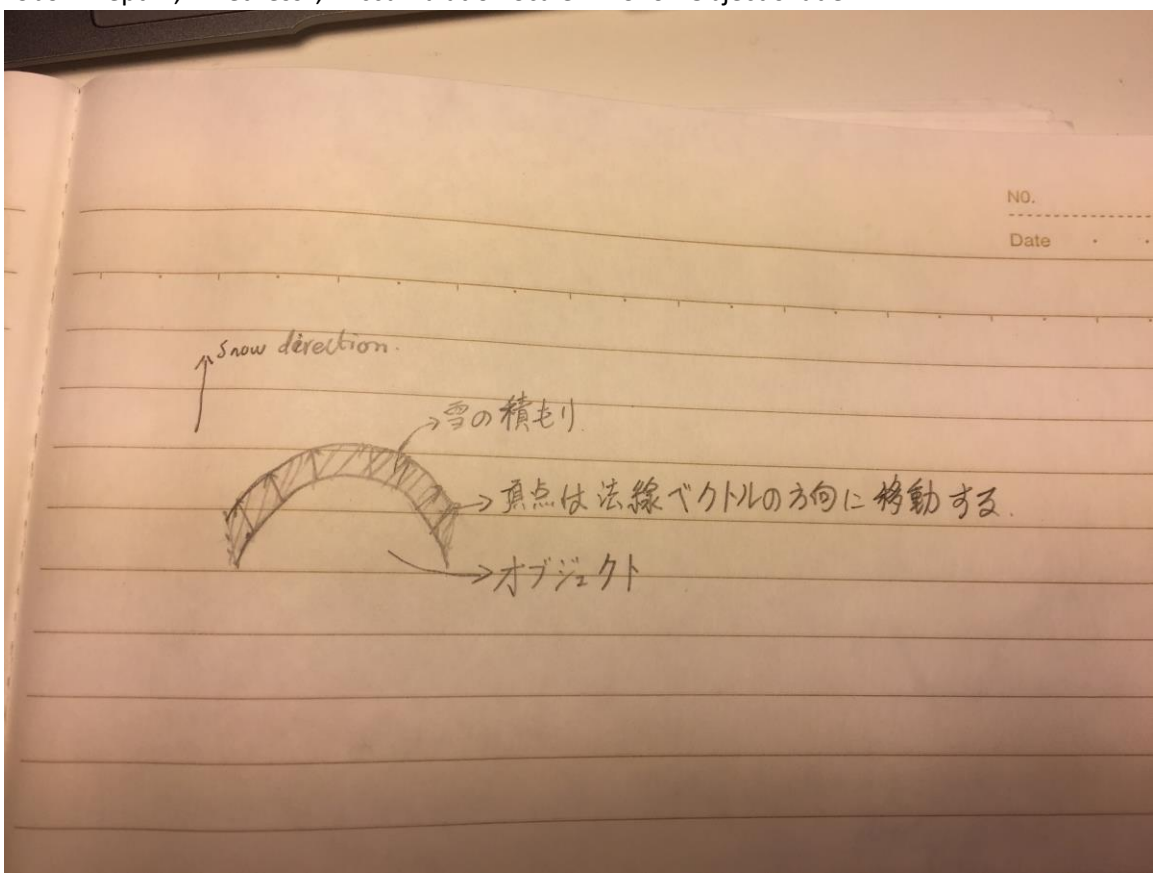
- To make these two kinds of snow accumulation. I have two shaders for them.
  - By adding a SnowAccumulatedObject script component into an arbitrary object, and set it with SnowCoveredObject layer, this object could be rendered as Snow Covered Object. The idea behind this is to render this object into a height map using a depth camera (SnowAccumulationCamera) and when rendering snow mesh, get height in height map texture and modify vertex position.

