Towards the Design of Playful Water Experiences Using Interactive Technology

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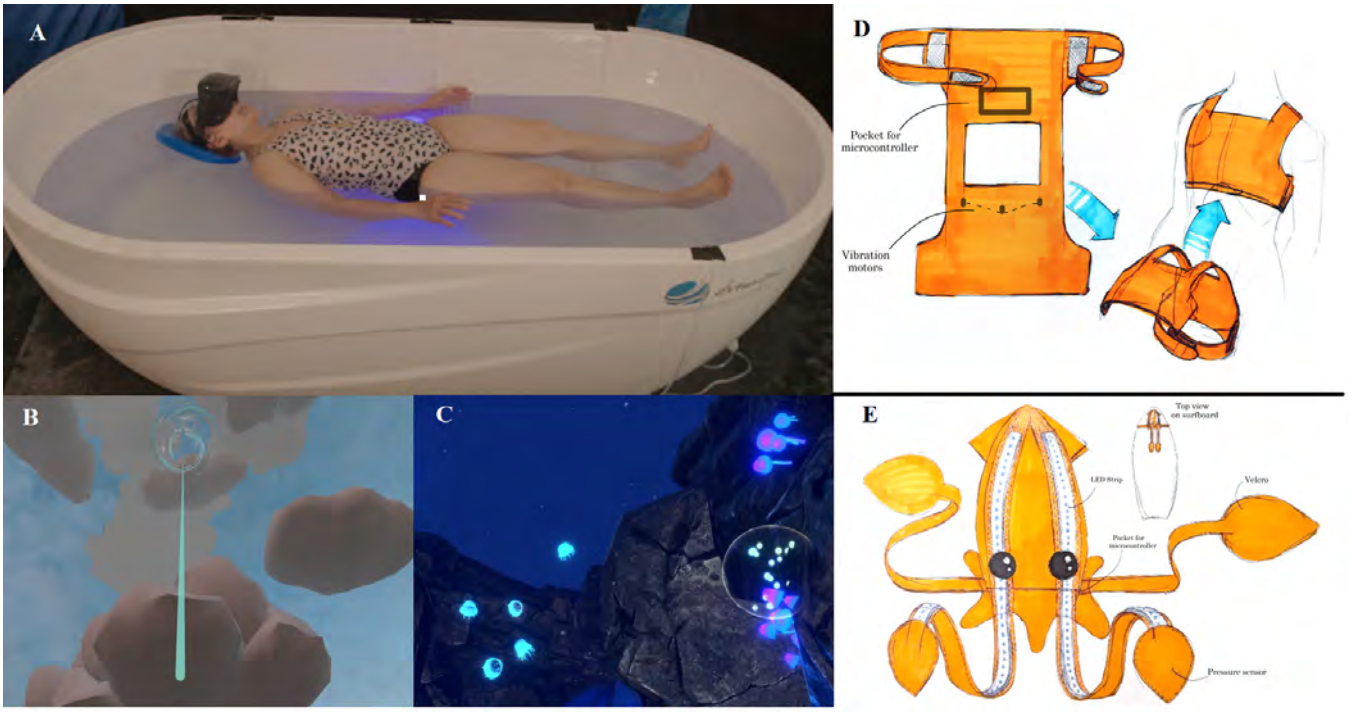

Figure 1: Designs developed in this PhD research: A) Participant in a floatation tank using Fluito, an extended reality experience exploring virtual worlds. B) Fluito's virtual sky world. C) Fluito's virtual underwater world. D) Interactive wearable top for surfing. E) Octopus Soft Robot for surfing.

ABSTRACT

The pleasant nature of water and the associated physical and mental health benefits of being in or interacting with water have captivated the interest of human-computer interaction (HCI) researchers - WaterHCI. However, prior WaterHCI work has advanced instrumental contexts, such as improving swimming performance. Consequently, our understanding of the design and use of systems that support interacting with technology in water in more playful contexts is still underdeveloped. This poses the opportunity to advance the design of playful water experiences using interactive technology. This research employs a somaesthetic design method and evaluations of case studies. I design, study, and analyse the user experience of interactive systems, employing extended realities, biosensors and tactile devices, in water. The result will be a framework to guide the future design of playful water experiences that aim to foster the physical and mental benefits of being playful around water.

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CCS CONCEPTS

• **Human-centered computing** → **Interaction paradigms**.

