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Gravity Well: Underwater Play

Abstract

More and more technology supports utilitarian interactions in altered gravity conditions, for example underwater and during Zero-G flights. Extending this, we are interested in digital play in these conditions, and in particular see an opportunity to explore underwater bodily games. We present an interactive shallow-water system that supports bodily play through water-movement interactions: Gravity Well. Through designing the system and combining aquabatic principles with exertion game design strategies, we identified a set of design tactics for underwater play based on the relationship between the afforded type, and level, of bodily exertion relative to pressure change and narcosis. With our work, we aim to inspire designers to utilize the unique characteristics of bodily interactions underwater and guide them in developing digital play in altered gravity domains.

Keywords

Diving, exertion games, game design, aquabatics.

ACM Classification Keywords

H.5.2. [Information Interfaces and Presentation]: User Interfaces – Miscellaneous.
Introduction
The kinds of bodily activity available to people in and with water differ from those on land. Underwater bodies can float, hover, sink, fly, and dive. We can move objects twice our body weight underwater, turn a triple-sumersault and balance up-side-down on our little finger with half the effort required on land. Moving in water allows one to act out a fantasy element that one cannot experience in real life [1], reminding us of the power of computer games to facilitate fantasy elements [2] and equally, highlighting limitation of technologies to support full-bodied actual immersion in real, wet, and dynamic altered-gravity environments [1,10]. We are therefore particularly interested in bodily movement underwater engaged in digital play and call it underwater exertion play based on the fact that physical effort determines the interaction outcome [3]. We combine our experiences in Aquabatics and exertion games to drive this forward: Aquabatics combines commercial diving with live art to describe human performance underwater [1], and exertion games are digital games controlled by gross-motor movement [4].

Related Work
Other designers are considering interactive technology and water. For example, Deen et al. have shown that interactive technology in public swimming pools can facilitate engaging experiences [5]. Many of their games focus on interactions on the water surface or just above, while being in water, whereas we are interested in interactions while underwater (whether while holding breath, snorkeling or with deeper diving equipment). We reference underwater acoustic and dance-tech of artists working in shallow-water and recreational depths including WetSounds, 2008-2012 J. Cohen, Aquadelica, UK and Portal 2008, an exploration of underwater wheelchair play by artist Sue Austin, UK and related to the bodies of works by the early pioneers of Aquabatics [1] and altered-gravity performances and micro-gravity movement workshops by Kitsue Dubois and The Arts Catalyst, London. These works generate sensory-perception and bodily-motor movement knowledge critical to designing for underwater play in parallel to the fantasy-elements of virtual domain, i.e. computer games that produce many seductive experiences related to underwater play such as fLOw, (PS3) 2007 SONY/That Game Company, and Endless ocean, (Wii) 2008 Nintendo/Arika.

Gravity Well
The player’s experience of engaging with Gravity Well is as follows: the player either dives in to a body of water i.e. a pool (Fig. 1) or reaches in to a water tank depending on availability. Gravity Well encourages communication between smart objects we call "exploration fish" and the body of water (Fig. 2,3). The larger "mother fish" provides a real-time visual response to the player’s human-aquatic movement interactions and touch (Fig. 4). It emits local sound and communicates accelerometer and positioning data (Fig. 5) to remote autonomous fish. The through-water Bluetooth data signal controls the “baby fish” (Fig. 6). In response, “baby fish” light up and mimic the player’s altered-gravity movements (Fig. 7). By communicating with and through the water, the player engages in an aquabatic performance through play (Fig. 8-9).

Design tactics
Through the process of creating Gravity Well, we learned that many designers are not familiar with pressure-change variables [6]. Furthermore, many land-based exertion game design assumptions are not suitable for underwater systems [10]. The gap in this knowledge inspired us to create a set of design tactics for other designers creating underwater systems.

As a framework, we refer to signs and symptoms of Narcosis [6] to scaffold our set of design tactics [8]. We suggest designers first consider a) mood b) intellectual function c) visual and auditory stimuli and d) balance and coordination related to underwater play as each issue relates to measurable Narcosis experience [6].
Narcosis produces a narcotic-like effect. Design to harness mild euphoria mood – but not to distract from water safety.

Clear, concise simple tasks or open play design. Rules aid concentration at depth. Tasks assist direct focus.

Sci-Fi futuristic theme adding to euphoric feeling.

Low-level intellectual function required for play. Open to interpretation. User determining rules.

Vibrant LED color tones easily detected underwater. Low-intensity LED array shows movement. Ambient sound.

The overt design feature. A user-designed interaction sensing aquabatic motion (body & body of water)*.

Physically altered buoyancy, balance and coordination.

Table 1. Signs and symptoms of narcosis 0-30m underwater (UW) compared to land and implications for game designers.

**Discussion**

We apply this work for underwater digital play by comparing the effects of with a pedestrian-fixed frame, to describe implications for the design of underwater exertion play [Table 1]. We also express these considerations in the shallow-water Gravity Well.

We believe there is an opportunity to take advantage of movement underwater and changes to sensory perception caused by pressure changes to design unique exertion games that facilitate full-bodied play experiences [1,7,9]. We also see further opportunity to develop underwater exertion games that support the wellbeing of players at various recreational and commercial diving depths from 0-30m, promote new human-computing-aquatic approaches to design, and positively contribute playful interaction design in other altered-gravity domains such as Zero-G flights, low Earth-orbital flights and human spaceflight. [10].

**Conclusions**

We have explored digital play in altered gravity conditions by investigating underwater bodily games, exemplified by an interactive underwater system that supports bodily play through movement interactions called Gravity Well. Through designing the system and...
combining underwater and game design principles, we
identified a set of design tactics for underwater play.
These design tactics – based on Narcosis – are only an
initial set, and future design guides may relate to
oxygen toxicity, decompression sickness, refraction and
other topics. We also focused on shallow-water
interactions, thus future work will explore how
interactive technology would need to be designed for
depth. Nevertheless, our work offers a unique
exploration into digital play design for altered
gravity conditions. With our work, we aim to inspire designers
to utilize the unique characteristics of bodily
interactions underwater and guide them in developing
digital play in altered gravity domains.

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Figure 8, 9. Player engaged in full-bodied immersion and interactions
with Gravity Well “Mother Fish” underwater.