PaintyFeet
painting is more than a sitting-in-a-chair activity

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ABSTRACT

In this paper, we present our findings regarding the designing process of PaintyFeet, a touchfloor application for foot painting in school and kindergarten. The touchfloor bases on the technique of rear diffuse illumination.

With PaintyFeet children can paint together in groups. They make new experiences by using their feet and toes instead of hands to create pictures.

A big color pot menu on one side of the floor allows even younger kids at the age of two to play with PaintyFeet. Older children can additionally use an individual foot menu, which offers advanced functionality.

To distinguish the children, the touchfloor reacts sensitively to colored toe sox, made of infrared fluoroscent material.

For administrative functions, PaintyFeet includes a Tablet PC, which should be used by an responsible educator.

Keywords: foot painting, PaintyFeet, touchfloor, rear diffuse illumination, infrared fluoroscent sox, multi user, children

INTRODUCTION

In kindergarten and school physical activities are just as much a part of education as teaching art is. However, in the majority of cases children have to sit quietly in their chairs, while they are painting. The educators do not allow them to be creative by trying hand or foot painting, because they are afraid of the mess the kids could produce with the paint.

Microsoft Surface, a multi-touch computer, offers a paint program, which allows children to paint with their hands and fingers on a screen without creating a mess. Standing around the computer table, small groups of kids can paint together with digital colors, chosen by one of them.

Unfortunately, Microsoft Surface Paint provides no opportunity to use feet for painting. Therefore, the experience of painting the rising sun with the big toe is not given. Furthermore, the problem that all children must use the same color at the same time could provoke a conflict between the older kids.

To address these shortcomings of MS Surface Paint we have invented the touchfloor application PaintyFeet. We will describe its functionality in the following part of this paper.

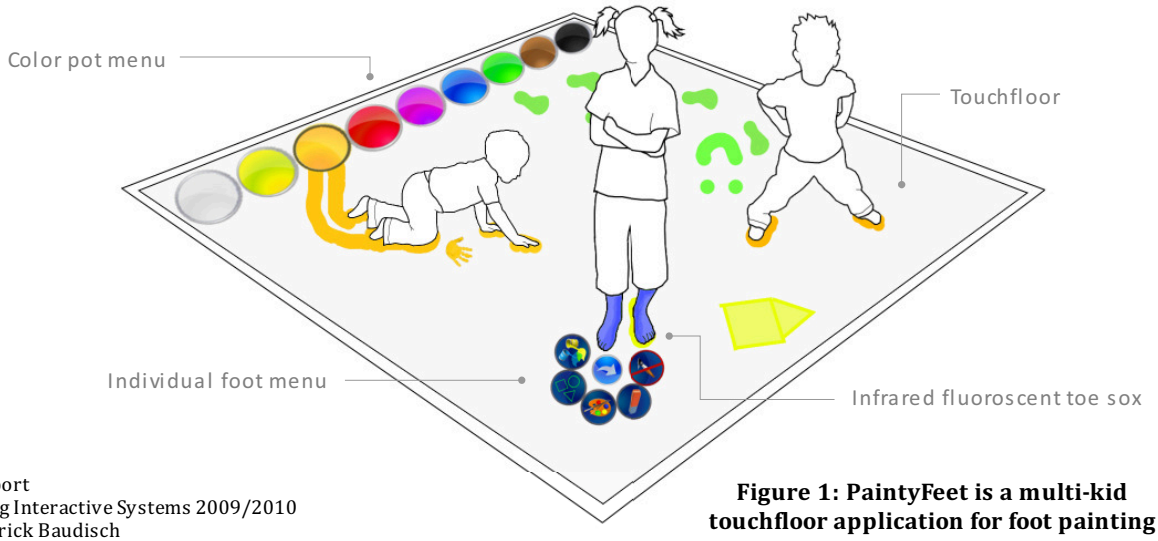

Figure 1: PaintyFeet is a multi-kid touchfloor application for foot painting

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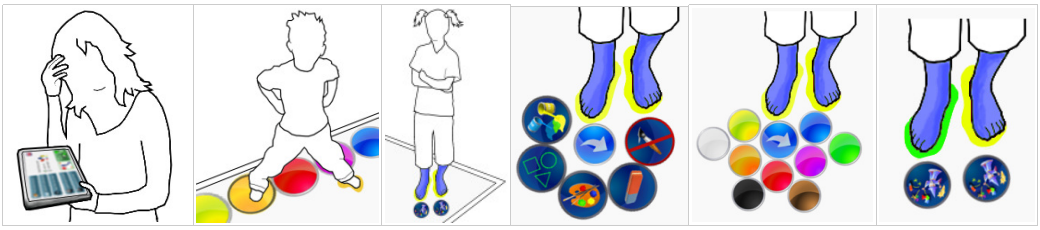


a) b) c) d) e) f)

