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Physical Rendering with a Digital Airbrush

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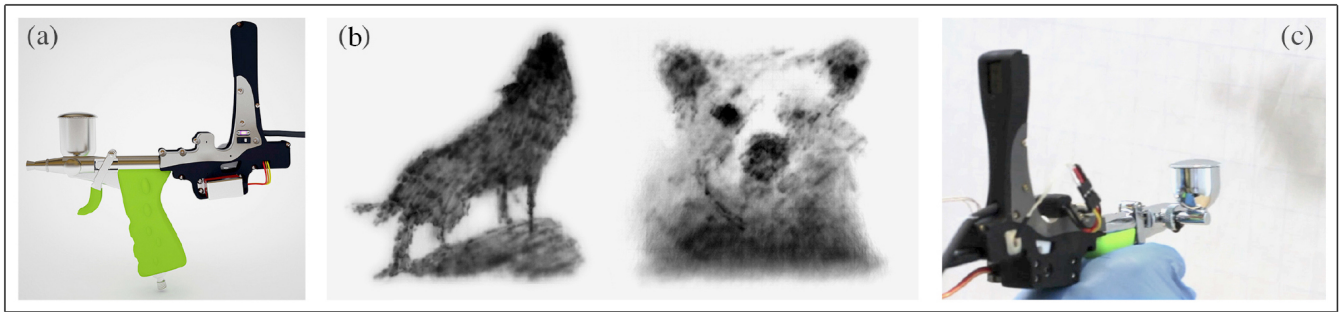
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Figure 1: *(a) A rendering of the airbrush and augmentation, (b) a novice painter's results on real canvas, (c) the device at work*

Introduction. Airbrush painting is an expressive art form that allows for unrepeatable spray patterns and unique ink staining. Artists utilize these properties while painting, expressing subjective style and artistic intentions. We present an augmented airbrush device that acts both as a physical spraying device and an intelligent digital guiding tool, that maintains both manual and computerized control. We demonstrate our custom designed hardware and numerous algorithms that control it through hands-on usage examples of a human-computer collaborative of a physical painting effort.

Related Work. The field of assisted expression is growing rapidly, with works in graphics such as ShadowDraw [Lee et al. 2011] and in smart tools for manual fabrication [Zoran and Paradiso 2013; Rivers et al. 2012]. Part of this research agenda, a number of attempts at creating a computer-augmented airbrush device were recorded, most notably are the efforts of Konieczney et al. [Konieczny et al. 2008] and Yang [Yang et al. 2007], who used augmented or virtual reality to create a training system for spraying, however their focus was on a virtual result in contrast to ours.

Airbrush Hardware. We used a GREX Genesis.XT pistol-style airbrush, relieved of its rear paint-volume control knob and fashioned with a custom made augmentation of our design. We integrated a 6DOF magnetic tracker, and a mechanical actuation system composed of a servo, multiple gears, a potentiometer (POT) to measure the trigger action, an LED and a 2-state switch. Onboard electronics drive the servo and LED, query the POT and also include a 6DOF inertial measurement unit (IMU) alongside a USB connection for power and communication. The computer-controlled servo and gears restrict the trigger action so the painter can only spray as much as the software allows at a certain point in space.

Software Elements. We implemented a comprehensive driver for the hardware that allows loading a reference image to paint, registering and calibrating the tool and canvas, and controlling the tool's mechanical operation. The GPU-implemented control algorithms determine if the painter is in risk of spraying in the wrong direction and location, as calculated from the information from the tool, and issue control commands to the tool at ∼100Hz. The system simulates in real-time the paint deposit based on a parametric model of the typical spraying pattern of the airbrush, with respect to distance from the canvas, the trigger action and the radius from the center of spray projection. A color-decomposition algorithm based on a derivation of the Kubelka-Munk theory [Baxter et al. 2004] gives us the opportunity to spray layers of pigments to reconstruct a colourful image from a given palette of pigments.

Mode of Operation. The painter has complete manual freedom to explore the canvas and spray at will, with subtle haptic response from the computer delivered through the trigger as the servo restricts it. We used an invisible feedback interface to allow the painter to be immersed in the embodied action of painting instead of relying on a virtual crutch. The 2-state switch can shift between the paint governor aggression modes, one for strict restriction and another for very light restriction (up to none at all), where artists can apply stylizations if they feel confident in their technique.

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