Interaction with water

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Figure 1: AquaTop Display by Koike Laboratory, Data Fountain by Mensvoort et al., Rain Room by rAndom International

ABSTRACT
This paper discusses state of the art of interactive art with water and limitations of existing technologies and ways of interaction. Based on our study, we have suggested how interaction with water can be improved. Our proposal is that water should be used as a three-dimensional space where the participant is immersed. This gives the benefit of weightlessness to the participant, which leads up to new types of interaction using water.

Author Keywords
Interactive art; water; design; haptics; art; futuristic; Arduino

INTRODUCTION
The aim of this paper is to apply a futuristic approach on what interactive art using water as a medium could evolve in to. This will be done in two steps; first by making a state of the art analysis in which we will highlight what we think is missing in today's interactive art with water. Secondly by giving a proposal of how this field can grow to use water in more ways that is not fully explored today. Lastly, we will present a prototype that we created to demonstrate a few of the main characteristics of our vision for interactive art using water in the future. The focus for this paper have been on combining haptics with water interaction and to explore the benefits that comes from moving the interaction from the surface into the water.

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BACKGROUND
Interactive art concerning water happens in many forms, but a few are more prominent than others. One of the most common forms of interaction with water is using the water surface as a display, either by projecting pictures from above the surface or from underneath if the surface is in horizontal mode. A lot of artworks in this area substitutes the display with touch to take the interaction to it's full potential. See, for example, *AquaTop Display* [1] (fig 1) that turns the water surface into an interactive touchscreen using a Kinect camera for gesture recognition, a projector, waterproof speakers to pump up the water and make splashes and a PC to run the program. When interacting with AquaTop Display the participant can play simple games by doing different gestures on the surface or look through photographs using a sweeping motion on the water surface.

Other artworks are using the water as a falling down, curtain-like, display or by using submerged water pumps to write and draw on the water surface. To the prior of these belongs a water display at the Osaka station in Japan that displays time, temperature or artworks using falling drops of water. *Liquid Pixels* [2] is an artwork belonging to the latter of these types (fig 2). By using a smartphone connected to submerged water pumps, where each pump

represents a pixel on the phone display, the participant can write or draw on the smartphone's screen and see it manifest on the water surface.

Figure 2. Liquid Pixels by Daniel Kupfer for Samsung

Different ways of controlling water in interactive art is present in e.g. *Pumpspark* [3]. Pumpspark is a fountain development kit, that uses miniature water pumps and a controller with which you can shoot water streams one meter up in the air at the most. Pumpspark is one amongst other artworks and art-tools that uses microcontrollers to run it. Water fountains are widespread in this area of interactive art and can usually be controlled directly by participants or other kinds of data input. *Data Fountain* [4] shows relative currency rates in real time. The highest value correlates to the highest fountain stream. The three different fountain streams represent currency rates for yen, euro and US dollars (fig 1).

This leads us to artworks like *Rain Room* [5] (fig 1) at Museum of Modern Art in which a constant downpour is present and where the participant can move around without getting wet. The installation consists of movement sensors which tracks where the participant is and stops the water falling at these precise points. The participant is in this case controlling the environment by triggering sensors connected to a computer.

FUTURE INTERACTION WITH WATER

In interactive art using water as a medium today our research has shown a gap between what could be done with water and what is done. The interactive art today uses water as a projection surface in different forms, as a touchscreen or lets the participant steer the water in different ways, e.g. with water pumps or sensors. The participants are limited to control the interaction by using hands or fingertips on the water surface.

Our vision

The aim of this study was to explore the possibilities of using water in innovative ways in the area of interactive art and not just as a two-dimensional surface. If the participant is below the water surface the water can be used as a three-dimensional space. This gives the artist new possibilities, and limitations, for interactive art. Water as a three-dimensional space will give the participant an enhanced possibility to move freely since gravity is not as prominent in the water. Some of the participants senses will be weakened, e.g. hearing, which to some extent may isolate the participant from the world outside of the water. The artists then have the possibility of the participants heightened attention of the artwork. The fact that the participant is immersed in the water gives an awareness of the room that is hard to experience otherwise.