Figure 2: When an educator started the application kids can play with PaintyFeet

WALKTHROUGH

Our device has three main kinds of interaction - the main menu on a Tablet PC, the color pot menu and the foot menu.

An educator (Figure 2a) turns on the system by inserting a smartcard into the Tablet PC. The Tablet PC includes the main menu, which is shown in Figure 3. It offers a file browser, a music player and the function of loading and saving images. A big button in the corner starts the currently selected painting mode. After clicking it, it is still possible to use the other functions without interrupting the painting process. Using the start button also activates the color pot menu on the surface and allows for painting with and without sox.

One of the children steps onto the floor. The child chooses a color (Figure 2b) by stepping on a color pot and then starts walking, leaving colored footprints.

Another child enters the surface (Figure 2c) and joins the first one. This time, with the special PaintyFeet sox. The individual foot menu buttons appear near each foot of the second child when it stops walking. Those icons have a background color according to the sock color. Tapping on the button close to the right foot activates the respective foot menu (Figure 2d). Now settings for this foot - identified via SockID - like the no-paint-mode, rubber, color, drawn shape or the property of mixing colors or not, can be changed. Wanting to paint in green with the right foot, the child clicks on the pallet. A color menu akin to the color pot menu opens (Figure 2e) and tapping on green fulfills the task (Figure 2f).

Eventually the kids are done with their work. The educator saves the picture. Using the Tablet PC the image can be saved to an usb stick.

CONTRIBUTION

The functionalities provided by PaintyFeet are based on the idea to allow multiple users to draw with their feet. Being the main task of PaintyFeet, this was designed to meet the needs of as many children as possible. To accomplish that, we introduced infrared fluorescent sox to track the users (SockID).

PaintyFeet was designed to be used in the educational process. There are different levels of functionality, which are clearly separated - the administrative functions (mainly accessible by educators), the usage of SockID in conjunction with the individual foot menu (for children that are experienced and old enough to use menus) and the possibility just to scrawl by using only the color pot menu (for toddlers, who do not care much about anything except painting).

Interviewing educators, we found out that they think it is important to have access to administrative functions of the system at all time, but this should not interfere with the children's work. Those administrative functions where transferred to an independent device, a Tablet PC.

DESIGN PROCESS

PaintyFeet is designed for children attending the kindergarten or the elementary school. Very young kids, who just like to scrawl, should enjoy playing with PaintyFeet as much as older kids, who want to paint more creative and individual pictures.

We realized that younger children do not get the idea of menus, but that they understand how to use a color pot. The result from this observation is our 'color pot menu', which is situated at one side of the touchfloor. As you can see in Figure 1, the color pot menu consists of nine huge buttons. The buttons look like color pots and each of them represents a different color. It is a very basic menu. If one kid steps on a color pot all kids will paint with that chosen color.

Unfortunately, the fact that all children must paint with the same color at the same time turns out to be a problem for older kids, who care about the colors they paint with. This leads to the conclusion that children, who want to paint with their own color, have to be distinguished.

Furthermore, older children will not only want to paint with their own colors but also use a rubber or a function like not to leave footprints on the touchfloor the whole time. For those kids we designed the 'individual foot menu'.

