Major Project Report

Tom Minor - Level H
Major Project
Bournemouth University - NCCA

October 12, 2015

Project Overview

Main Aspects

1. Fractal Renderer
2. FX Work
3. Pipeline

Initial Research

1.1 Trying out existing stuff

Mandelbulb in Houdini

```
int iter = chi("iterations");
int n = chi("n");
float limit = chf("limit");

vector Z = ptransform("space:current", "space:object", @P);

for(int i = 0; i < iter; i += 1)
{
    /// Convert to spherical coords ///

    // Precompute component squares
    float xpow = Z.x * Z.x;
    float ypow = Z.y * Z.y;
    float zpow = Z.z * Z.z;

    // Spherical coords = (r, theta, phi)
    float r = sqrt(xpow + ypow + zpow);
    float theta = atan2(sqrt(xpow + ypow), Z.z);
    float phi = atan2(Z.y, Z.x);

    /// Exponentiation term (raise {x,y,z} to nth power) ///
    //
    /* -> simplified form
        {x,y,z}^n = r^n { sin(theta*n) * cos(phi*n),
                          sin(theta*n) * sin(phi*n),
                          cos(theta*n) }


        -> expanded form
```

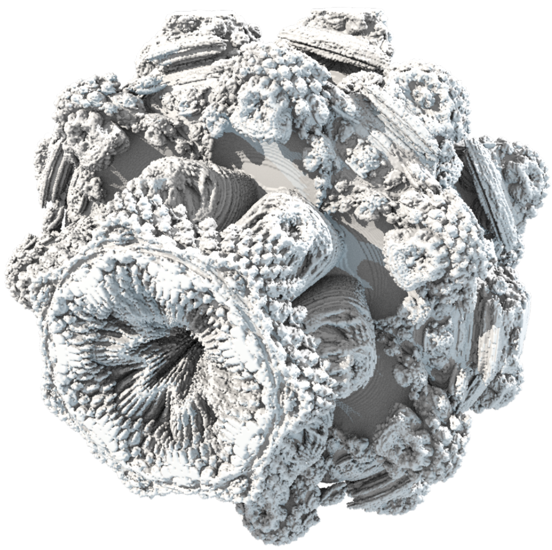
```
        {x,y,z}^n = { r^n * sin(theta*n) * cos(phi*n),
                      r^n * sin(theta*n) * sin(phi*n),
                      r^n * cos(theta*n) }
    */
    float tmpPow = pow(r, n);
    float tmp = tmpPow * sin(theta * n);

    vector newZ = set(
        tmp * cos(phi * n),
        tmp * sin(phi * n),
        tmpPow * cos(theta * n)
    );



    Z += newZ;
}

if( length(Z) < limit) {
    @density = 1.0;
} else {
    @density = 0.0;
}
```



1.2 Render Tests

1.3 Reading the documentation and tutorials

Superquads [4]

Production

2.1 Initial Tests

2.2 Results

2.3 Unforeseen Problems

Conclusion

Bibliography

[1] http://dctsystems.co.uk/renderman/angel.html. `http://dctsystems.co.uk/RenderMan/angel.html`. Accessed: 25th April 2015.

A Renderman compliant renderer developed by Ian Stephenson, I initially chose to use it because it had support for geometry shaders that provided me with a simple way of creating an ice cube shape through the use of superquadrics. Unfortunately, the superquad shader did not work with shadows, the feature set is fairly dated compared to current PRMan releases and opacity support was too noisy (which presented a problem for a project that makes heavy use of translucency), forcing me to move on to using Pixar's Renderman instead.

[2] Pixar's renderman. `http://renderman.pixar.com/view/renderman`. Accessed: 26th April 2015.

MUST ADD ANNOTATION TO THIS

[3] Pixar's renderman documentation. `https://renderman.pixar.com/view/documentation`. Accessed: 26th April 2015.

MUST ADD ANNOTATION TO THIS

[4] The super egg and other super surfaces. `http://www.math.harvard.edu/archive/21a_fall_09/exhibits/superegg`. Accessed: 25th April 2015.

Although certain superquadrics are similiar in shape to an ice cube, notably the super egg, in the end I instead decided to write a displacement

[5] Anthony A. Apodaca and Larry Gritz. *Advanced RenderMan: Creating CGI for Motion Picture*. Morgan Kaufmann Publishers Inc., San Francisco, CA, USA, 1st edition, 1999.

Used for : Texture mapping basics, volume shader basics, brownian noise RSL function?

