Modelling and rendering Techniques

Perlin noise

Homework 3.

1.12.2015

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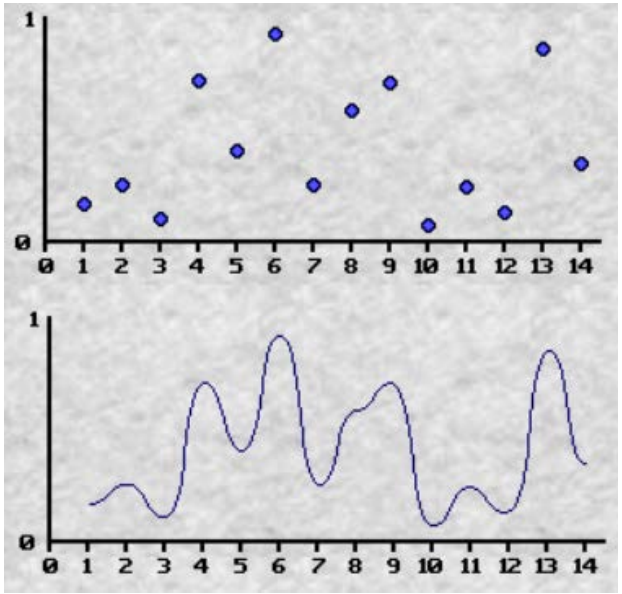
Perlin Noise

- Natural motion, behavior, textures …
- Fire, Smoke, Clouds, Terrain

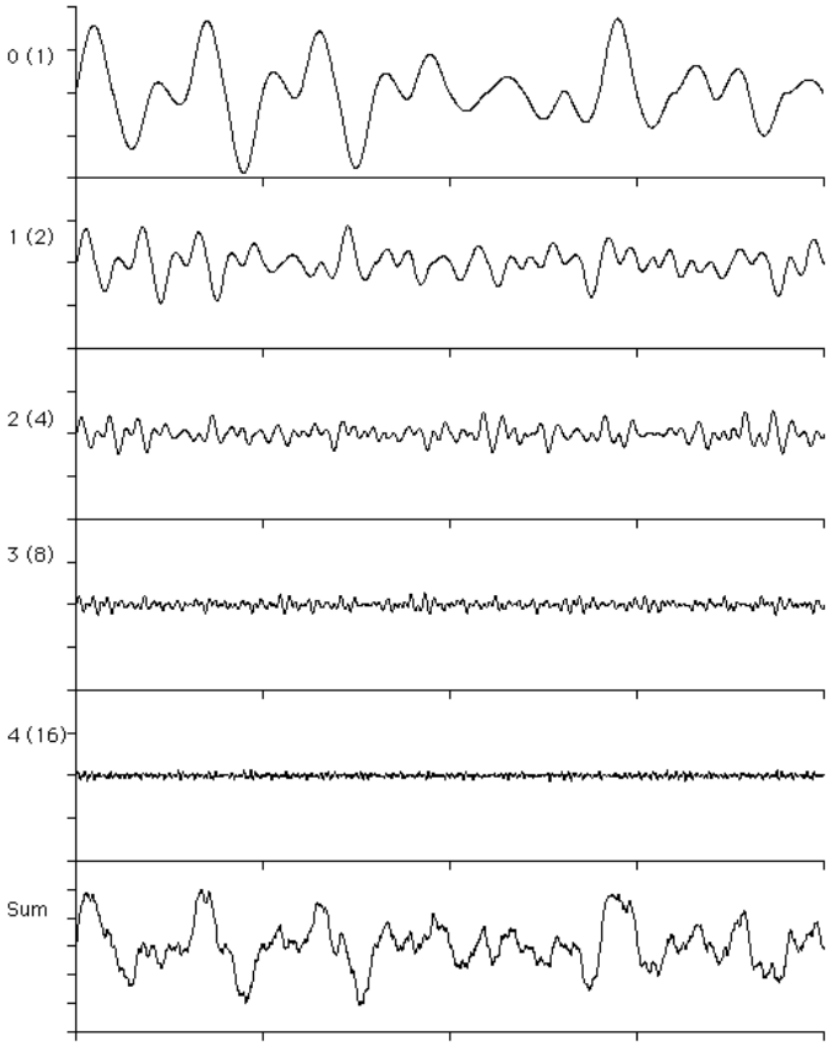
- Pseudorandom, repeatable
- Limited range and band
- Non-periodic, irregular
- Continuous domain