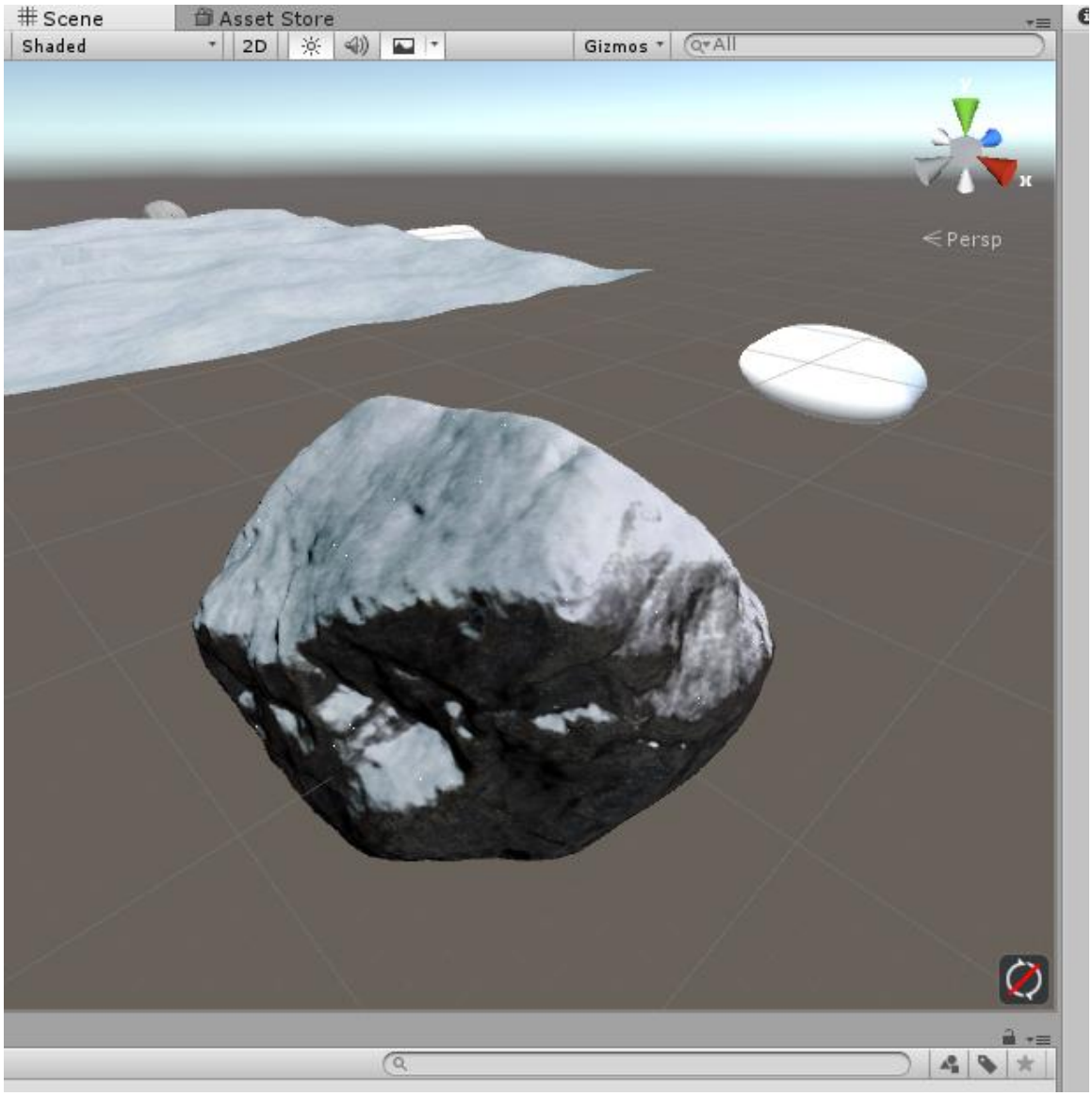




Source Files: SnowAccumulationCamera GameObject; SnowAccumulationCameraScript.cs; Height Map: SnowNormalsAndHeightTex

