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Towards Simulation of Handmade Painterly Animation

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Introduction

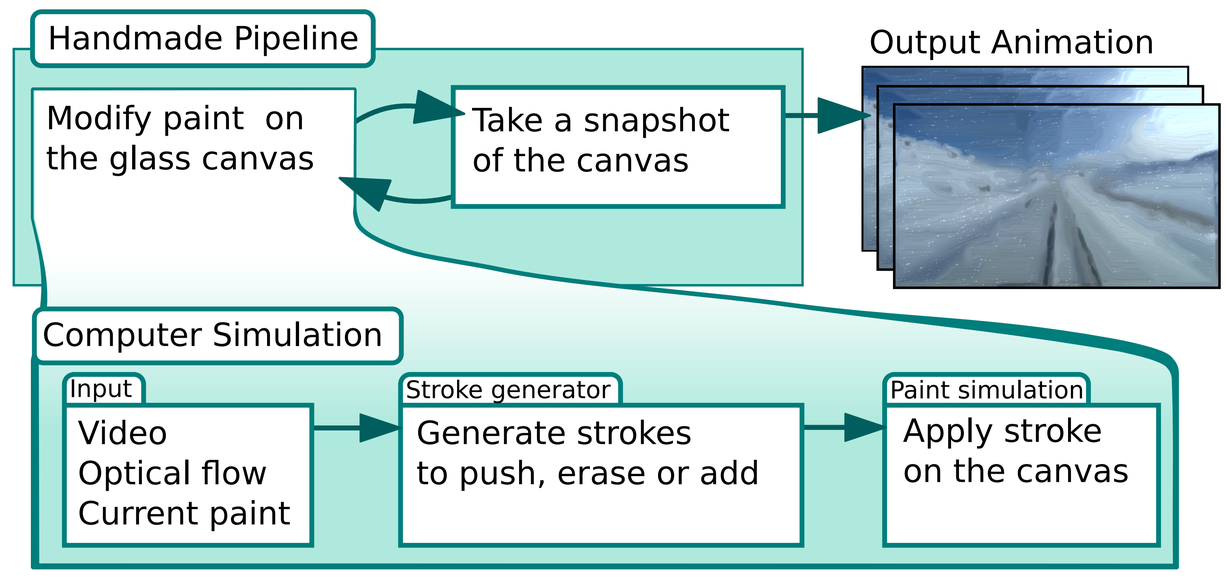
As research on painterly animation mostly focus on temporal coherence, the generation of an animation that could have been done by hand remains an open challenging problem. To produce an handmade painterly animation, the artist paints on a back lighted glass canvas. He creates successive frames one over the other. Paint is erased, smeared and added to convey the animation.

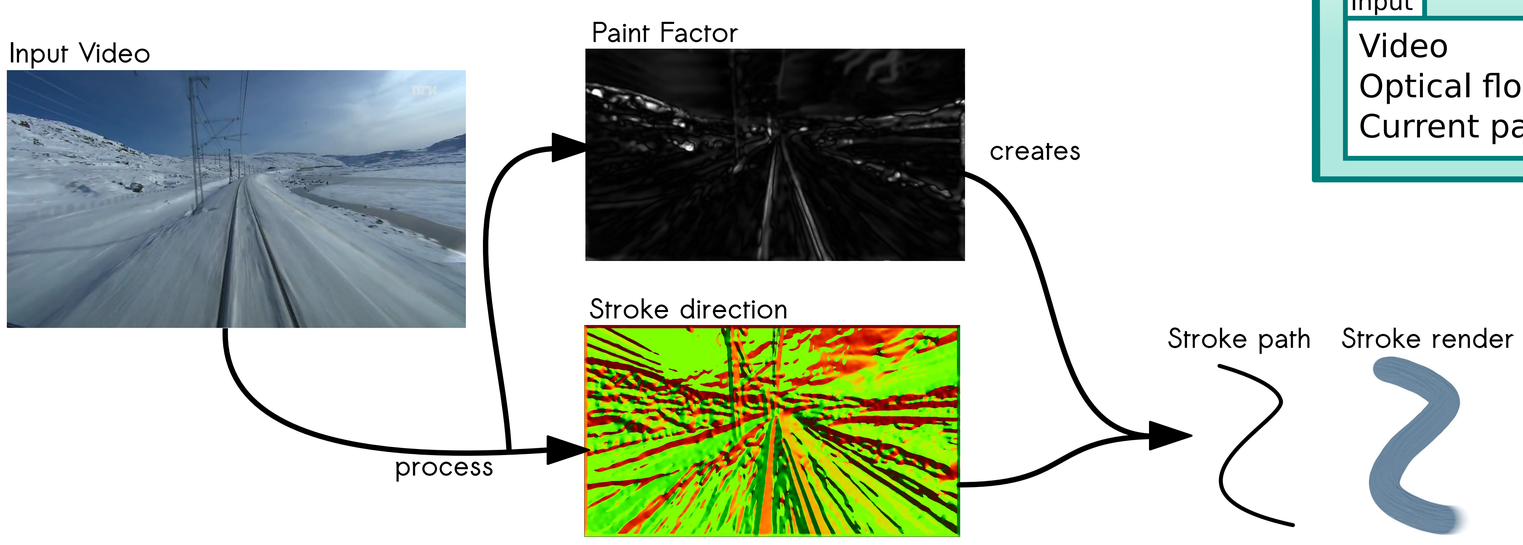
We propose to render painterly animations with a visual aspect tending towards handmade results. To this end, we combine two techniques: an automatic strokes generation and a paint simulation. We observe that previous approaches could not adapt as-is to our goal for the two following reasons:
- Paint appearance in painterly animation is backlit: Most of paint contrast comes from paint thickness which is usually not computed by paint simulation approaches.
- Automatic strokes generation make the assumption that a stroke covers underlying strokes without having thickness accumulation. In our case, paint thickness quickly increases if we do not apply special treatment.
We also investigate new kind of strokes that can only be generated by a paint simulation approach, as smear and erase strokes.

