EUROGRAPHICS 2018 / D. Gutierrez and A. Sheffer
(Guest Editors)

Volume 37 (2018), Number 2

Procedural Cloudscapes (supplementary material)

A. Webanck[1], Y. Cortial[2], E. Guérin[2] and E. Galin[1]

[1] Univ Lyon, Université Lyon 1, CNRS, LIRIS [2] Univ Lyon, INSA-Lyon, CNRS, LIRIS

1. General precisions

We use a combination of scaled cellular noise, or Worley noise, and gradient noise functions which in our implementation defaults to Simplex noise.

For clarity, we define the following:

- $G_3(o,p,l,f,\mathbf{p}) \in [0,1]$, a sum of o octaves of 3D gradient noises defined with persistence p and lacunarity l, with a base frequency f, evaluated at a position $\mathbf{p} = (x,y,z)$. Similarily, we define G_2 as a sum of 2D gradient noises over position (x,y).
- $W_3(o,p,l,f,\mathbf{p}) \in [0,1]$. W_3 is a sum of o octaves of complemented 3D Worley noise, likewise defined with persistence p, lacunarity l and frequency f. Each octave is defined as $1-w$, where w is a classic Worley noise in the range $[0,1]$.
- $H(a,b,t) = \begin{cases} 0 & \text{if } t < a \\ 1 & \text{if } t > b \\ u^2(3-2u) & \text{otherwise, with } u = \frac{t-a}{b-a} \end{cases}$
  H yields a value in $[0,1]$ and performs a smooth Hermite interpolation between a and b.
- Finally, we define the scale of the scene: one modeling unit corresponds to a hundred meters.

2. *Cumulus*

$$\phi = 2k_2 n_3 H(0.45,0.65,n_2) \quad (1)$$
$$\delta = 0.77((1-n_6)+0.5(1-n_7)+0.25n_8+0.5n_9) \quad (2)$$

where

$$k_2 = (1-k_1)+k_1 n_5 \quad (3)$$
$$k_1 = H(0.1,0.9,n_4)^2 \quad (4)$$
$$\mathbf{p}_n = (x_n,y_n,z_n) = \mathbf{p}/1080 \quad (5)$$
$$n_2 = G_3(8,0.52,2.02,15,(0.65x_n,y_n,z_n)+\mathbf{q}_2) \quad (6)$$
$$n_3 = W_3(2,0.5,2,30,\mathbf{p}_n+\mathbf{q}_3) \quad (7)$$
$$n_4 = G_2(10,0.5,2.02,8,(x_n,y_n)) \quad (8)$$
$$n_5 = G_3(8,0.52,2.02,36,\mathbf{p}_n) \quad (9)$$
$$n_6 = W_3(4,0.33,3,160,\mathbf{p}_n+\mathbf{q}_6) \quad (10)$$
$$n_7 = W_3(2,0.5,2,240,\mathbf{p}_n+\mathbf{q}_7) \quad (11)$$
$$n_8 = G_3(8,0.52,2.02,288,\mathbf{p}_n+\mathbf{q}_8) \quad (12)$$
$$n_9 = G_3(8,0.52,2.02,384,\mathbf{p}_n+\mathbf{q}_9) \quad (13)$$
$$\mathbf{q}_2 = (-\tau,0,0) \quad (14)$$
$$\mathbf{q}_3 = (-\tau,0,0) \quad (15)$$
$$\mathbf{q}_6 = (-4\tau,0,0) \quad (16)$$
$$\mathbf{q}_7 = (-0.8\tau,0,0) \quad (17)$$
$$\mathbf{q}_8 = (-8\tau,0,0) \quad (18)$$
$$\mathbf{q}_9 = (-8\tau,0,0) \quad (19)$$

τ is the time offset added for animating the clouds, unit being hours. Notice that the offset works along the x axis, so prior to evaluating ϕ and δ one should change the frame of reference for position $\mathbf{p}$ to match the local direction of the wind.

3. *Altostratus* and *Altocumulus*

$$\phi = k+(1-k)H(0.43,1,n_1) \quad (20)$$
$$\delta = (1-k)(0.75n_2+0.25(1-n_3)) \quad (21)$$

where

$$\mathbf{p}_n = (x_n, y_n, z_n) = \mathbf{p}/1080 \quad (22)$$

$$n_1 = G_3(8, 0.52, 2.02, 36, (0.35x_n, y_n, z_n) + \mathbf{q}_1) \quad (23)$$

$$n_2 = G_3(8, 0.52, 2.02, 96, \mathbf{p}_n + \mathbf{q}_2) \quad (24)$$

$$n_3 = W_3(4, 0.33, 3, 400, \mathbf{p}_n + \mathbf{q}_3) \quad (25)$$

$$\mathbf{q}_1 = (-2\tau, 0, 0) \quad (26)$$

$$\mathbf{q}_2 = (-8\tau, 0, 0) \quad (27)$$

$$\mathbf{q}_3 = (-8\tau, 0, 0) \quad (28)$$

$k \in [0,1]$ is a morphing parameter between the closely related *Altostratus* and *Altocumulus*, as the two types co-occur under the same meteorological conditions. For pure *Altostratus* $k = 1$, for pure *Altocumulus* $k = 0$ and any value in between gives a continuous blend between the two types. Here τ follows the same definition as shown above for *Cumulus*.