- The second, Snow Accumulated Object is made simply by modifying object vertex along the snow direction. This is controlled by “Snow level”, “Snow Derection”, “Sbow Depth”, “Wetness”, “Accumulation Scale” in SnowObject.shader

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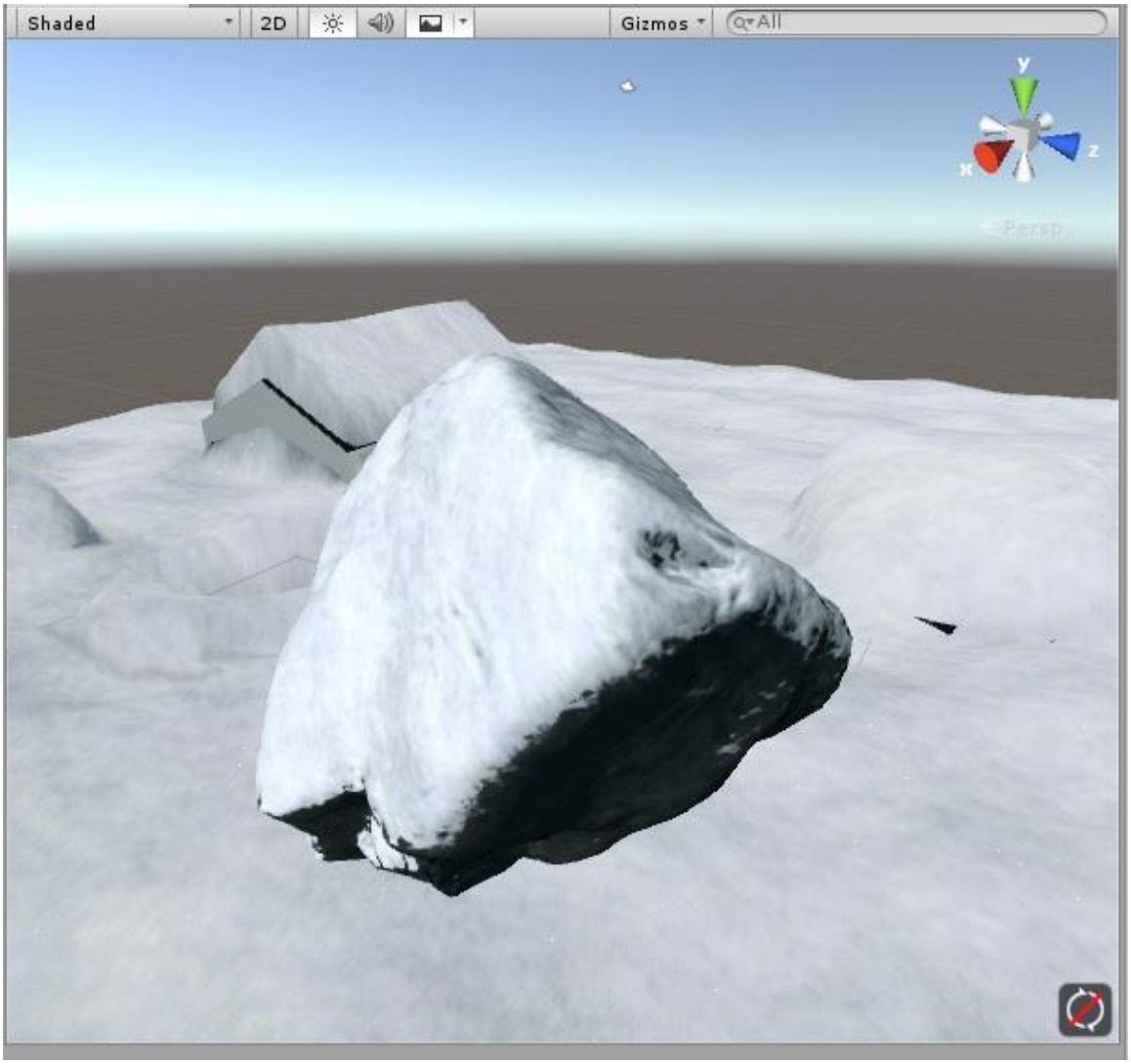
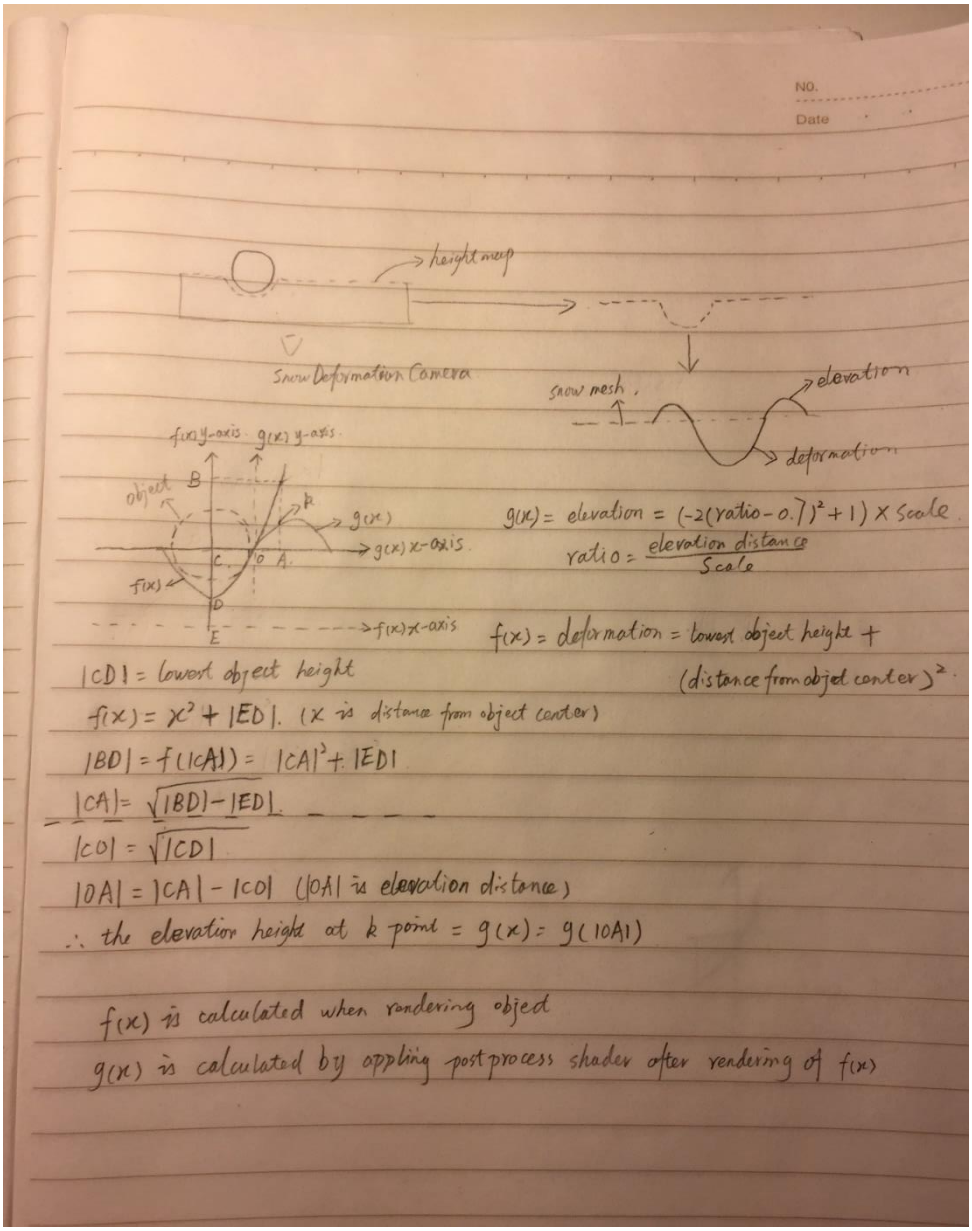