[6] Oliver Deusen, David S. Ebert, Ron Fedkiw, F. Kenton Musgrave, Przemyslaw Prusinkiewicz, Doug Roble, Jos Stam, and Jerry Tessendorf. The elements of nature: Interactive and realistic techniques. In *ACM SIGGRAPH 2004 Course Notes*, SIGGRAPH '04, New York, NY, USA, 2004. ACM.

MUST ADD ANNOTATION TO THIS

[7] Makoto Fujisawa and Kenjiro T. Miura. Animation of ice melting phenomenon based on thermodynamics with thermal radiation. In *Proceedings of the 5th International Conference on Computer Graphics and Interactive Techniques in Australia and Southeast Asia*, GRAPHITE '07, pages 249–256, New York, NY, USA, 2007. ACM.

MUST ADD ANNOTATION TO THIS

[8] Tomokazu Ishikawa, Yoshinori Dobashi, Yonghao Yue, Masanori Kakimoto, Taichi Watanabe, Kunio Kondo, Kei Iwasaki, and Tomoyuki Nishita. Visual simulation of glazed frost. In *ACM SIGGRAPH 2013 Posters*, SIGGRAPH '13, pages 14:1–14:1, New York, NY, USA, 2013. ACM.

MUST ADD ANNOTATION TO THIS

[9] Theodore Kim, David Adalsteinsson, and Ming C. Lin. Modeling ice dynamics as a thin-film stefan problem. In *Proceedings of the 2006 ACM SIGGRAPH/Eurographics Symposium on Computer Animation*, SCA '06, pages 167–176, Aire-la-Ville, Switzerland, Switzerland, 2006. Eurographics Association.

MUST ADD ANNOTATION TO THIS

[10] Theodore Kim, Michael Henson, and Ming C. Lin. A hybrid algorithm for modeling ice formation. In *Proceedings of the 2004 ACM SIGGRAPH/Eurographics Symposium on Computer Animation*, SCA '04, pages 305–314, Aire-la-Ville, Switzerland, Switzerland, 2004. Eurographics Association.

MUST ADD ANNOTATION TO THIS

[11] Theodore Kim, Michael Henson, and Ming C. Lin. A physically based model of ice. In *ACM SIGGRAPH 2004 Sketches*, SIGGRAPH '04, pages 13–, New York, NY, USA, 2004. ACM.

MUST ADD ANNOTATION TO THIS

[12] Theodore Kim and Ming C. Lin. Visual simulation of ice crystal growth. In *Proceedings of the 2003 ACM SIGGRAPH/Eurographics Symposium on Computer Animation*, SCA '03, pages 86–97, Aire-la-Ville, Switzerland, Switzerland, 2003. Eurographics Association.

MUST ADD ANNOTATION TO THIS

[13] Masaaki Matsumura and Reiji Tsuruno. Visual simulation of melting ice considering the natural convection. In *ACM SIGGRAPH 2005 Sketches*, SIGGRAPH '05, New York, NY, USA, 2005. ACM.

MUST ADD ANNOTATION TO THIS

[14] Takanori Nishino, Kei Iwasaki, Yoshinori Dobashi, and Tomoyuki Nishita. Visual simulation of freezing ice with air bubbles. In *SIGGRAPH Asia 2012 Technical Briefs*, SA '12, pages 1:1–1:4, New York, NY, USA, 2012. ACM.

MUST ADD ANNOTATION TO THIS

[15] Saty Raghavachary. *Rendering for beginners: image synthesis using RenderMan*. Elsevier, San Diego, CA, 2004.

MUST ADD ANNOTATION TO THIS

[16] Ian Stephenson. *Essential Renderman*. Springer-Verlag New York, Inc., Secaucus, NJ, USA, 2007.

MUST ADD ANNOTATION TO THIS

[17] Alexey Stomakhin, Craig Schroeder, Lawrence Chai, Joseph Teran, and Andrew Selle. A material point method for snow simulation. *ACM Trans. Graph.*, 32(4):102:1–102:10, July 2013.

MUST ADD ANNOTATION TO THIS

[18] Feng Xie, Mike Necci, Jon Lanz, Patrick O'Brien, Paolo de Guzman, and Eduardo Bustillo. Arctic ice: Developing the ice look for how to train your dragon 2. In *Proceedings of the Fourth Symposium on Digital Production*, DigiPro '14, pages 37–39, New York, NY, USA, 2014. ACM.

MUST ADD ANNOTATION TO THIS