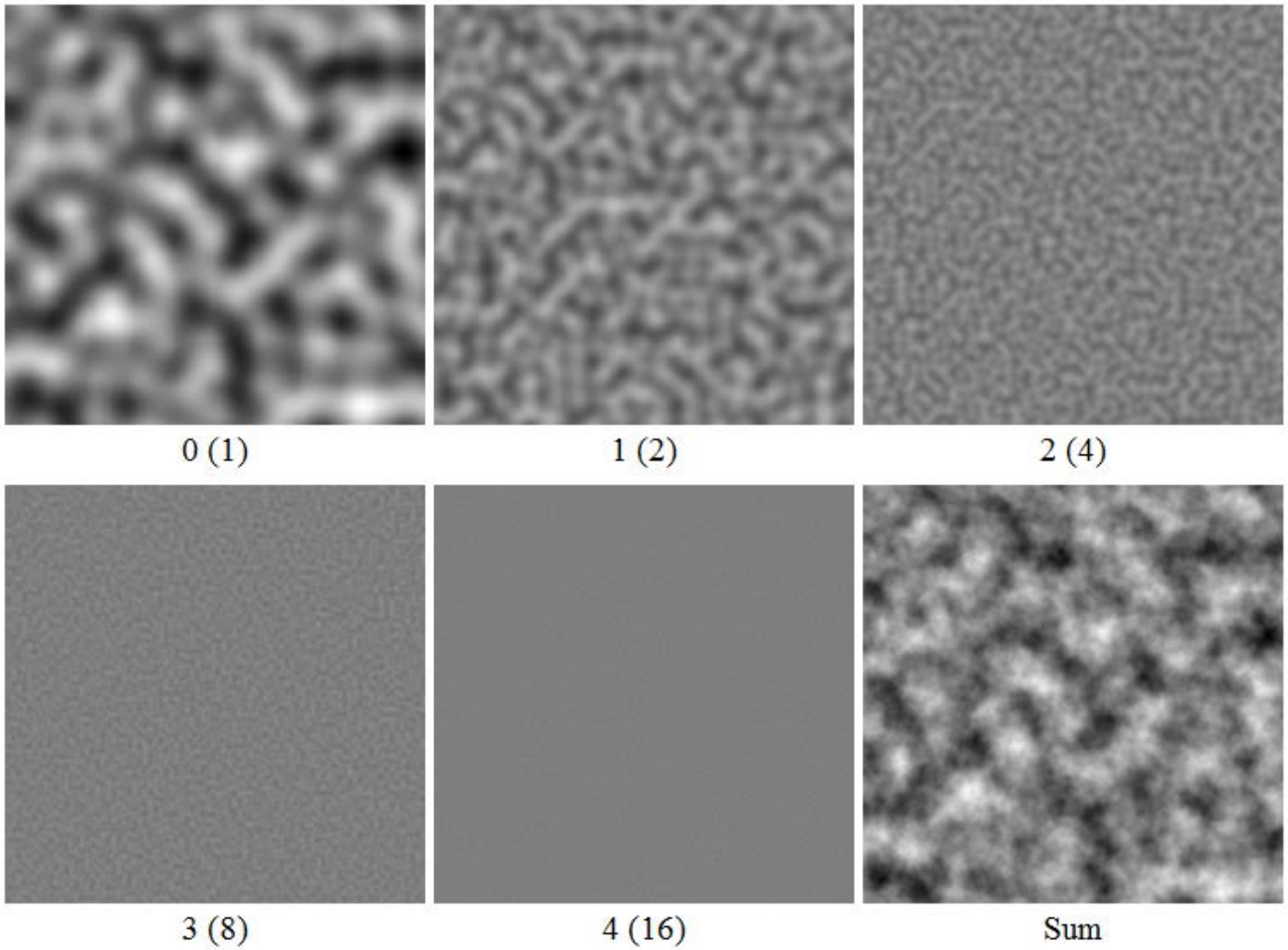
Perlin Noise 1D

$$NOISE(\mathbf{x}) = \sum_{i=0}^{N-1} \frac{Noise(b^i \mathbf{x})}{a^i}$$

- Amplitude ~ a (value scaling)
  - a > 1
- Frequency ~ b (harmonic scaling)
  - b > 1



Perlin Noise 2D



Gradient Noise

- Regular grid
  - resolution of highest frequency
- Random distribution of vectors
- Compute noise from vectors
- Interpolated to obtain values in between the lattices

Pseudorandom generating

- Random field of vectors
- Options :
  - Compute and store whole field
  - Smaller field with pseudorandom access

Generating of random vectors

- Generate in Cartesian coordinates
  - Non-uniformly distributed
- Generate in Polar coordinates
  - Uniformly distributed
  - Convert to Cartesian
- NORMALIZED !!!

