Recursive Implementation of Anisotropic Filtering

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Background

- **Image Smoothing**
  - Isotropic Smoothing (Gaussian filter)
  - Anisotropic Smoothing (edge-preserving)

Original Image  Isotropic Filtering  Anisotropic Filtering
Background (contd.)

- Implementation
  - Non-recursive (convolution)
  - Recursive (propagation)
Paper#1: Bilateral Filtering

“Bilateral Filtering for Gray and Color Images”,
C. Tomasi and R. Manduchi, ICCV’98

\[ h(x, \xi) = e^{-\frac{(x-\xi)^2}{2\sigma_d^2}} \cdot e^{-\frac{(f(x)-f(\xi))^2}{2\sigma_r^2}} \]
Recursive Implementation of the Gaussian Filter”,
Ian T. Young and Lucas J. van Vliet, Signal Processing, vol. 44, pp. 139-151, 1995

Forward:

\[ w[n] = B \cdot \text{in}[n] + \frac{b_1 w[n-1] + b_2 w[n-2] + b_3 w[n-3]}{b_0} \]

Backward:

\[ \text{out}[n] = B \cdot w[n] + \frac{b_1 \text{out}[n+1] + b_2 \text{out}[n+2] + b_3 \text{out}[n+3]}{b_0} \]
Exponential Filtering:

\[ S_\alpha(n) = k(\alpha \mid n \mid + 1)e^{-\alpha|n|} \]

Constant \( \alpha \) → varying parameter

\[ \alpha_n = g\left(\left| \frac{\partial x}{\partial t}(t_n) \right| \right) \]

\( g \) is non-decreasing