Flow based Image Abstraction

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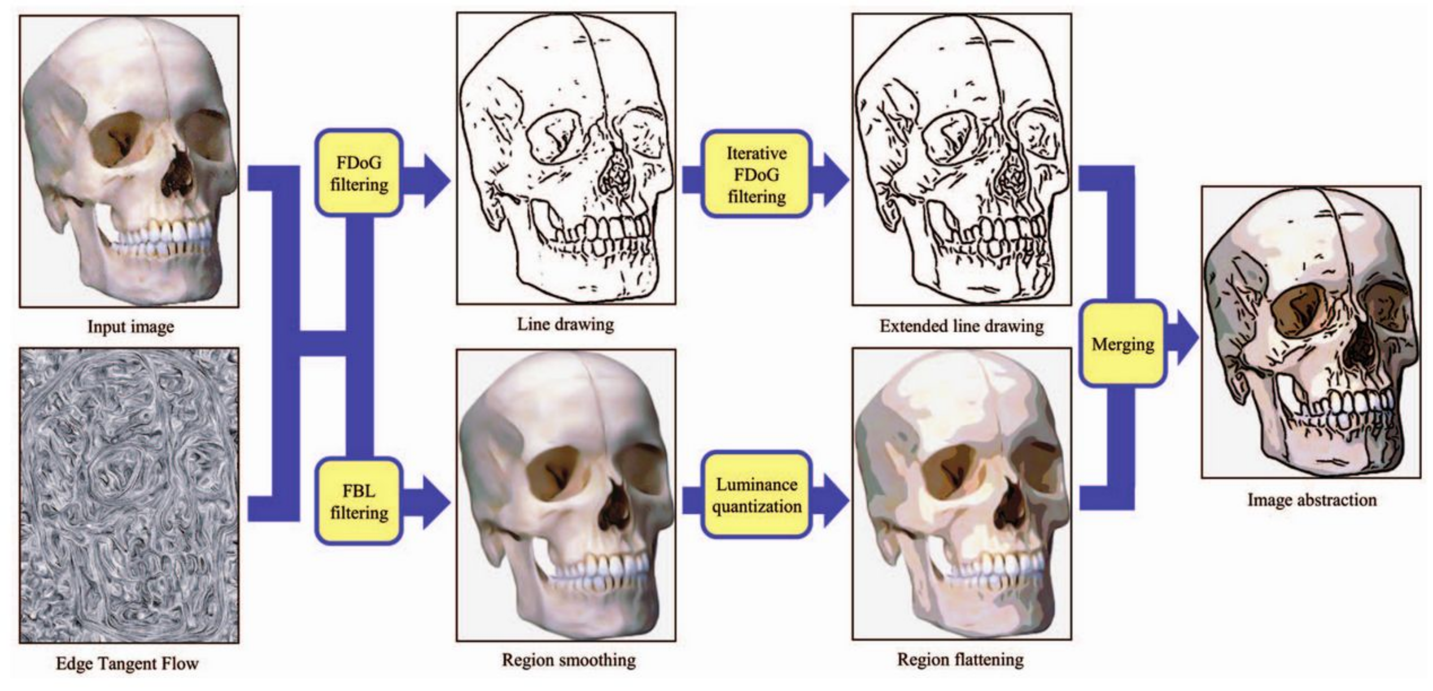
Introduction

Project Idea: Cartoonification of natural images using flow based abstraction

Research Paper: Flow Based Image Abstraction by Kang, Henry and Lee, Seungyong and Chui, Charles K., Jan 2009

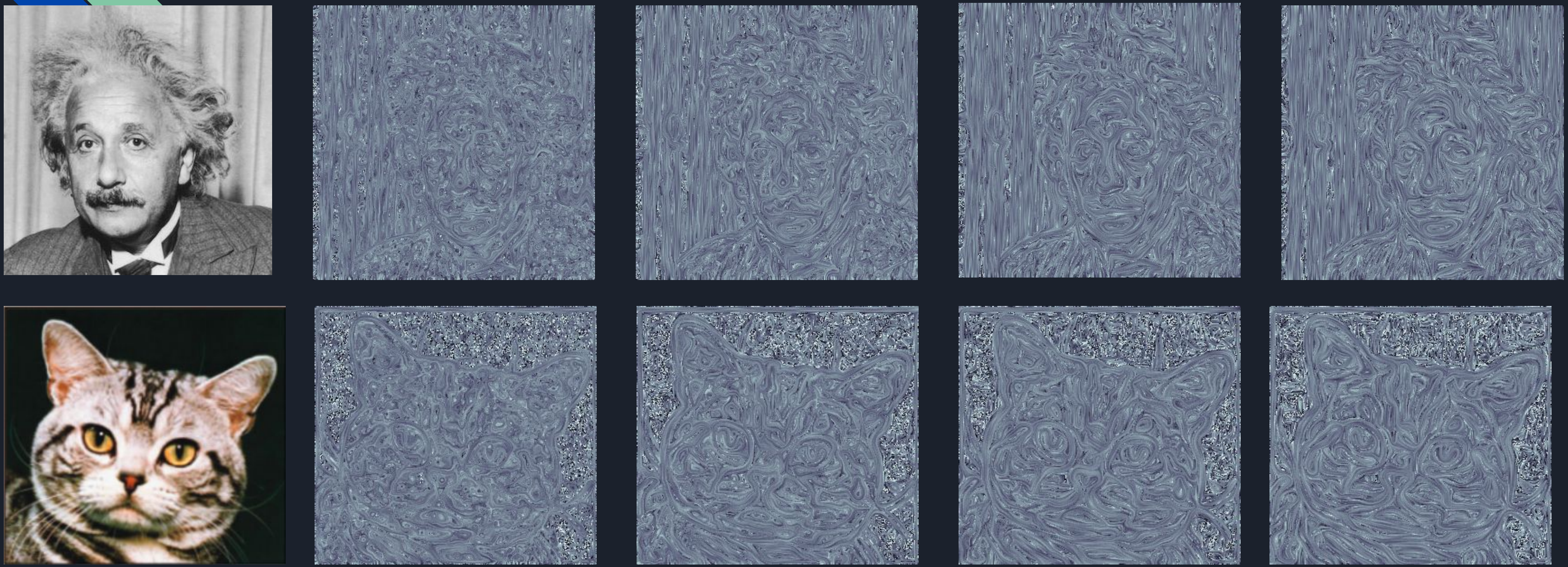
Pipeline of the image abstraction algorithm



