VFX Fractal Toolkit

Juraj Tomori
tomori.juraj@gmail.com

Animationsinstitut,
Filmakademie Baden-Wuerttemberg

1   Abstract

This paper proposes an innovative industry practice regarding fractal geometry generation and rendering processes. VFX Fractal Toolkit (VFT) is work in progress and aims to provide a powerful, yet intuitive and artist-friendly workflows for exploration and generation of vast amounts of fractals. VFT is built specifically for Visual Effects (VFX) pipelines and aims to employ standard practices.

2   Previous work

Available tools for rendering fractals among others include *Mandelbulb 3D, Mandelbulber2* and *Fragmentarium*. Prior to developing the toolkit an evaluation of the mentioned tools was made. Evaluated tools and VFT both rely on distance field representation of fractal surfaces. Generating and rendering fractals involves raymarching those distance fields [4]. The aforementioned tools have accurate and efficient rendering engines, but are not compatible with VFX Digital Content Creation (DCC) packages. Their workflows often diverge from those of VFX artists. Generated imagery or geometry is not easily transferable to, or replicable in VFX tools. This concludes that those tools have not been built with VFX pipelines in mind. Fractal scenes in the aforementioned tools are represented by a stack of layers. The VFT integration in *SideFX Houdini* takes advantage of a node-based workflow which results in more flexibile fractal scenes description and in better visual understanding of the scenes.

3   Challenges

VFT was built with the following challenges in mind: Creating a fast and accurate generation workflow for capturing small details even at miniature scales, deep down in fractal structures. This workflow should be consistent across multiple VFX DCC packages.

4   Features

The toolkit takes advantage of and is fully integrated with animation, geometry processing and rendering tools available in industry standard DCC applications. This makes it easy to integrate VFT into established VFX pipelines. Fractal generation in VFT is GPU accelerated and leverages modern parallel hardware. GPU acceleration is achieved by using *OpenCL*, which can run on hardware from multiple vendors and in case of memory constraints can yield identical results when executed on CPU. VFT is designed as a framework, which can be easily extended or customized to suit specific needs. Current state of the toolkit includes the integration into *SideFX Houdini*, which means that generated data can be further processed by standard *Houdini* node-based workflow, can be exported into various standard VFX formats and can be rendered with multiple production renderers. Fractal output formats include point clouds, Signed Distance Function (SDF) volume grids, density volume grids and polygons. During the fractal generation process, each sample (point or voxel) computation is independent from its neighbors, which results in efficient scalability, both vertically (GPU, multiple CPU cores) and horizontally (multiple machines).

5   Implementation

VFT is to be integrated into multiple DCC applications. As a result, artists, which are familiar with DCC packages, will be able to employ standard workflows for using the toolkit. Fractal generation process outputs rich color information using orbit traps technique [3]. This color information follows fractal structures, is customizable and allows for artistic shading. The color information can be stored either in point attributes or in volume grids, depending on the chosen format. VFT aims to encourage artists to intuitively explore many fractal combinations. It is achieved by
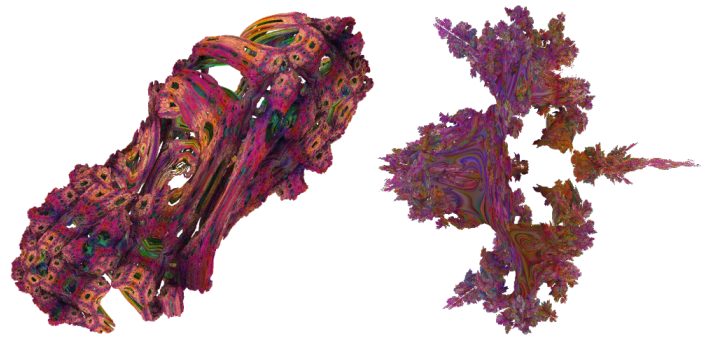

Figure 1: Example fractals generated with VFX Fractal Toolkit

promoting animatable fractal parameters to artists and using node-based workflow within *SideFX Houdini* for creation of hybrid fractals. In VFT can each fractal by represented by its Julia set for an arbitrary coordinate which increases amount of possible fractals. Multiple fractals can also be combined into weighted "hybrid" fractals, which inherit features from its sources [1]. SDF-like representation of fractals enables for use of Constructive Solid Geometry (CSG) boolean operations between different fractals [2]. The amount of promoted parameters to artists and the toolkits flexibility result in numerous possible combinations.

6   *SideFX Houdini* integration

Fractals can be generated in multiple formats depending on VFX workflow needs. If a set of points on surface is required, then surface can be raymarched from perspective camera, point in space (e.g. for VR applications), or enclosing shape (e.g. sphere encompassing fractal surface). If occluded points are missing, then fractal surface points can be generated from multiple sources. If full internal structure is required, fractals can be sampled into dense voxel grids in specified bounds and afterwards can be converted into *OpenVDB* format for efficient further processing and storage.

7   Further work

Current implementation suffers from accuracy issues at miniature scales. Further development will focus on accuracy and efficiency of raymarching. VFT aims to be available to artists in multiple areas of VFX pipeline. Fractals can be raymarched in screen space in a form of fragment shader [4], which makes them suitable for being integrated into game engines, compositing packages or even web applications. Fractal logic and parameters from one tool can be transferred into another, which will result in identical fractal generation, but in environment and format specific to the package. Further work will aim on basic integration into those areas, which will enable artists and studios to enhance it and integrate into their workflows and pipelines.

[1] K. Marczak et al. Mandelbulber end user manual. https://github.com/buddhi1980/mandelbulber_doc/releases/download/untagged-f939f0542fc9b9e38305/handbook-compressed.pdf, June 2018.

[2] I. Quilez. Distance functions. http://iquilezles.org/www/articles/distfunctions/distfunctions.htm, . Accessed: 2018-10-10.

[3] I. Quilez. Geometric orbit traps. http://iquilezles.org/www/articles/ftrapsgeometric/ftrapsgeometric.htm, . Accessed: 2018-10-10.

[4] I. Quilez. Nvscene 2008 - rendering worlds with two triangles. http://iquilezles.org/www/material/nvscene2008/nvscene2008.htm, . Accessed: 2018-10-10.