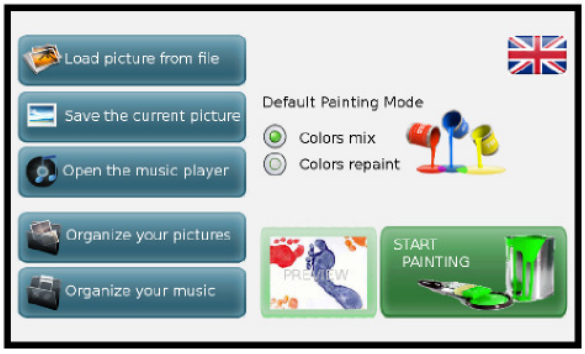


Figure 3: The main menu

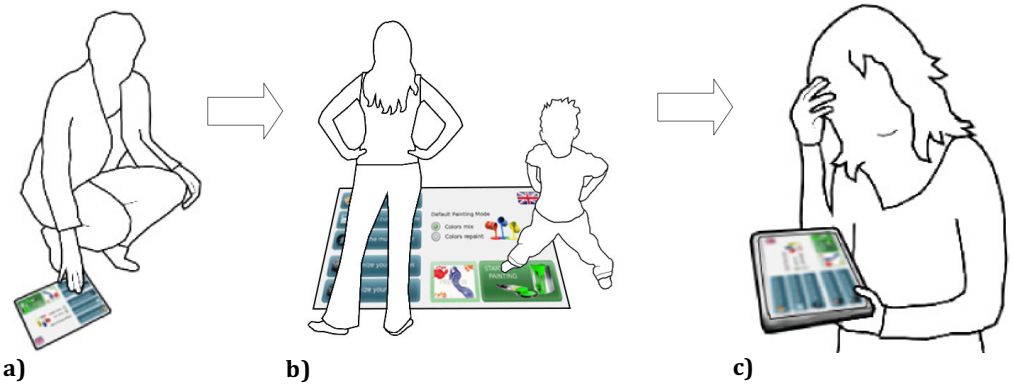
Besides the two paint menus (the color pot menu and the individual foot menu) there is the 'main menu' for administrative functionality. We noticed that it would be a bad idea to give children the possibility to access that main menu. This one should only be operated by a person of authority, because otherwise children could delete the pictures of other children or start the music player with a high volume, which is originally intended for creative painting with music and rhythm .

Turn off and on and the main menu

Our first idea of turning PaintyFeet off and on was to use a button. But children could easily push it and turn the system off while the others are still painting. So a button is not a good solution.
Then we thought of a key, which educators could push into the PaintyFeet floor. A key would be easy to use, since using it is well known. But one of the drawbacks is that the educators would have to bend down, which might be too hard.

Bending down is a problem for designing the main menu as well. At first we imagined a small menu on the touchfloor, which has to be operated by hand (Figure 4a). But during paper prototyping we found out that our users do not want to stoop down to use it. So we tried a menu operated by feet (Figure 4b). But a menu, which has to be used by feet, must be huge and if children run around they will interfere with the usage of that menu. That is why we decided to use a second device for the main menu, a Tablet PC (Figure 4c), which is wireless connected to the PaintyFeet touchfloor. This way educators may organize PaintyFeet while the children are painting.

The idea of the Tablet PC is beneficial for turning the system off and on as well. The educators can use a smartcard, which they put directly into the tablet-PC-remote-control.



a) b) c)

Figure 4: The designing process of the main menu

Data management

During contextual inquiry we found out that many children want to take their paintings home and show them to their parents. That is the reason why we wanted to use usb sticks to exchange data. An important question here was where the usb slot could be. An usb slot on the border of the touchfloor would be bad, because it is flat, so the usb stick would protrude from the floor (and also the educators have to bend down ...). Therefore, we integrated the usb slot into the Tablet PC, where it does not get in the way.

User/feet differentiation

In the beginning we thought of differentiating between children by their footprints. But we quickly figured out that there are certain problems with accuracy.

We also thought of RFID-chips, but it is hard to distinguish the kids, when they stand close together.

Then we considered sox with special patterns on them. But when children paint with their feet the cameras under the touchfloor sometimes only see one part of the sock and not the whole foot. This is why we envisioned to distinguish the sox not by patterns but by colors until we realized that with the technique of rear diffuse illumination ordinary cameras can not recognize colors. In addition, it would be impossible to discern the PaintyFeet sox from common sox which have the same color by accident. Hence, our special sox, absorbing a certain wavelength of infrared light, were invented.
These sox allow the system to identify them, and therefore, every sock may paint with a different color. This way we can have multiple users on our touchfloor, who all paint with different colors and have their own individual foot menu. We call this system SockID.

Individual foot menu

Older children are more sophisticated than toddlers. They want to draw lines, which have to be straight, and they do not want to mess up their paintings by making one footstep by mistake. The older kids want to use functions like a rubber or an on-off-switch for paint.