Pipeline of the image abstraction algorithm

1) Edge Tangent Flow (ETF) - ETF construction is essentially a bilateral filter adapted to handle vector-valued data.
2) Flow based Difference of Gaussians(FDoG) - DoG (acting like a LoG) for line extraction applied along the ETF flow
3) Flow based Bilateral Filter (FBL) - Perform region smoothening with flow aware kernels

Edge Tangent Flow



$$\mathbf{t}'(\mathbf{x}) = \frac{1}{k} \iint_{\Omega_\mu} \phi(\mathbf{x}, \mathbf{y}) \mathbf{t}(\mathbf{y}) w_s(\mathbf{x}, \mathbf{y}) w_m(\mathbf{x}, \mathbf{y}) w_d(\mathbf{x}, \mathbf{y}) d\mathbf{y}$$

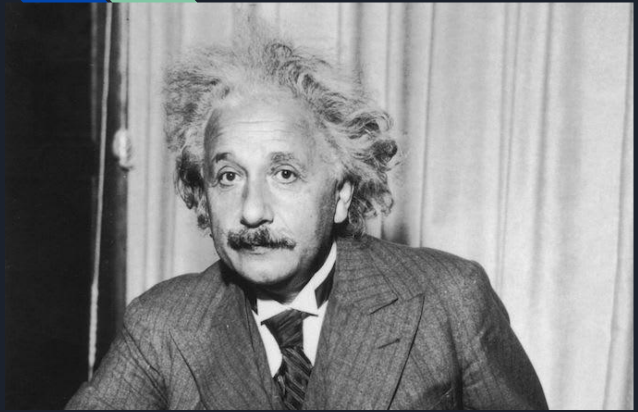
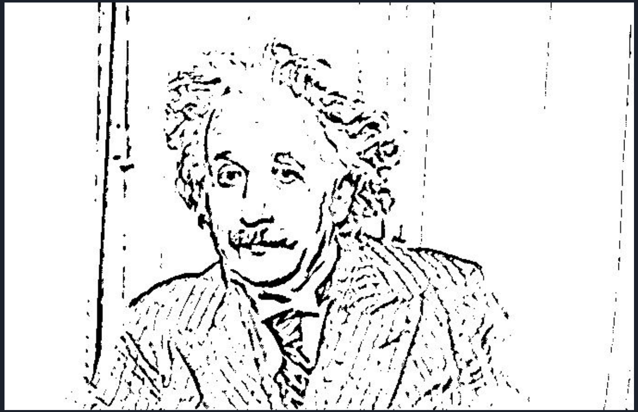
$$w_s(\mathbf{x}, \mathbf{y}) = \begin{cases} 1 & \text{if } \|\mathbf{x} - \mathbf{y}\| < \mu \\ 0 & \text{otherwise.} \end{cases}$$

$$w_m(\mathbf{x}, \mathbf{y}) = [\hat{g}(\mathbf{y}) - \hat{g}(\mathbf{x}) + 1]/2$$

$$w_d(\mathbf{x}, \mathbf{y}) = |\mathbf{t}(\mathbf{x}) \cdot \mathbf{t}(\mathbf{y})|$$

$$\phi(\mathbf{x}, \mathbf{y}) = \begin{cases} 1 & \text{if } \mathbf{t}(\mathbf{x}) \cdot \mathbf{t}(\mathbf{y}) > 0 \\ -1 & \text{otherwise.} \end{cases}$$

Flow based Difference of Gaussians



$$\mathcal{H}(\mathbf{x}) = \int_{-S}^{S}\int_{-T}^{T} I\big(l_{\mathbf{x},s}(t)\big) f(t) G_{\sigma_m}(s)\,dt\,ds$$

$$G_\sigma(x) = \frac{1}{\sqrt{2\pi}\sigma} e^{-\frac{x^2}{2\sigma^2}}$$

$$f(t) = G_{\sigma_c}(t) - \rho \cdot G_{\sigma_s}(t)$$

$$\tilde{\mathcal{H}}(\mathbf{x}) = \begin{cases} 0 & \text{if } \mathcal{H}(\mathbf{x}) < 0 \text{ and } 1 + \tanh(\mathcal{H}(\mathbf{x})) < \tau \\ 1 & \text{otherwise,} \end{cases}$$

Flow based Bilateral Filter

$$\mathcal{C}_e(\mathbf{x}) = \frac{1}{\nu_e}\int_{-S}^{S} I(c_{\mathbf{x}}(s))G_{\sigma_e}(s)h(\mathbf{x}, c_{\mathbf{x}}(s), r_e)ds$$

$$h(\mathbf{x}, \mathbf{y}, \sigma) = G_\sigma(\|I(\mathbf{x}) - I(\mathbf{y})\|)$$

$$\mathcal{C}_g(\mathbf{x}) = \frac{1}{\nu_g}\int_{-T}^{T} I(l_{\mathbf{x}}(t))G_{\sigma_g}(t)h\big(\mathbf{x}, l_{\mathbf{x}}(t), r_g\big)dt$$

Results after combining