This typical setup for handmade painterly animation has a camera placed over a glass canvas to take snapshots. The glass is front- and backlit.

Images courtesy of Sam Samai http://rumi.studio2pi.com.au

The artist produces each frame by painting onto the canvas.





Stroke generator

We follow the approach of Hertzmann and Perlin (2000). To paint a frame, the approach is to paint several layers, each layer corresponding to a brush radius R. To compute new strokes we first compute a paint factor for each pixel. If the sum of paint factors over a cell as large as the brush is larger than a user controlled threshold, we trigger the creation of a new stroke. Then, we determine stroke position and shape. A stroke starts where the paint factor is maximum, the stroke path following the normal to the gadient of luminance.
The paint factor P is computed as follow:

$$P = S(B_R(I))|B_R(I) - C|)$$

Sobel edge detector Gaussian blur input frame Current paint

We also use a cummulative difference between frames of the input video. This difference alows us to focus creation of strokes where the input video actually changes.

Area of investigation:
- Improve stroke generator to have better suited strokes.
- Build specific strokes to push paint.
- Build specific strokes to erase paint.
- Decompose paint factor in thickness and color, to render back lighted paint.

Ad-hoc Paint Remover

We do not obtain good results yet when we create strokes to erase paint. Instead we test an ad-hoc paint remover. It removes paint accumulation without loosing thickness variation details. It is implemented by substracting a blurred version of the thickness from the thickness of the canvas with the following formula:

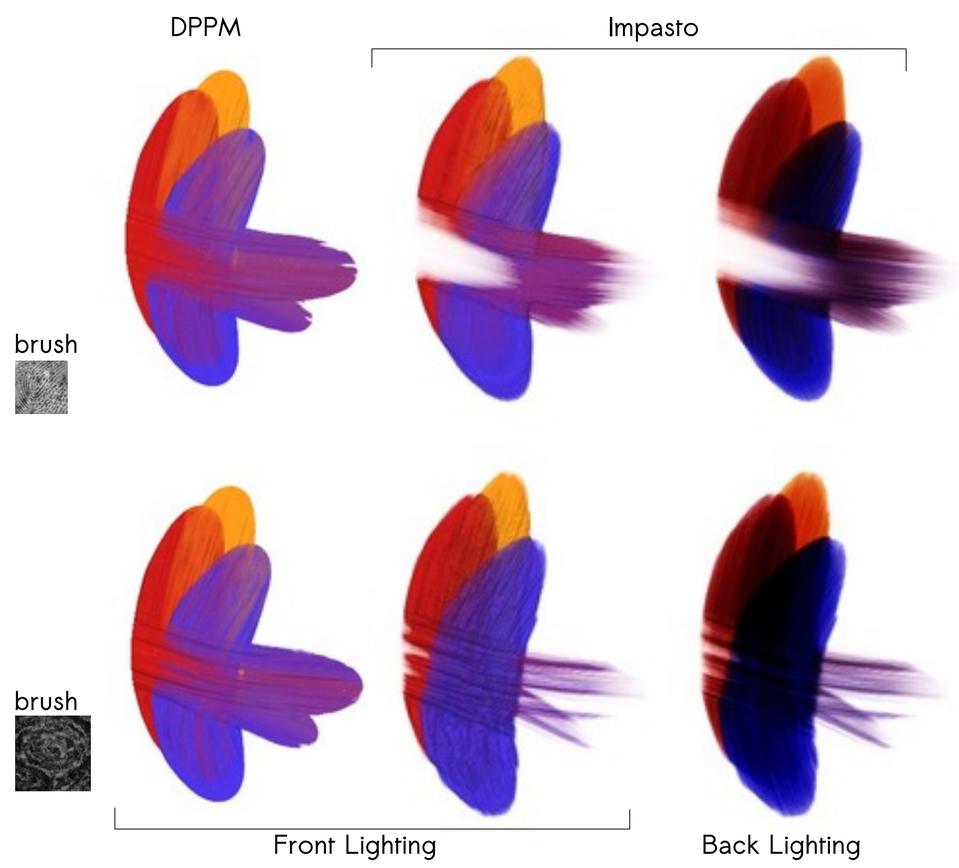
$$\alpha \leftarrow \min(\alpha, \max(\alpha - \max(B(\alpha) - .5, 0), 0.1))$$

thickness

Paint Simulation

Each stroke is rendered by applying a brush footprint along the stroke path. We have tested two paint simulation approaches: Impasto (Baxter et al. 2004) and Detail-Preserving Paint Modeling for 3D Burshes (DPPM, Chu et al. 2010).
DPPM renders sharp and crisp color blending and color streaks, which is visually close to real paint blending. This phenomenological approach does not consider paint thickness, and retro lighted rendering is impossible.
Impasto is physically inspired and provides plausible paint appearance. This paint simulation also computes paint thickness, though paint is easily rendered as front lighted or transparent retro lighted.

Area of investigation:
- Hybrid approach producing both back lighted rendering and color streaks.



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