At first we imagined a menu, appearing when the children touch the floor with their hands. But we figured out that little children may also want to do some hand painting. Therefore, the individual foot menu was invented. Every kid wearing one of our special toe sox gets this menu. So every child having a SockID-sock is an advanced user. As shown in Figure 2f they have the foot menu next to their foot.

As you can see in the second image of Figure 5 the

advanced functions of the individual foot menu include: Toggling the color mix mode (overwrite/ mix), using basic geometrical shapes, choosing a color for the foot, clearing the picture with a rubber, and the 'invisible mode'.

The invisible mode is used to walk without leaving traces. At first a little ghost was the icon for that button but during paper prototyping we recognized that the users did not get the idea which functionality is hidden behind the ghost button. So, (look at Figure 5) we changed that icon as well as other icons our probands did not understand straightaway.

Figure 5:
The designing process of the individual foot menu

Device

In this section we discuss the hardware of our device. PaintyFeet consists of two devices. One is a 3m x 4m touchfloor, which is embedded in the ground. The other one is a little Tablet PC, which is used as a remote control.

Our touchfloor uses diffuse illumination, because the system needs to determine whether it is looking at one of our special sox or at something else.

The special sox absorb a certain wavelength of infrared light, that's how we can distinguish them from ordinary clothing. Sox are registered within PaintyFeet as pairs (the sox absorb a different wavelength of infrared light but have the same color to the human eye). This is needed so that if one foot menu of a user is activated, the menu of the other foot disappears.

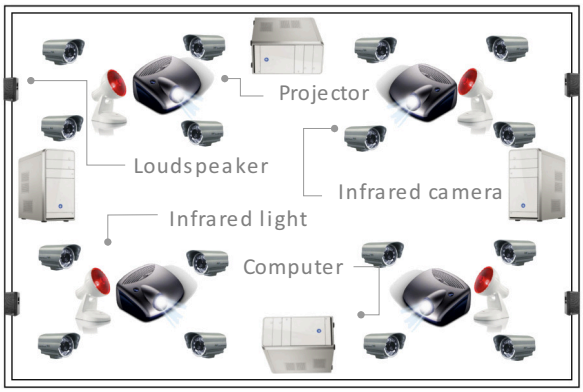


Figure 6: The PaintyFeet touchfloor device

Furthermore, we need dragging because with PaintyFeet drawing is basically dragging your foot over the touchscreen. Dragging works really well with diffuse illumination (DI) in contrast to - for example - frustrated total internal reflection (FTIR).

One of DI's biggest weaknesses is operating under full sunlight, but this is not a problem for PaintyFeet since it is an indoor-application.

We decided to use rear DI because shadow-casting with front DI would be a huge problem. Our device is designed for multiple users to paint simultaneously.

In our general setup we need multiple infrared cameras, infrared lights and projectors. This is due to the fact that our touchscreen is rather large. As shown in Figure 6 we basically divided it into 4 areas. Of course we also need fast personal computers taking care of all the computation.

The Tablet PC includes a cardreader for smartcards, which are used to start the Tablet PC and authenticate oneself. It is used to operate the main menu in a convenient way. The Tablet PC is connected to the system via WLAN. We use the new IEEE 802.11n standard which allows up to 600Mbit/ s. We need the high data rate because we might want to transfer pictures to an USB-stick. The Tablet PC has some USB 2.0 ports.

CONCLUSION

In the course of designing PaintyFeet we encountered several issues. Dealing with those, we found solutions that may not only be restricted to the system we developed.

Discriminating between multiple users on a touchfloor has been one of the most pressing matters. In deriving the idea of using the technique SockID, we found a way of tracking elements on the floor without using markers. This might not only be relevant to our PaintyFeet, but may be applied to any system allowing for cameras sensitive to other wavelengths than encountered in the visible light.

Furthermore, we found that we have to allow for different levels of access to the system. Namely administrative access for educators and restricted use for children. Since those administrative functions may turn rather complex, a comfortable use of them via feet input cannot be guaranteed in all cases. We use an external access device to work around this inconvenience. This device should be interfaced with more commonly known input methods like finger touch.

Regarding the work with children we had one main insight. Children are very good at working with and discovering the workings of an application. It is of utmost importance though that the application gives accurate feedback on the changing of its state. This is to make exploring the system a rewarding experience.