Fluid Surface:Interactive Water Surface Display for Viewing Information in a Bathroom

Figure1. Fluid surface

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ITS'12, November 11-14, 2012, Cambridge, Massachusetts, USA.

Abstract

Information is becoming accessible everywhere in everyday life due of the spread of smart phones and portable personal computers; however are very few methods in accessing contents in a bathing environment. Sometimes smart phones can be carried into a bathroom but it is unnatural to be holding a device during bathing, so a suitable technique for information browsing in a bathing environment is required. We propose an interactive water surface display system, which uses image-recognition techniques. By using water, the system can perform an intuitive interaction peculiar to water such as poking a finger up from under the water surface, stroking the water surface and scooping up water. In this paper, we discuss interaction design in a bathroom, describing an implementation of our system and its applications.

Author Keywords

Bathtub; fluid interaction; gesture recognition; interactive surface; water surface display

ACM Classification Keywords

H.5.2. Information interfaces and presentation (e.g., HCI): Graphical user interfaces.

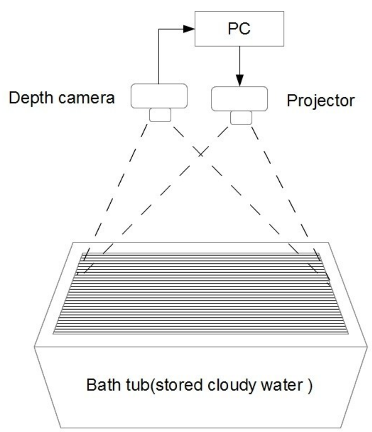

Figure2. System configuration

Figure3. Usage scenario

Introduction

The accessibility of data and contents has changed a great deal with the development of portable computers and hand held devices; however, in a bathing environment it is still scarce. In Japan, idling in a hot water bath has become a part of everyday life, and bathing has long been a very common method for health maintenance and relaxation. Therefore, the needs for the entertainment or information at the time of bathing is growing; sometimes a TV set is installed in a bathroom or a smart phone is carried into a bathroom to view information. Holding a remote control or a device at the time of bathing is very unnatural, so information browsing technique of having been suitable for bathing environment is required. Thus we proposed interactive water surface display system. This system can interact with information without any markers and devices. We specifically focus on input and output techniques which use the characteristics of water. In related research, there are some systems that use water as a display, but the projection of and interaction with images on the water surface is not common [1]. Hirai proposed a Bathtub touch user-interface [2] however this system is using the frame of the bathtub, and is not projecting on to the water surface. In addition, some systems suggest flexible surfaces like sand, which is a radical alternative to conventional rigid screens and the interaction with this suggestion uses the physical features of the surface material [3]. Following this approach, the physical feature of water was also considered for the interaction of our system.

System

System configuration of our system is shown in figure 2. Hardware construction of our system is consists of a Microsoft Kinect depth camera for finger recognition, a projector for image projection and PC for processing. We use cloudy water made from bath salts for the water screen. It is reasonable to consider the cloudiness of water in a bathing situation from the use of soaps, etc. Given the expectations of a standard bathing environment, the surface of the bath is wide and allowed for a large screen for information presentation. The bathroom lighting should also have sufficient lighting for visibility. Usage scenario is shown in Figure 3.

Interaction

In this section, we propose the intuitive interaction technique and information display techniques that can be used during bathing. A feature of this system is the input using the unique characteristics of fluids. We suggest three gestures which use features of water, such as poking fingers out from water surface, stroking water surface and scooping up water. A comparison of these gestures and their mappings with traditional input interfaces can be shown in Table 1. In our system, pointing gestures can be poking a finger from under the water surface, scrolling gestures from stroking the water surface and dragging by scooping up water. Details of each input technique are given below.

・Poking a finger from under the surface

Although the input in a legit touch display system is a touch input from the upper part of a display surface, during bathing, it is possible to use gestures from semi-submerged hands under the surface. Using this method, single touch gestures as well as multi-touch gestures with two or more fingers can be detected much like conventional touch screens through interactions unique to water, such as submerging fingers underwater, etc. Since it is common to move hands in and out of water

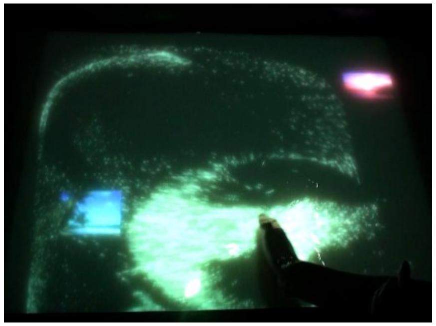

Figure4. Fluid simulation

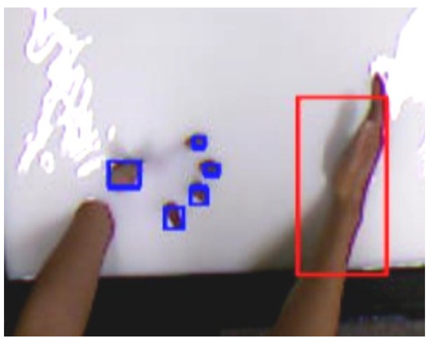

Figure5. Recognition of fingertips and hand

during bathing, it can be assumed that poking one's fingers out from the water's surface, which uses very few movements, will give a very simple input method to the users. Furthermore, since the inputs (and outputs) will follow the user's finger positions it is easy on the human cognition.

