

Three Algorithms

Space Concept

The Mandelbrot set is a fractal formed by repeated iterations of the complex number formula $z \rightarrow z^2 + c$. A first naive algorithm is to simply iterate repeatedly to check if the sequence diverges. An improvement is to check for convergence, using Newton's method for root finding to check that a periodic limit cycle has derivative less than 1 in magnitude. A third optimisation is to optionally postpone those more expensive checks, depending on the outcome of the previous pixel - if a pixel diverges, its neighbour is likely to diverge also, while convergent pixels cluster together too.

These three algorithms are sonified by stereographic projection of the complex z coordinate (after each $z \rightarrow z^2 + c$ iteration) to the unit Riemann sphere in 3D space, whereafter Ambisonics takes over. The waveform so placed in space is a hash noise function of the current iteration number of the pixel together with the candidate period of the cycle under investigation for interior checks.

Technical Description

The piece is a fixed multimedia video composition. The soundtrack is encoded in 16 channel ACN/SN3D 3rd order ambisonics, with a separate binaural render provided for preview purposes only. The sound is synchronized to the image, both are generated by the same fractal iterations. One audio sample frame is calculated per iteration at 48000 Hz, a pixel may take many iterations, thus the image appears in scanline fashion.

The video file is rendered at 480×240 pixels, upscaled $4\times$, which gives a total audio length of approximately 4 minutes 30 seconds.

- audio codec: f32_le 16ch 48000Hz PCM
- video codec: yuv420p h264 profile high level 4.1 crf 20
- media container: Matroska (MKV)

Requirements

- video playback and projection ($1920 \times 1080p60$), synchronized to
- sound reproduction (Ambisonics decode to Cube speakers)
- setup time: a simple 5-10mins playthrough (a/v line check)

Download Links

- <https://mathr.co.uk/three-algorithms/three-algorithms.mkv> 800MB
- <https://mathr.co.uk/three-algorithms/three-algorithms-binaural.mkv> 100MB

About mathr

Claude Heiland-Allen (<https://mathr.co.uk>) is an artist from London interested in the complex emergent behaviour of simple systems, and mathematical aesthetics.

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