Interactive, Immaterial FogScreen

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ABSTRACT
The walk-through FogScreen has become very popular and famous during recent years. It is an immaterial projection screen that consists of air and a little humidity, and enables high-quality projected images in thin air, as well as many new applications. In this paper we describe a new extension, the interactive FogScreen, which turns it into a computer touch screen.

KEYWORDS: Projection screen, walk-through, touch screen, interactive screen

INTRODUCTION
There are several water, smoke and fog screens and related patents already since the end of 19th century. The earlier works are often very wet, non-penetrable, require long viewing distance, and/or suffer from bad image quality.

We have presented a novel and optimal method for forming a superior quality physically penetrable particle display [2]. The basic idea of our FogScreen is to create a large non-turbulent airflow to protect a dry fog (or any particle) flow inside it from turbulence. Fog thus remains thin and crisp, enabling high-quality projections and the walk-through possibility. The FogScreen feels like slightly cool air.

The FogScreen creates an image floating in thin air and encourages the audience to play with it (like for example blowing the image, as in Figure 1). One nice feature is the possibility to project different images on both sides without interfering each other.

The FogScreen enables many novel applications indoors, for example in art, theater, trade fairs, and in other fields of business, entertainment, and life. The audience or a performer can enter through the FogScreen, which could be a walk-through advertisement, or an entrance to a theme park. Mixed reality and immersive projection technology can use virtual rooms with fog walls.

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A nice effect is created, when a video camera captures people in front of the screen, and the image is shown on the FogScreen. In this way people can see, shake hands and walk through themselves. Also a video conference with a ghost (a real person appearing in thin air) is possible.

Every FogScreen demonstration has brought up new ideas from the spectators. People tend to switch into creativity gear in front of it. See http://www.fogscreen.com for images and videos. However, the screen looks better in real life.


Figure 1: FogScreen is an immaterial screen.

The FogScreen seems to intrigue people as a passive, immaterial walk-through screen, and few even think that it could be interactive, reacting to proximity or touch. However, our vision is that turning it into an interactive computer touch screen ignites the real fun and significantly widens the application possibilities.

In this paper we present the interactive FogScreen, which turns it into computer touch screen. It greatly extends the application possibilities of the FogScreen. Compared with any solid touch screen, the immaterial property of the FogScreen enables all kinds of magic and fun, i.e., drawing, gaming or web browsing. It is possible to walk through the screen to and see the interactive work on both sides.

INTERACTIVE FOGSCREEN
The tracking of the user's hand or finger could be based on many principles well-known from e.g., virtual reality trackers. Most tracking methods are using some kind of transmitters and receivers, which means that hand-held pointer wands or other artifacts are needed, and perhaps also wires. Luckily, to use a pointer as a mouse on the screen, we need only 2D tracking on the screen plane.

Figure 2: The interactive FogScreen enables e.g., to write fiery characters into air.

We have employed low-cost ultrasonic tracking, and used the commercially available e-beam System 1 hardware [1] as the basis. We had to do some minor modifications to the hardware (to remove the need to push the wand against a solid screen), but after that it worked nicely with all Windows software. We put the tracking plane slightly in front of the screen plane so that the pointing does not disturb the flowing screen. Also the tip of the pointing stick may be sensitive to humidity, so it is better to keep it off the fog.

In Figure 2 we are using our demo software to draw fiery characters onto the screen. The amount of fog was adjusted to low, so only the bright spots were visible. A calibration phase is necessary before using any software that relies on the absolute coordinates of the tracking device, as the tracking space is the physical space and the system does not have any knowledge of how the screen maps to this. Of course, if the setup stays the same, so does the calibration.

The accuracy of the tracking is reasonable (typically ±2cm on a 2 m wide screen), and the tracking system works reliably. The fog flow or the ultrasound emissions of the device itself have no noticeable effect on the accuracy of tracking. This accuracy is adequate for most entertainment and business applications, save very detailed, high-precision work. In addition to the spatial inaccuracy, the ultrasound tracking introduces also a temporal delay of about 100 ms. In typical 'push-button' interaction this is almost unnoticeable, but it might present a problem in a fast paced application e.g. in a game.

The FogScreen is a living surface by definition, and very high projection resolutions are not needed. SVGA or below is fully adequate. Small buttons in the user interface of projected applications may be hard to use, so it is recommended to design large buttons and objects for it. Considering also this, the tracking precision of the e-beam system is adequate for the FogScreen.

We have run several test sessions in various venues. One of our prototypes is permanently placed at the lobby of Vapriikki Museum in Tampere, Finland. We temporarily installed the interactive option to it, and immediately a flock of children surrounded it. It seemed to be even more popular than the plain passive FogScreen. We also soon noted that the pointer stick has to be very robustly constructed for real environments. The stick broke into pieces at the hands of the children.

We have tried also computer vision-based finger tracking, where no hand-held pointers are needed. A plain finger can be used to point and click. However, in many cases a finger mouse is more problematic. Typically the FogScreen attracts a flock of people, and an interactive screen does even more so. It may be difficult to judge which of the several hands should be tracked, or should they all be tracked simultaneously.

Also, vision based tracking has to deal with the images projected on the screen, as in praxis they always show up in the tracking camera, too. By using near-infrared (to which BW cameras are sensitive by nature) for the tracking and filtering this out from the image projectors this problem is expected to decrease. Nevertheless, the fog itself will contribute to the tracking image.

An especially interesting extension would be to use shutter glasses for stereoscopic viewing, and 3D tracking for a pointer and the glasses. This would enable truly immersive 3D work with the FogScreen.

CONCLUSION

We have presented an immaterial, interactive screen, which is a new kind of a user interface floating in thin air. We employ ultrasonic tracking, although many other kinds of tracking methods could also be used. We have also tried computer vision-based finger tracking.

The interactive screen has many applications on many fields of entertainment, visualization, art, etc., and can have an impact on many future interfaces. The interactivity significantly expands the possibilities of walk-through screens.

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REFERENCES

1. Luidia e-beam System 1 whiteboard tracking. www.e-beam.com.

2. Rakkolainen, I., and Palovuori, K. WAVE – A Walk-thru Virtual Environment. In *CD Proceedings of 6th Immersive Projection Technology Symposium in association with IEEE VR 2002 Conference*, March 24-25, 2002, Orlando, FL, USA.