

CoolPaint: Direct Interaction Painting

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ABSTRACT

We present *CoolPaint*, a system for computer painting that uses a props-based direct interaction technique. By instrumenting real paint brushes and developing corresponding digital models of the brushes, we allow the user to control digital tools by directly manipulating their physical counterparts. In addition, we use a tabletop display which allows the display space and interaction space to be unified. The painter picks up a real paint brush, dabs it in ‘paint’, and makes a brush stroke across the canvas. Digital paint immediately appears on the canvas, directly under the brush, with exactly the brush stroke the painter expects. The result is an intuitive, expressive, and fun painting experience.

1. INTRODUCTION

Most computer drawing programs have several layers of indirection between the actions of the user and the image produced. Movement of the physical input device, typically a mouse or tablet, is mapped to movement of a cursor on the display. The cursor is then mapped to the action of a virtual tool that manipulates the image. *CoolPaint* is a digital painting system that removes these layers of indirection to create an immersive, natural painting environment.

One source of indirection in desktop graphics applications, such as Adobe Photoshop, is that a single input device is mapped to many virtual tools. This forces modal operation, which adds to the user’s cognitive load. Another problem is the use of a 2- or 3-degree-of-freedom (dof) input device to control what is conceptually a 6-dof tool. The virtual model becomes a crude representation of its real-world counterpart with only a fraction of the expressiveness. For example, when using the paint brush or spray can tools, the user cannot take advantage of the orientation and rotation of the brush, or the distance between the spray can and the canvas.

Using real paint brushes instrumented with 6-dof trackers and corresponding 3D virtual models (see Figure 1), *Cool-*

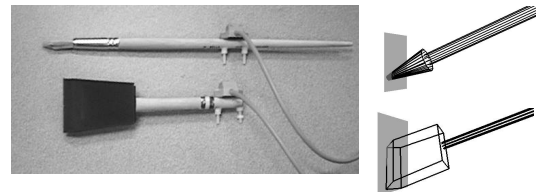


Figure 1: The *CoolPaint* instrumented brushes (left) and the brush models (right).

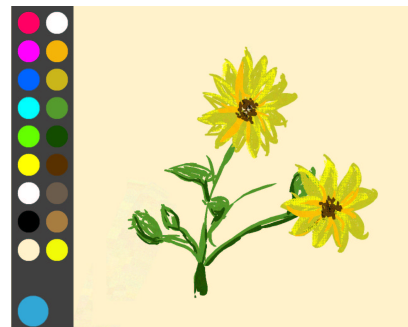


Figure 2: A painting created with *CoolPaint*. The palette area is shown on the left; the ‘mug’ for rinsing brushes is in the bottom-left corner.

Paint allows for more natural and concrete gestural input than is afforded by abstract mouse- or tablet-based input. In the mind of the user, no distinction is needed between the virtual and real tools because the real tool directly manipulates its virtual counterpart. In addition, *CoolPaint* uses a tabletop display to unify the input and display space. By interacting directly on the display surface, we remove layers of spatial indirection, and by using a tabletop, we allow interaction on a more natural scale than typical desktop-based drawing programs. Figure 2 shows an example of a painting created using *CoolPaint*.

2. RELATED WORK

The use of props was introduced by Hinkley *et al.* [2]. *Props* are passive physical objects which represent and manipulate virtual objects. The Tangible Bits group at MIT has presented several prototype graspable user interfaces that couple real-world objects with virtual ones [3].

Props-based interaction is a common technique for large dis-

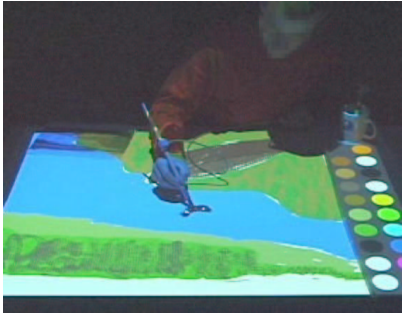


Figure 3: *CoolPaint* in use.

play surfaces. A well-known commercial example of this is the SmartBoardTM, a full-size touch-sensitive digital whiteboard on which ‘markers’ and ‘erasers’ can be used¹.

There has been considerable work in interactive computer painting. For example, the *DAB* painting system presented by Baxter *et al.* uses a Phantom haptic display for 6-dof input and 3-dof force feedback, and allows the painter to use a variety of virtual brushes on a virtual canvas [1]. The *CavePainting* system [4] allows artists to create 3D brush strokes in an immersive CAVE environment. Several brush types are controlled with a single physical wand, in conjunction with a pinch glove worn on the non-painting hand. With *DAB*, *CavePainting*, and other painting systems, either interaction does not occur directly on the display surface, or one input device is used to control several virtual tools.

3. PROTOTYPE

The system uses a top-projected tabletop display and two paint brushes to which Polhemus Fastrak 6-dof trackers have been attached (see Figure 1). The position of each brush is constantly tracked and its intersection with the surface of the canvas is calculated using the corresponding model. Figure 3 shows the system in use.

CoolPaint attempts to recreate the experience of real painting. Instead of using a colour-choosing widget, therefore, we provide a palette area to one side of the canvas. Colour mixing is performed by dabbing a brush into a primary colour (to pick up paint) and then touching the brush to one of the colour-mixing areas (to mix in the paint). We also provide a ‘mug’ of water to rinse paint from the brushes. For concreteness, we place a real mug over the projected mug.

4. USER EVALUATIONS

We ran informal user evaluations with six users. Users painted the same picture using both *CoolPaint*, and Adobe Photoshop with a tablet input device. A post-questionnaire asked them to rate several statements on a 7 point Likert scale (1 = strongly disagree; 7 = strongly agree). Preliminary results show that *CoolPaint* is:

- **Collaborative.** Participants showed no hesitation in picking up a spare brush and joining in. Each brush has an equal level of control, facilitating collaboration.

¹“SMARTBoard Interactive White Board”. Retrieved February 2, 2003 from <http://www.smarttech.com/products/smartboard/>.

- **Easy to use.** Participants rated *CoolPaint* as easy to use (6.5/7).
- **Expressive.** *CoolPaint* was rated as more expressive than the tablet/Photoshop combination (6.5/7).
- **Fun.** The above factors encouraged creativity and all of our users expressed interest in using *CoolPaint* further.

Although they had some problems with mixing colours, users found *CoolPaint*’s colour mixing to be more natural (6/7) than Adobe Photoshop’s colour chooser. Nuanced actions, such as swishing the brush while cleaning it, suggest that users imagine they are manipulating real paint. They are engaging in “natural user dialog” rather than conforming to a “contrived” interaction style [2].

5. FUTURE WORK AND CONCLUSIONS

CoolPaint shows that a direct interaction style is effective for an expressive domain such as painting. The use of physical props modelled in the digital domain provides an easy to use interface and allows skill transfer for users with real-world painting experience.

Further user evaluations need to be completed to determine the effectiveness of this system for amateur and professional artists, and to explore the collaborative advantages of the system. We would also like to implement more sophisticated brush and paint models, such as those of *DAB*.

There are several research directions we would like to explore. One is that we need to provide a wider range of physical tools. It is not feasible to attach a 6-dof tracker to every tool the user may need. One suggestion is to provide a few brush handles along with a larger set of removable brush heads.

Another issue is how best to incorporate digital image editing tools, such as copy/paste, while maintaining the simplicity of the interface. Two possible solutions are to create a physical counterpart for each of these tools, or to provide a stylus-type tool that would act as a 2-dof input device for those tools that do not have real-world counterparts.

6. REFERENCES

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