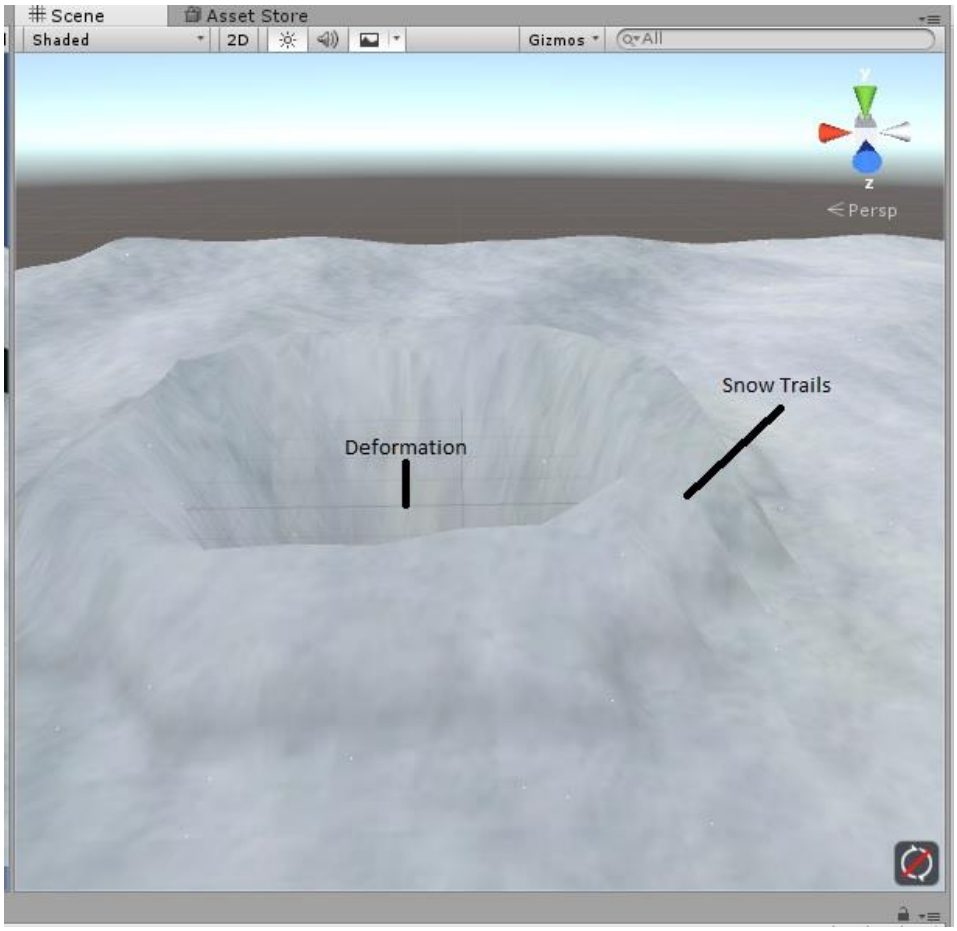
Source Files: SnowAccumulatedObejct.cs; Snow/SnowObject.shader

- Then move to snow deformation. To make a snow deformation with arbitrary object, I read two articles: GPU PRO 7: Deferred Snow Deformation in Rise of the Tomb Raider; Deformable Snow Rendering in Batman: Arkham Origins. Then I implemented similar technique.

