Submerging Technologies

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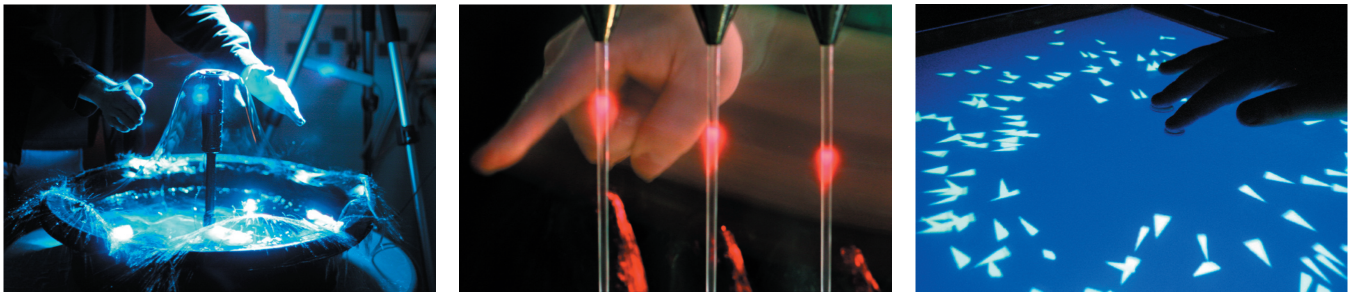

Figure 1 (left to right): The *Tantalus Fountain*, *AquaHarp*, and *TouchPond*

1 Introduction

Fountains, reflecting pools, and other water displays have a long history in art and architecture. In the fountain industry, an "interactive fountain" is one that guests can touch or walk inside of to get wet. This is counter to our typical definition of an interactive system which requires sensors to detect user actions, and an output that changes in response to these actions. In this work, techniques for making truly interactive water displays are presented.

Submerging Technologies is a collection of three interactive water displays (Figure 1) which demonstrate sensing techniques that exploit the electro-optical properties of water itself. Municipal water is fairly conductive, typically 30-1500 µmhos/cm. [CWT 2004]. This conductivity is sufficiently high that the water can be used as a capacitive proximity electrode. Municipal water is also very transparent, and can serve as an optical waveguide.

2 The Tantalus Fountain

The Tantalus Fountain is named for the mythological character, Tantalus, who was forced to stand in water up to his neck, but could not take a drink because the water receded every time he bent down. The Tantalus Fountain is an interactive fountain that withdraws from approaching hands.

The fountain uses a small, electrically controlled pump, which sends water up through a water bell nozzle. An electrode in the nozzle provides electrical contact to the water. When the pump is activated, the water sprays out to form the water bell shape (a rough hemisphere). The system is designed to create smooth, laminar flow, giving the water bell a clear glass appearance. When the speed of the pump is changed, the size of the bell changes. However, the dynamics of the system cause the bell to flare in unexpected and beautiful ways.

The proximity of a hand is detected by measuring the capacitance to ground of the water bell via the electrode in the nozzle. A person standing in a room typically has on the order of several 100pF capacitance to ground. Placing a hand near the water capacitively couples the water, through the person, to ground. The control circuit servos the pump speed to maintain a constant capacitance to ground. This corresponds to a constant distance between the user's hand and the water bell. Thus, the water seems to be repelled by an approaching hand.

3 The AquaHarp

The AquaHarp is musical instrument controller similar to a harp, but with strings made of flowing water. Like a harp, the instrument is played by touching the strings. Unlike a harp, the point of contact lights up. The AquaHarp provides a unique tactile, visual and auditory experience for the player.

The AquaHarp uses specially designed nozzles. These create laminar streams that are internally lit by high brightness LEDs. Because the laminar flow nozzle produces a smooth column of water, the light travels inside the stream via total internal reflection. With very little light escaping, the stream appears like a clear glass column. However, when the stream is broken by an interposed finger, the light escapes and brightly lights the finger. Light sensors in the receiving tank detect the decrease in light due to the finger, and generate a MIDI event to control a music synthesizer.

4 The TouchPond

The TouchPond is a liquid touch screen based on frustrated total internal reflection [Han 2005]. This shallow pool of water allows users to interact with virtual sea creatures in their own wet environs. It consists of a clear tray, side lit with IR light which travels laterally through the water via total internal reflection. When the surface is disturbed by a touch, light exits normal to the surface. This is detected by a camera underneath the pond. A video projector, also underneath the pond, creates the submerged graphics on a translucent sheet mounted on the bottom of the tray.

References

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Han, J. Y. 2005. Low-Cost Multi-Touch Sensing through Frustrated Total Internal Reflection. In *Proceedings of the 18th Annual ACM Symposium on User Interface Software and Technology*. UIST '05. ACM Press, New York, NY, 115-118.