Using haptics to create artificial shapes in water gives the possibility to explore this new space and the benefits of the medium, e.g. freedom of movement, without adding physical artefacts. This gives the freedom of instant variability to the shapes and ultimately the artwork itself.

What could be done with this new way of interaction?

To gain a better understanding of the technique and way of

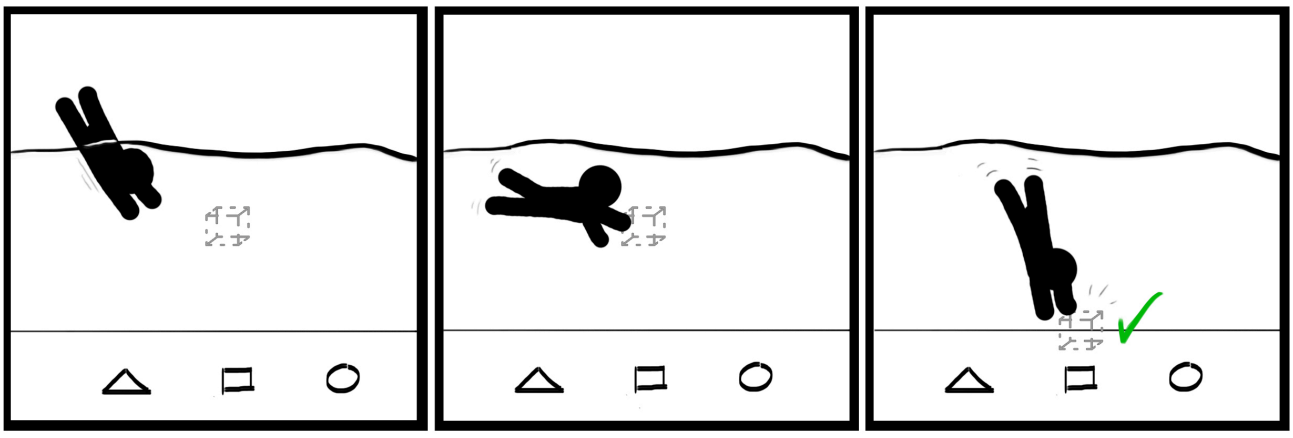

Figure 3. Scenario showing a possible way of interaction with artificial shapes using haptics where the shape should match a symbol below.

interaction, which is mentioned in the passage above, two potential scenarios in which this can be applied will be presented below.

When applying this in the area of experiencing and creating artworks, the water can be used as an immersive environment in which the interaction takes place. The haptic feedback makes the participant experience artificial shapes or objects as tangible. By adding haptic feedback in form of resistance, pressure and texture, these shapes might be created. When using haptic shapes instead of physical ones the artwork can vary more in its form and be manipulated by the participant in more ways. For example this could be used to show the life cycle of an artwork in a short amount of time and the participant can experience it from new to old.

This approach can also be used in the area of learning and play. Water play may be fun as it is but can have a greater variability if using wireless haptics. Simple exercises in swimming school, like picking up rings on the bottom of the pool, can possibly be made more fun by adding changing haptic shapes instead of the rings which you can pass from child to child.

Technical challenges

In our opinion, two major problems stands in the way for interactive art under water when it comes to technology; waterproofing the technology and using haptics without compromising the feel of the water and the possibility to move freely. Waterproofing is a natural first step to be able to use the technology in the water.

Since two major affordances with interaction under water is the feeling of it – being wet, slippery and by it having a certain temperature – and the freedom of movement. Interaction techniques, artefacts and tools must be developed with this in mind. If the main characteristics of the medium are extracted due to the physical design of the artefact, the participant loses a part of the experience. In interaction with water, where the participant can not feel the sensation of the water due to the physical design of the artefact, the main characteristic of the medium is removed. Also, interaction regarding experience of shapes can be disturbed by a lot of wires to the haptic device that inhibits the mobility of the participant. We believe that for interactive art under water to reach its full potential, the technical tools used must be waterproofed, wireless and not extract the characteristics of the medium.

PROTOTYPE

To visualize a part of the concept of our study we have made a low-fi prototype using the Wizard of Oz method. With this method developers and artists can test the interaction of future technologies not yet developed and realised by mimicking the intended process of interaction with simpler available means and technologies [6]. The prototype is meant to simulate the feeling of haptic feedback used in water.