By observation of snow interaction in real world, this snow deformation has two parts, one is deformation and another is trail.
Adding a DynamicObject script component into an arbitrary object, and set it with DynamicObject layer, this object could be rendered as DynamicObject, which could interact with snow mesh (make a hole, tracks, trails and so on).
The technique is similar to accumulation. First render a height map (with SnowDeformationCamera and RenderDepthAndObjectHeight.shader), then calculate deformation height and trail elevation height (DeformationPostProcess.Shader), at last modify snow mesh vertex position to make deformation and trails (SnowMeshSimple.shader).
I also add a recover parameter that makes refilling of snow deformation. It could be set to make an effect that in heavy snowing/blizzard, the deformation could be refilled by new snow. The “Recover Speed” parameter in SnowDeformationCamera controls this.
To make a real snow trials, artist could make a trail texture. I just make a shadow on the connection point between snow mesh and trials. Artist could control trail height with “Artist Scale” and control deformation size with “Deformation Scale” to achieve different effect for different object.
The deformation color also set with its depth, the deeper the object makes, the darker the deformation becomes.
To clear deformation: use “Clear Deformation” in SnowDeformationCamera
To build new mesh with Perlin noise: use “Build Mesh” in SnowMesh with different parameters.

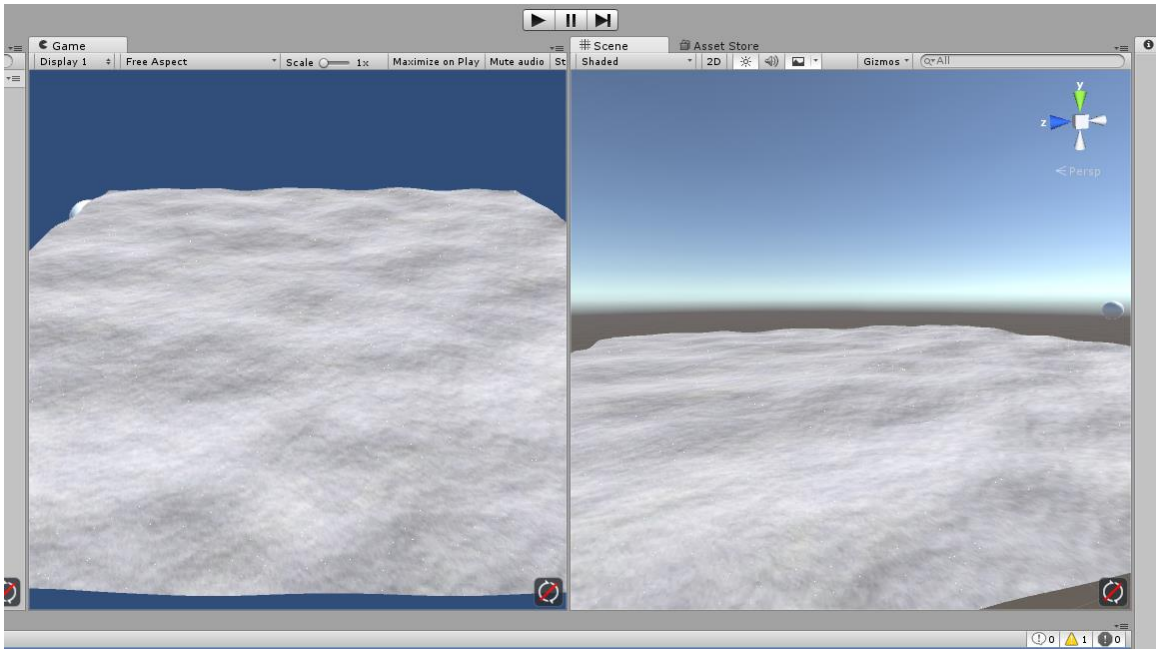
Source Files:
SnowDeformationCamera GameObject;
SnowDeformationCameraScript.cs;
DynamicObject.cs;
SnowMeshRendering.cs;
Snow/SnowMeshSimple.shader=>Rendering Snow Mesh;
Snow/RenderDepthAndObjectHeight.shader=>Calculate f(x);
Snow/DeformationPostProcess.Shader=>Calculate g(x);
Height Map: SnowDeformationHeightTex