・Stroking the water's surface

Using one's hand to stroke water in this context is a natural movement, which can also be used for both expression and input - we suggest using this interaction for scrolling information. By adopting this method, an intuitive input interaction can be obtained.

・Scooping up water

Since water is a physical object, the tactile feeling that comes with holding a real object and the visual effect make the user feel like they are holding information in their hand. It can be thought that the operations like scooping up water can be used for choosing and moving information projected on the water surface that also makes good use of the characteristics of water. The 'drag' metaphor is a perfect interaction equivalent for the moving of information.

Table1. Comparison of proposal gesture and traditional input interface

	PC	Touch pad	Our system
Pointing	Click	Touch	Finger poking
Scroll	Move a mouse wheel	Swipe	Stroking water
Drag	Click and move	Touch and move	Scooping up water

Display using Fluid Simulation

Modification of the projection image is also applied before the projection. In this system, we apply a fluid simulation to the information to 'warp' the image such that it appears to be floating on water. An example of a fluid simulation is shown in figure 4. The reason for this is that when interaction is applied to the water's surface, the surface shape changes dynamically, thus making the information move in a similar fashion will bring about a more 'natural' impact.

Implementation

An example of sample detection of fingertip and hand recognition (of two of the three interaction metaphors) is shown in Figure 5. Using color recognition with a common RGB camera tends to be very sensitive to illumination change, and recognition with markers (IR) require some type of attachment, which, in this context is very difficult. To solve this, we use a depth camera which is resilient to illumination change and does not require wearable markers. The use of cloudy water allows the depth sensor to be able to measure the water surface; applying background subtraction to this will allow us to recognize fingertips and hands on the water surface. Because area of detection region in a fingertip is smaller than a hand, we apply simple threshold processing to area of detection region for distinction between fingertips and hands.

Application

We created a multimedia viewer as interactive application using our system. The appearance of application is shown in a figure 6 and figure 7. This application consists of a top menu and a viewer/playback mode. In the top menu, both videos and image stills appear floating on the water via the

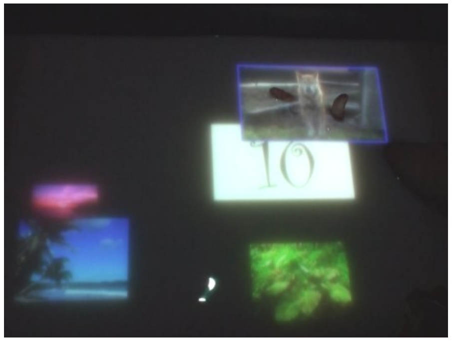

Figure6. Example of top menu

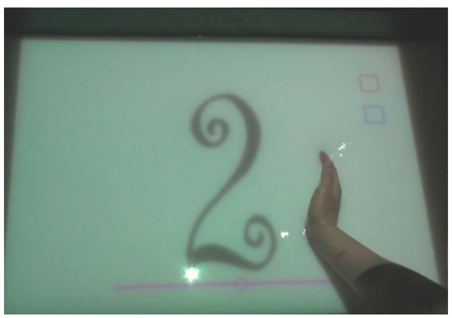

Figure7. Example of movie playback mode

fluid simulation effect. User can interact with media files being previewed in this mode using the gestures mentioned in the previous section: poking will move the position of the displayed information, pinching (multi-touch) can be used to zoom and a three-finger submerge will switch modes. In addition to these interactions, stroking gestures will create ripples in the information via the fluid simulation and scooping can be used to select the target information. Moreover, scooping the information into various locations such as shared folders (Dropbox) is also possible. In the viewer mode, the user can watch movies and images selected in the top menu full-screen and in playback mode the user can control the movie sequence by stroking the water surface. Since the slider moves with time across the water, stroking this slider to move it along can be considered natural. Playback, pause, volume control and back can be performed using icons using finger interactions. When viewing image stills, stroking gestures are used to scroll the image; icons are available for finger interactions to return back to the top menu.

Discussion

We discuss about usability of our system. We proposed new interaction techniques that can be used during bathing. Focusing on fluid simulation, it makes the information move in a similar fashion, and brings about a more natural impact. On the other hand, the application is not making the best use of fluid simulation. Selecting the information is difficult because the information move freely. Thus, we should have second thought about information display technique.

Conclusions

In this research, we proposed interactive water surface display system for intuitive information browsing during bathing – the result was a multimedia viewer a top of a cloudy water surface. In this application example, the information displayed was prepared beforehand. We would like to expand this by connecting the application with media available online such as YouTube and Twitter to be presented on the water's surface – this allows the user to be connected, even while bathing. Another area of development is the accuracy of the system, specifically in finger recognition, when the user has erratic movements within water, which is typical during bathing.

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