KEYWORDS

water experiences, WaterHCI, floatation, surfing, playful experience, soma design, XR

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1 INTRODUCTION

Being in the water has many physical, mental and cultural benefits, which have captivated the interest of human-computer interaction (HCI) designers, practitioners and researchers. "WaterHCI" [14, 23, 30] is concerned with designing and evaluating interactive systems for water activities. However, WaterHCI in more playful contexts is still underdeveloped, so far, focusing on supporting instrumental aspects such as improving athletic performance in water [9, 10, 15, 36]. Although researchers have proposed interactive experiences in water [5, 13, 32, 33] studies investigating the user's experiences with these systems are limited, leading to a lack of design guideline to create such experiences. By providing an understanding of the human-technology-water intersection, this PhD work will start guiding and inspiring designers and researchers to create more interactive water experiences, and start answering the research question: **How do we design playful water experiences using interactive technologies?**

To advance this understanding, my research adopts a somaesthetic design methodology [19, 20], while taking inspiration by playful design [3, 4], to explore integrating the human body and water through interactive technology (e.g., extended realities, biosensors, tactile devices) creating aesthetically pleasing, playful water experiences. I study user experiences through case studies in water activities, specifically an indoor flotation experience tank and outdoor surfing experience, to understand interaction dynamics in different bodies of water. Using a postphenomenological lens [21, 35, 41], I aim to see technologies as mediators between humans and water, shaping their interactions. This approach seeks to elucidate a framework to guide the future design of playful water experiences.

Overall, this research makes the following contributions: I) Demonstrate original design in the form of novel, playful water systems, II) provides a structured understanding of the user experiences with playful water systems by conducting case studies, III) provides an initial understanding of the design of the interaction between the human, the water, and technology to facilitate playful water experiences by proposing a framework with design considerations for the design of future playful water experiences. These contributions can be used by WaterHCI researchers and interaction designers aiming to create interactive water experiences, as well as valuable for water sports and wellbeing industry practitioners.

2 RELATED WORK

2.1 Interactive experiences in indoor and outdoor water environments

My first case study on the design of an indoor water experience has been informed by the use of extended reality (XR) technologies in water. Prior work shows the limited exploration of XR technologies in water-centric applications, although notable exceptions include underwater augmented reality (UWAR) systems [5, 15, 31, 43], emphasising waterproofing challenges but showcasing it's potential. Recent industry adoption of XR for water parks has been popular among park visitors [2], however, it has received little academic attention [24]. Despite these commercial applications showcasing the potential of XR scenarios in water, there is a gap in understanding the user experience of using XR in contact with water. To address this gap, I propose the introduction of a flotation tank as a research vehicle for playful XR experiences in bodies of water.

The second case study focuses on using technologies to create a playful experience that enhances surfers' enjoyment. Although various stakeholders have a vested interest in the design of surfing equipment [34] and technologies [7, 8], the adoption of interactive technologies in surfing practice remains limited in both industry [37] and research and is mostly performance-oriented [11, 17, 25, 42]. Examples include Microsoft and USA Surfing's motion capture recordings for training [16] and the Redbull High Performance Team's [1] using brain-computer interfaces to track surfers' brain waves for performance improvement. Interestingly, the design of interactive technology for the experiential aspects of surfing, such as enjoyment through play and connection with the environment, appears less investigated, and there is a gap in the understanding of the surfer's experiences with interactive technology. Hence, my work aims to start building this knowledge by exploring the design of a playful surfing experience using interactive technology.

3 RESEARCH METHODOLOGY

I aim to answer the research question through a somaesthetic (soma) design-led exploration, which is an encompassing methodology for creating aesthetically pleasing designs [19, 20, 39]. Somaesthetics has been previously suggested as an approach for designing introspective bodily and movement-based experiences [22, 38, 40]. I decided to use soma design because water activities have a high bodily movement component while being in water can also trigger introspective experiences. Additionally, this first-person approach allows designers to consider the influence of the environment where the bodily activity takes place, hence highlighting the lived and felt body in water. Moreover, I took inspiration from the playful design framework PLEX [3, 4] to propose different playful experiences that can be afforded by interactions that emerge from the human-technology-water intersection.

Furthermore, I conducted studies to evaluate the experiences designed through the process mentioned above. Through gathering quantitative data, such as heart rate variability [12], questionnaires [26], and thematic analysis [6] of user's interviews, I aimed to understand the implication of the design choices on user's experiences. Moreover, the studies aimed to provide insights into the use of digital technology as an interaction mediator between humans and the water and ultimately come to articulate the human-technology-water notion in a water play framework.