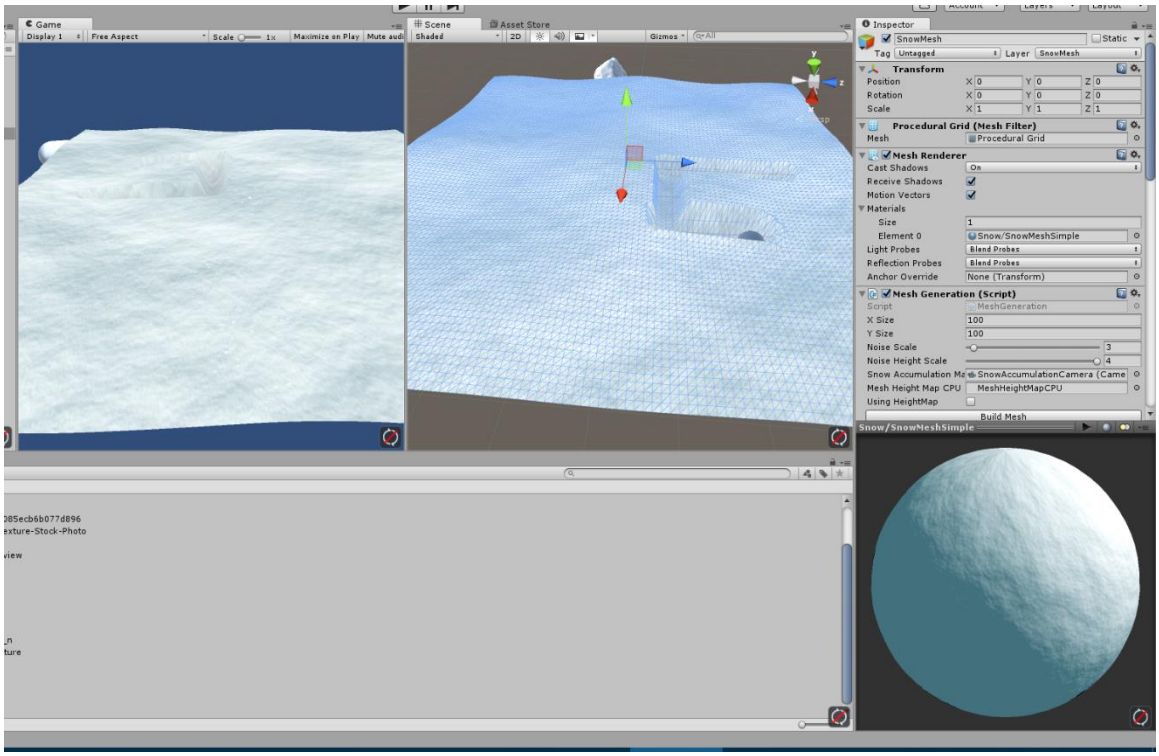




- At last, I have investigated snow rendering in real time. I implemented Oren–Nayar reflectance model with Cook-Torrance shading model(specular term).

Observing that there are sparkles on the surface of snow. I have added random sparkles and added a specular map that present this snow effect.



