A Review of Oil Painting Simulation Techniques

Literature Review I
(see official assignment for name)

INTRODUCTION

People have long been enthralled by the imagery created by oil paint. There is something unique about the way linseed oil and pigments look after being pushed around on a canvas. There is also something unique about the hassle of setting up, mixing, and cleaning oil paints. For these reasons, a digital simulation of the medium is far more convenient.

Because of its viscosity, oil paint blends unlike watercolor and other runny mediums. Oil paint is made of a relatively thick vehicle (usually linseed oil) and colored pigments. It stays wet for days, meaning it can be pushed around, transferred to and from the brush, accumulate on the edges of the stroke, and mix with the layers of paint below it. The colors from the pigments mix very coarsely with each pass, and become further blended as they are passed over again and again. All of these characteristics require consideration when trying to realistically simulate the physical medium.

The selected papers, “IMPaSTo: A Realistic, Interactive Model for Paint” from NPAR in 2004, and “Real-Time Oil Painting on Mobile Hardware” in a 2017 CGF journal, discuss digitally simulating the experience of oil painting.

IMPaSTo (2004)

IMPaSTo models pigments and the varied surface height that comes from oil painting. Pigments are only blended into the one wet layer. When paint is pushed around on the canvas, the height is modeled using the brush velocity and the concentrations of pigments from the brush path. The Kubelka-Monk model is used to render the color of pigments. Specular highlighting is done using the Blinn-Phong technique.

This approach worked well; it created an illusion of physical oil paint being brushed onto a canvas in real time. The software achieved this by running on a graphics processor on a desktop computer - again, this paper is from 2004, six years before the first iPad was launched. An artist could use IMPaSTo to mix paint, push it around, create areas of thicker or thinner paint, and blend in a relatively natural fashion.

There are two significant usability limits to the IMPaSTo simulation. First, it is hindered by the relatively unrealistic approach to fluid physics. Instead of using pressure, as has become common with modern drawing applications, the simulation uses brush velocity to calculate the pressure with which the brush is "pressed" into the layer of wet paint below it. The fluid algorithm is basic in comparison to more recent and comprehensive fluid dynamics techniques. Second, it is hindered by its limitation to a single wet layer. As understood by reading the paper, there is only one other color available to be mixed at any given time. While this may have been a previously blended color, its homogeneity limits the ability to create strokes of more than two adjacent colors. These limitations of fluid simulation and color mixing are addressed by the more recent work reviewed.

Real Time Oil Painting on Mobile Hardware (2017)

The approach as described by Stuyck et al in "Real Time Oil Painting on Mobile Hardware" tries to strike a balance between a realistic oil painting experience and the performance required to run on mobile hardware. Between a more concise design of the paint's data structures and hardware performance improvements made since 2004, Stuyck et al were able to achieve a subjectively more realistic experience on mobile hardware (namely, an iPad).

Fluid dynamics (the flow of paint as it moves around the brush) was modeled using shallow-water equations that could provide a subjectively more realistic experience.

There is added functionality when using an oil painting simulation on an iPad: because it is a mobile device with an accelerometer, you can measure its angle. Stuyck et al took advantage of this capability by allowing paint to run “down the canvas” to simulate gravity acting on the paint. The lighting also changed according to the angle of the iPad. The front camera of the device was used to measure incident light in the room and create reflections accordingly. These effects could significantly affect the painting experience, allowing you to see colors from different light angles and drip the paint to create heavier sections of color.

LESSONS LEARNED

The approaches outlined in the two papers shared a lot of ideas. First, both approached blending pigments by using the Kubelka-Monk model. Both approaches modeled the movement of paint as it is sculpted into a near-3D shape using algorithms that mimic fluid. In the interest of running real-time, neither employed computation-heavy non-Newtonian fluid simulation. Both lit implemented specular highlighting to give the appearance of glossy reflections. These characteristics appear to be great building blocks for simulation of oil painting.

CONCLUSION

While the papers outline very similar high-level approaches, there are important algorithmic and implementation details that make the newer work noteworthy. Using more advanced shallow-water fluid simulation appears far more true-to-life than IMPaSTo’s

pressure-velocity model. The iPad's camera, sensors, and pressure sensitivity have allowed new freedom to create and view the work in a more lifelike sense. Most important of all is the ability to bring a simulated paint set with you anywhere.

REFERENCES

Stuyck, T., Da, F., Hadap, S. and Dutré, P. (2017), Real-Time Oil Painting on Mobile Hardware. Computer Graphics Forum, 36: 69–79. doi:10.1111/cgf.12995

William Baxter, Jeremy Wendt, Ming C. Lin, IMPaSTo: a realistic, interactive model for paint, Proceedings of the 3rd international symposium on Non-photorealistic animation and rendering, June 07-09, 2004, Annecy, France