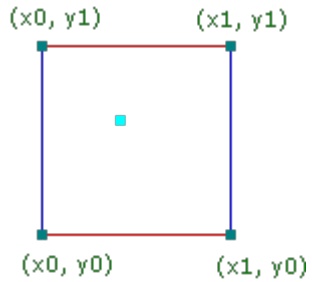
Pseudorandom access

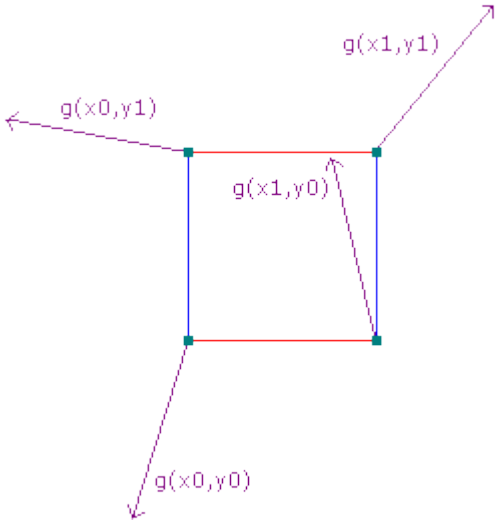
- Random permutation of field 0,..,255
  - unsigned char permutation [256]
  - size = 256, 2^n
  - mask = 255 (Size -1)

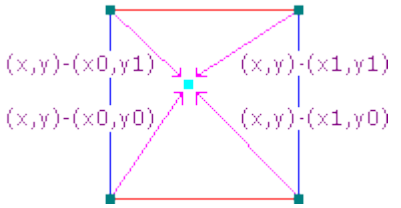
- Index(int x, int y)
  - Perm(x + Perm(y))
- Perm(int x)
  - permutation[x & maska]
  - size is power of 2
    - x & mask = x % mask (mod)

Noise computation

- Regular grid of vectors

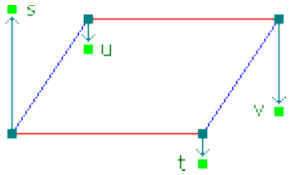






Noise computation (2)

$$s = g(x_0, y_0) \cdot ((x, y) - (x_0, y_0))$$
$$t = g(x_1, y_0) \cdot ((x, y) - (x_1, y_0))$$
$$u = g(x_0, y_1) \cdot ((x, y) - (x_0, y_1))$$
$$v = g(x_1, y_1) \cdot ((x, y) - (x_1, y_1))$$