4 RESULTS

I designed Fluito (Fig 1A), a novel extended reality (XR) prototype within a floatation tank [27, 28]. The experience involves floating in the tank while a VR headset delivers a virtual auditory and visual

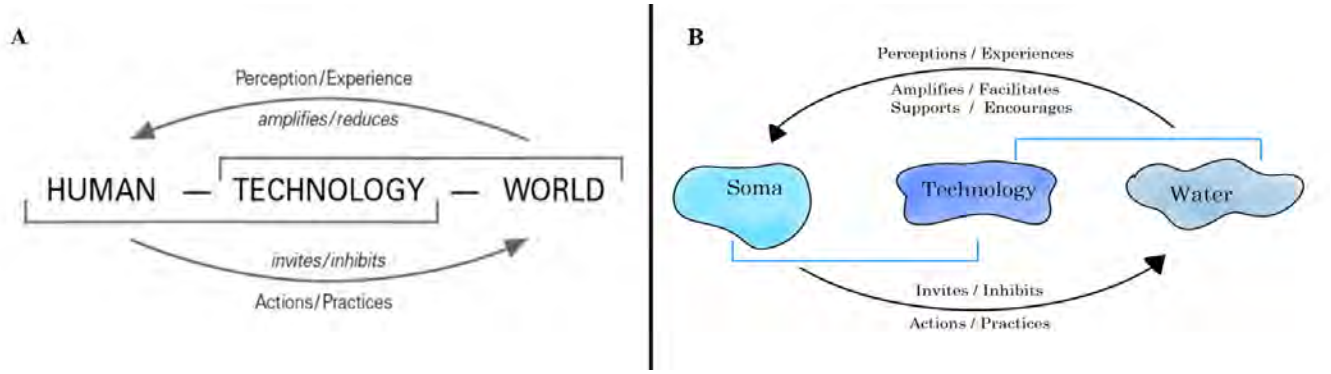

Figure 2: Postphenomenological mediation theory. A) Verbeek's Human-Technology-Water relations. B) Soma-Technology-Water relations proposed in my work.

environment and haptic feedback through bubbles. The participant's heart rate, breathing, and slight head movements control interactions within the virtual environment (Fig 1B and 1C). The user's study evaluating Fluito resulted in the articulation of eight strategies useful for designers aiming to develop digital playful experiences in water, such as designing to call attention to the water and designing to encourage breathing and body awareness in water experiences. I also evaluated Fluito to reduce the fear of being in water, where the findings, supported quantitatively by heart rate variability and qualitatively by interviews, suggest that playful extended reality could mitigate fear responses in an entertaining way [29]. Currently, I am in the design phase of an interactive, playful experience for surfing, where the soma design process led to two design concepts: A wearable top and (Fig 1D) a soft robot (1E), aiming to communicate ocean information (depth, wave rate, wind speed) to surfers in embodied ways (i.e., haptic stimuli), embedding vibration motors, LEDs lights, heat pads, and pressure sensors. I am facing technological challenges, such as waterproofing haptic actuators, and interactive challenges, such as feeling the haptic stimulus while in water.

5 DISCUSSION

Based on the soma design process and user experience analysis with Fluito, I discuss the findings through a postphenomenological lens [21, 35, 41]. Following Verbeek's widely explored approach built on Ihde, which focuses on bodily-perceptual relationships with technologies, I analyze the co-constituting subjectivity and objectivity of the experience. This aligns with my somatic design process's intentions. I discuss the findings in terms of human (Soma)-Technology-Water relationships (Fig 2), borrowing from postphenomenology's "Human-Technology-World" concept [18]. In this context, "human" refers to the soma (body and mind), and "world" refers to the water, focusing on the fluid environment. My analysis suggests that when technology mediates the Soma-Water interactions, it amplifies, supports, facilitates, and encourages perceptions and experiences for the soma [27] (Fig 2).

6 LIMITATION AND FUTURE WORK

Our work will advance the design for playful water experiences. I will evaluate the surfing prototypes in a user's study, which will contribute data to the design framework. I hypothesize that new Soma-Technology-Water relations will emerge from the human-water interactions in an open water environment. Although our learning and discussions are based on one indoor and one outdoor water experience, I hope to be able to provide a generalization to other water activities. Future works could explore introducing interactive technologies in playful ways for other water activities like kayaking and scuba diving.

7 CONCLUSION

The design explorations developed in this research have led to one novel design for water play, advancing the design understanding of playful water experiences. Additionally, I show advances in developing novel designs for surfing, which I aim to finish as another novel device for water play once I overcome the design challenges. By proposing the Soma-Technology-Water notion, I advance the understanding of the interaction of these three agents in a playful context and start building a design framework with designing strategies for researchers interested in playful water experiences.

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