Figure 4. Demonstration of prototype

Interaction

The prototype that represents our idea is intended to simulate interaction with haptic shapes in a water environment. The interaction will, in our prototype, be portrayed by a participant trying to push a button in the water in order to light up two LED-eyes in a plastic toy. The participant will not see that the button is embedded in a barrier of gelatine. When trying to reach the button the participant will experience what it is like to get haptic feedback when reaching this invisible barrier. The button will be pushed down when pressing the gelatine form that activates a microcontroller, we use the open-source electronic prototyping platform Arduino Uno [7], which is connected to the two LEDs. The LED-eyes lights up when the participant activates the Arduino pressing the button and as soon as the pressure is released the Arduino will switch off the LED´s.

Simulating the technique

In this case we want to simulate the haptic resistance in a scenario without visual feedback. This means we need to use a material that is barely seen by the naked eye when in water but which provides immediate three-dimensional feedback to the participant when interacting with it. To simulate haptic resistance and feedback we have chosen three-dimensional forms of translucent gelatine, which meets all our criteria's for representing our intended future way of interaction.

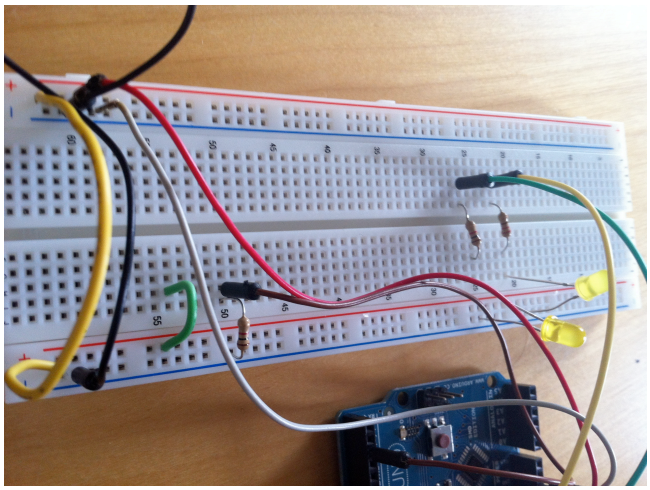

Figure 5. Prototype

DISCUSSION

In this paper, we have presented several existing artworks, where interaction in some way affects water. Water can today function as either input or output, but we have found that it is mostly used as a display for which the user interacts with. For example as a screen that reflects the interaction of what the user is doing with another device, as with Liquid Pixels (fig 2) or AquaTop Display (fig 1).

Based on our state-of-the-art analysis, we believe there is a limited usage for this kind of screen-based interaction and that water as a medium could preferably be explored in several ways.

By presenting two different scenarios in two different contexts, we aim to show the diversity and complexity of using water as a medium in a creative way. We believe that for the technology to be used in a larger context, it is not only a matter of accessibility, but also a question of how to make the technology secure enough to use together with water. It should also offer an additional value to place the artwork in water for it to be implemented. This could be a context where technology meets a clear goal or purpose, which today cannot be unified through existing, modern techniques. Electricity and water is a combination of technology and medium that needs to be so safe that the artist should feel fully confident with the technology and its design to safely include participants in their interaction. It is important that these limitations does not affect the feeling and beneficial characteristics of water when immersed in it.

This is of course not impossible, but we believe this development will probably not take place unless there is an external motivating factor to trigger it. A divers watch, for example, is made up of waterproofed electronics and has a consumer market, but is there a desire for waterproofed haptic devices? If the goal is only to make interactive art under water, waterproof haptic devices may be created, but might not be produced in a large scale since it is a relatively small market today, making it expensive for artists to use. However, if interaction in water can contribute not only to the domain of interactive art, but e.g. to serve a bigger purpose, such as enhancing and creating new types of play and game experiences.

CONCLUSION

In this paper we made a state of the art analysis, which resulted in a proposal for future interaction with water. Our vision is that interaction with water in the future will not only be made on the waters surface, but that there will be a possibility to use the whole medium. This will result in a greater diversity in interactive art with water and benefit from the usage of water as a three-dimensional space.

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