

# PALETTE: Connecting Kids through Tangible Color-Mixing

Nan Gao, Ben Ilegbodu, Nundu JanakiRam, Björn Hartmann and Scott Klemmer

Stanford University HCI Group

353 Serra Mall, Stanford, CA 94305, USA

{ngao, benmvp, bjoern, srk}@cs.stanford.edu, nunduj@stanford.edu

## ABSTRACT

We introduce PALette, a tangible color-mixing and drawing interface that enables the mixing of digital paint through physical actions. We sought to create a system that will allow children to express their collaborative creativity while also facilitating “thinking through doing.” In addition, we wanted a system that would provide remote collaboration and could be used across language barriers so that children across the world would be able to interact with each other as visual pen pals. In our system, a child can create a color by physically pouring one or more paint buckets onto a display, and can consequently draw on a virtual canvas with the mixed color. A single PALette system encourages collaboration through multiple, tangible input devices (the paint buckets). Through two connected systems, two children far apart can draw on a shared canvas, thereby supporting remote, synchronous, and language-independent collaboration.

## Keywords

tangible user interface, children, collocated, remote, collaboration, color mixing

## INTRODUCTION

Interfaces targeted at children should be conscious of children’s eagerness for expression and desire to collaborate with others. Tangible user interfaces (TUIs) are especially appropriate for children because they encourage direct physical interaction and active learning. TUIs are more likely to foster collaboration because they often involve multiple inputs.

Creating visual art (which among other activities includes choosing colors) appears to contribute to children’s cognitive development, and helps develop their ability to communicate and think critically [5]. We aimed to create a color choosing interface that permits maximum expressiveness (like the color wheel in Adobe Photoshop), but is still simple and intuitive (like the palette in Microsoft Paint). We supported this intuition by linking the mixing process to the well-known physical act of pouring.

Collaborative systems are especially beneficial to children because through social interaction, children acquire important new skills such as cooperation and teamwork [1]. Children also reap mutual satisfaction in working together to accomplish a task. Moreover, observations on the use of computers in classrooms show that children prefer working in groups [1]. We



Figure 1. The PALette box.

wanted to create an interface that can naturally support multiple users. We also do not require collaborators to be collocated, or to even speak the same language.

In this paper, we discuss a novel approach that integrates the concepts of “thinking through doing” and collaboration (both collocated and remote). We present PALette, a tangible color-mixing and drawing interface that enables the mixing of digital paint through physical actions. A single PALette system supports collocated collaboration where multiple children can pour separate buckets to create a color. Multiple PALette systems can also support synchronous, remote collaboration. When two systems are connected, the two children can mix separate colors, but draw on a shared canvas. Consequently, a child can collaborate with a friend across an arbitrary distance to create a shared drawing. Lastly, because PALette does not rely on text or dialogue, it supports collaboration between children of different cultures and languages.

## SYSTEM

PALette’s physical input was built with d.tools [3], a rapid prototyping hardware and software system that supports physical controllers (e.g. buttons, sensors, etc.) and easily integrates them into a programming environment via a USB connection to a host PC. The primary components of PALette are the four buckets (see Figure 1), a small screen to show the pouring and mixing visualization, a larger screen to represent the drawing canvas, and a stylus. When a user pours a bucket on the visualization screen, a stream of paint simulates the pouring of the appropriate color, and when other colors are poured, the visualization updates showing the newly mixed color. The buckets can also be poured at the same time. The user then “picks up” the color with the stylus and can begin drawing on the canvas screen.



**Figure 2. The PALette system, seen here supporting multiple collocated kids working together.**

When two PALette systems are connected, several feedback mechanisms help facilitate coordination between users. Synchronous drawing enables two users to work on the same drawing. The position of each user's cursor on the canvas is displayed on the other's canvas, suggesting where each user might draw next. A picture-in-picture (PiP) display of the color visualization informs the user of how his partner is making his color. Lastly, the user's bucket vibrates when the other user is pouring with the corresponding bucket, furthering the user's awareness of his partner's actions. These feedback mechanisms minimize the frustrations with non-verbal, remote collaboration and improve the depth of interaction by exposing the step-by-step process of each user's creation [2].

#### **USER TESTS**

Our first set of test results on PALette's user interface as a collocated collaborative device (see Figure 2) found that kids preferred simplicity over complexity in the UI. We removed switches that allowed children to save and load colors, for example, because less than 5% of them used it correctly. The second set of tests investigated whether users could create meaningful drawings together using only remote feedback mechanisms to communicate. Users quickly divided up sections of the canvas and added to each other's initial drawings to create a cohesive picture. Furthermore, the children reported that the PiP and vibration feedback were "cool" but not essential to the interaction.

#### **RELATED WORK**

The PALette system draws on related work in multi-display interaction and drawing systems for children. Pick-and-drop [4] is a pen-based interaction technique that lets users exchange information from one display to another by manipulating a physical object. Pick-and-drop allows files to be easily transferred from one computer to another by "picking up" the file on the source computer and "dropping" it on the destination computer. We extended this idea further in PALette by enabling the user to "pick up" the mixed color from the palette and transfer the color to the canvas.

The I/O Brush [5] is an augmented paintbrush that can pick up textures from the real world, and allows children to make drawings with them. The I/O brush helped solidify our decision to use visual art as the driving force of our system, and in particular, our focus on color-mixing, which was stated as one of its future directions for development.

While these works and others together served as a major impetus for our design, they only focused on collocated collaboration. We have added remote collaboration to PALette, increasing the degree of collaboration possible and allowing two children to interact regardless of their location and native language.

#### **FUTURE WORK**

Making the PALette system more portable would allow it to better integrate into kids' environments, allowing the device to be more like a toy and less like a computer peripheral. This portability can be accomplished by utilizing a newly planned wireless version of d.tools. Second, we wish to enhance the collaborative aspect of the system by employing rich media for communication. For example, video cameras would allow the children to see each other as they work together, making the experience more personal and engaging. Finally, we wish to explore additional uses of the PALette system beyond exploring creativity. These include educational uses, such as teaching kids about color theory through interactive demos, or entertainment uses, such as a game that utilizes drawing collaboratively to accomplish tasks.

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