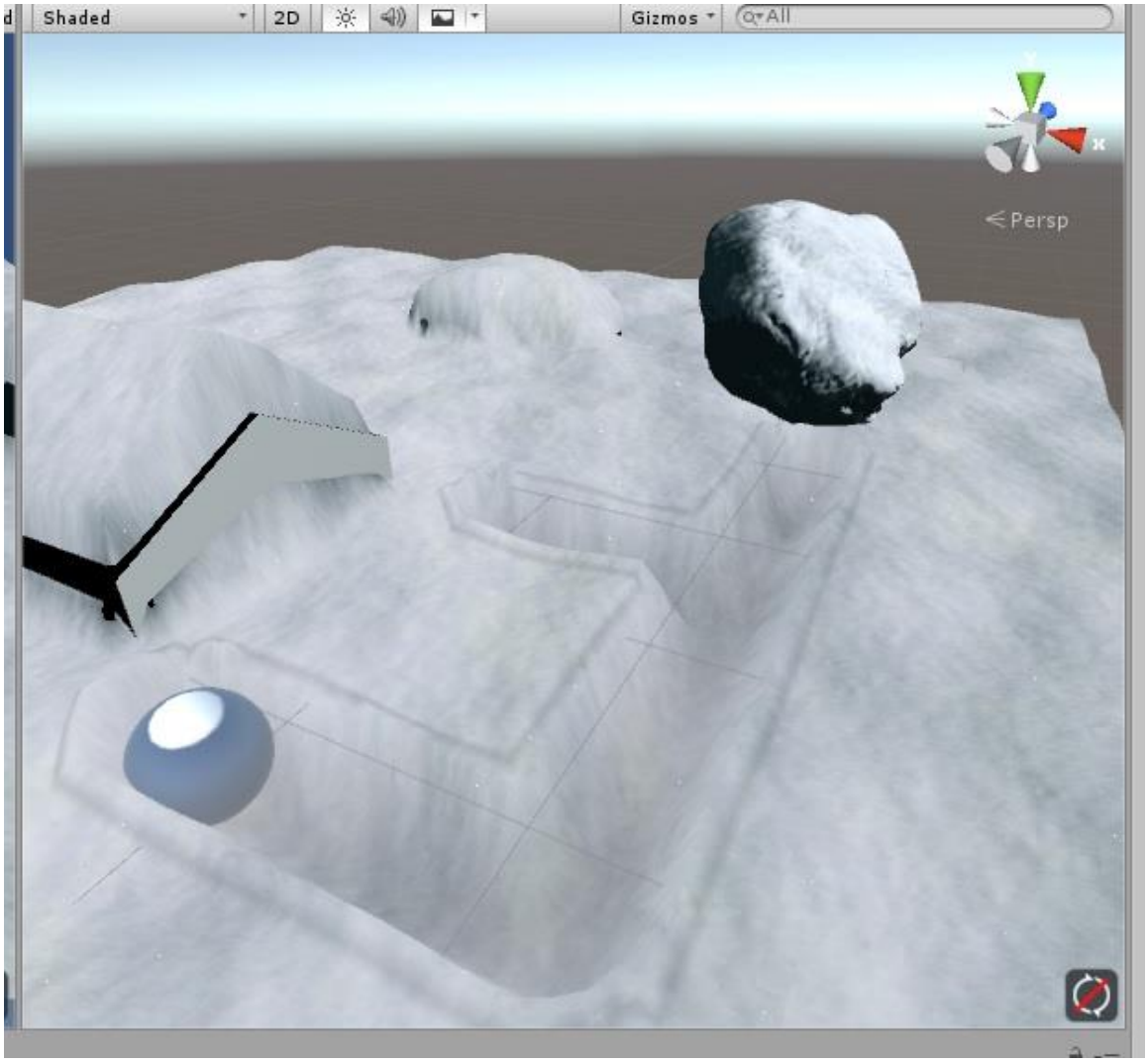


I also add a snow shading color parameter, to present a blue shading color of real world snow. It could be adjusted by artist for different effect. Snow sparkle is also a parameter controlled by artist.

With artist's help, it could be refined by making a snow-like normal map and choosing a good looking snow shading color to achieve desired output.

Source Files: LightingAndUtility.cginc CalLighting_OrenNayarBlinn function

Final result:



Reference:

1. GPU PRO 7: Deferred Snow Deformation in Rise of the Tomb Raider
2. Deformable Snow Rendering in Batman: Arkham Origins
3. Real Shading in Unreal Engine 4
4. Writing a Cook-Torrance Surface Shader
5. Physically-Based Shading at Disney