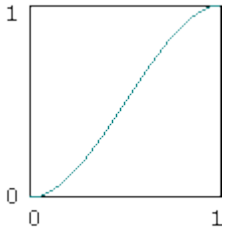


- Bilinear interpolation
  - Problems with continuity
  - Smoothness function

Smoothness function

- Perlin's idea

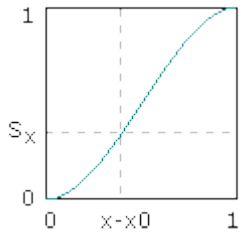
$$smooth(t) = 3t^2 - 2t^3$$

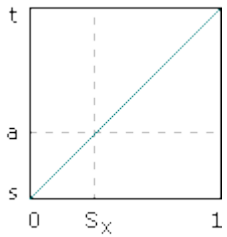


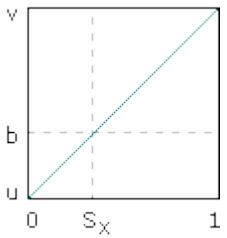
- Later improved

$$smooth(t) = 6t^5 - 15t^4 + 10t^3$$

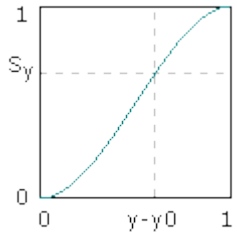
Interpolation







$$S_x = smooth(x - x_0)$$
$$a = s + S_x(t - s)$$
$$b = u + S_x(v - u)$$



$$S_y = smooth(y - y_0)$$
$$noise = a + S_y(b - a)$$

Noise composition

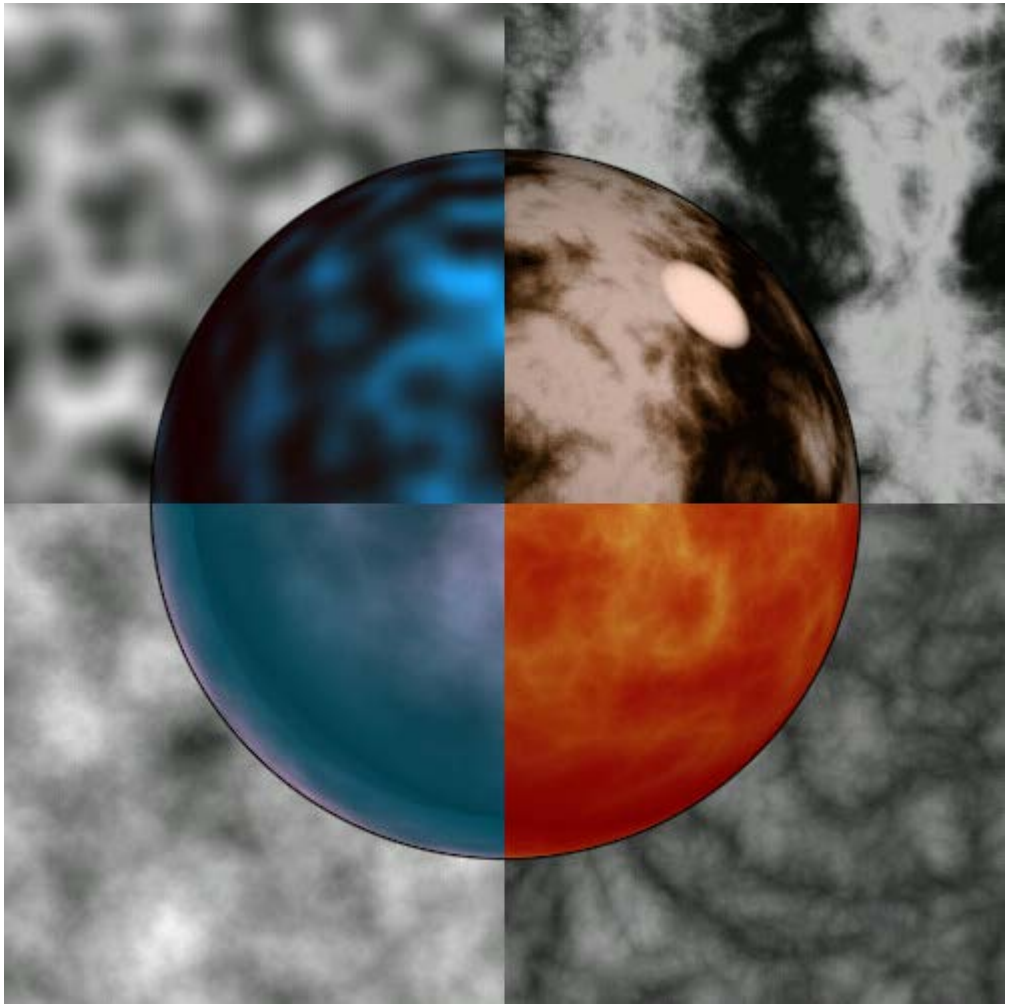
- Sum noises
  - with different amplitudes and frequencies

  - freq *= f;
  - amp *= a;

Output

- Scale from interval (-1,1) to (0,255)
- Map to texture pallet
  - Read first row from texture
  - FreeImage
    - FreeImage_GetPixelColor
    - FreeImage_SetPixelColor

Results



Links

- http://freespace.virgin.net/hugo.elias/models/m_perlin.htm
- http://people.cs.kuleuven.be/~ares.lagae/publications/LLCDDELPZ10SPNF/LLCDDELPZ10SPNF.pdf
- …

Homework (3)

- Study the problematics
  - Perlin noise
- Write short paper about perlin noise (1 x A4)
  - Description of perlin noise
  - Utilisation of perlin nois in modelling and rendering
  - Examples (images)

- Deadline
  - 8.12.2015, 23:59
- 1A4 name.pdf
- kucerova@sccg.sk
- Subject: MRT, DU3