INTERAQUATICA - Designing Interactive Aquatic Experiences with Geodesic Domes In-the-Wild

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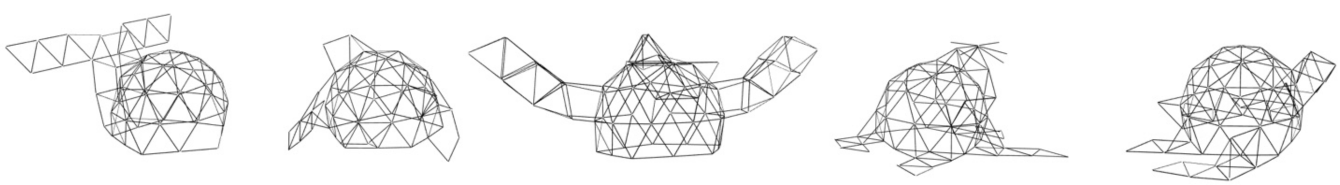

Figure 1: INTERAQUATICA Geodesic Domes as Marine Megafauna (from left to right) - Whale, Dolphin, Seabird, Seal, Turtle

ABSTRACT

While HCI remains vastly abundant in human- and land- centric applications, in this work we focus on exploring further the Human Computer Biosphere Interaction (HCBI) concept in aquatic settings. Based on the existing techniques for prototyping the geodesic domes, we design them as five marine megafauna species, for the on- and off- shore locations. We describe novel interaction concepts with and within such structures: (i) Turtle AR nesting, (ii) Bird XR watching, (iii) Dolphin acoustic swimming, (iv) Seal night scuba-diving, and (v) Whale projection mapping. We report the design of such *interaquatic* environments, focused at depicting the ongoing concerns with such marina megafauna species, discussing their feasibility, suggesting research, implementation and validation for all *interaquatic* domes, planned in our future work.

CCS CONCEPTS

• **Human-centered computing → Human computer interaction (HCI)**.

KEYWORDS

Aquatic User Interfaces; Human Computer Biosphere Interaction; Marine Megafauna; Geodesic Domes

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1 INTRODUCTION

Geodesic domes date back to the 1920's, when first used by Walther Bauersfeld as planetariums. Twenty years later, they were further popularized by R. Buckminster Fuller, who used them to improve human shelters [15]. Nowadays, geodesic domes are commonly used for personal hideouts, gardens, interactive installations, conference meetings, concerts, parties, to public festivals such as the Burning Man [11]. With a focus on Human Computer Biosphere Interaction (HCBI) [13], we present the design of a series of geodesic domes as vectors to connect the audience with the remote marine megafauna species. Goal of this study is to bridge the gap between the human users and aquatic nature, whilst minimizing the human impact on marine biodiversity.

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To enrich such area of research with marine environment, we provide the concept of interactive and aquatic (in further, *interaquatic*) experiences, planned for on- and off- shore future installations. We support such a concept with the design of five geodesic domes, depicting them as five marine megafauna species, being the main aquatic biodiversity protagonists of the Atlantic ocean. For each, we discuss the feasibility and provide the application scenario, describing the possible interactions with and within such structures in diverse environments, from the sea surface, to the seabed.

2 RELATED WORK

Literature review describes HCI in exploring geodesic domes in-the-wild, and audience engagement with biodiversity.

2.1 Geodesic Domes and HCI

HCI research shows moderate usage of technology when crafting experiences with geodesic domes. AstroSurf used Xbox 360 controllers with the audience lying down inside of the dome, racing through the space in a fast-paced multiplayer infinite runner game [9]. Study revealed potential issues with usability and motion sickness. Pinch-the-sky coupled the dome with an omni-directional projector and a camera to track hand gestures. Work reported an immersive, interactive experience, with wide possible applications from astronomy to social networking [1]. Bit Dome used the Kinect motion sensor, where the audience interacted with distributed RGB lights around the dome, allowing them to create vibrant light displays [5]. One workshop explored role-playing, turning the geodesic dome into an igloo, beehive and a planetary base for a colony on Mars [7]. Pollution Pods, consisting in five interconnected domes where the audience could explore the air quality of five major cities [21], concluded that the engagement of the audience is high when such structures are brought to the public. While geodesic domes have a long history in design, they are sparking initial HCI interests. To the best of our knowledge, no aquatic setting has been explored, with which we contribute with this study. Moreover, most of these studies either used dark and enclosed environments, being limited to battery autonomy, high cost of technology, projection distance throw and focus, etc. In our work, we conceptualize interactions with geodesic domes in on- and off- shore aquatic settings, focusing on less distracting technological input.

2.2 Biodiversity Engagement and HCI

Following the HCBI vision, the latest effort provided a real-time interface capable of bridging the gap between users in an urban context and the forest animals [12], including a system to stream the presence of wildlife to the undeveloped natural locations [14]. Similarly, Gaver et al. developed a My Naturewatch Camera, as a cheap and DIY solution to observe nature while respecting the conservation distances [8]. In our study, we expand a similar vision, enriching it with aquatic settings.

HCI literature also reports diverse technologies being used for mostly land-based exploration of flora and fauna. Augmented Reality (AR) field guides were used for the identification of botanical species [24], mentioning the tangibility of the devices being appreciated by the users. In the zoo, authors found that technology distracted the users from the actual animals [23]. Virtual animal companions were also found to promote better learning habits [4]. However, HCI remains quite scarce in aquatic settings, and mostly focused on sounds. Amphibian, a Virtual Reality (VR) application provided a simil-scuba diving experience for users on land [10], finding the importance of noise reduction. POSEIDON used acoustic monitoring from whale-watching sea-vessels, providing real-time whale-listening experience for tourists [18]. Echology combined spatial sound with table-top displays, exploring the Beluga whales using live camera feed [6]. Ocean Game used a treasure hunt game to increase marine literacy [17]. Only one initiative explored AR/VR with marine environment, seen in Antarctica, depicting the food chain of the Red Sea [16], suggesting more exploration of gamification experiences in such environments. In our work, we complement and enrich such limited efforts, combining them with the geodesic domes.

3 INTERAQUATIC DOMES

With the aim of involving the audience with remote aquatic species, throughout **INTERAQUATICA** we imagined several interactive experiences using: (i) *aquatic domes*, to provide a physical environment for exploration by the audience; and (ii) *aquatic interactions*, application scenario, with an interface for the interaction between the user and marine megafauna species.

Based on the existing techniques, a 2V geodesic dome was used given its simplicity with having only two dimensions. We increased the height by augmenting the bottom part to comfortably accommodate 5 persons inside (4m diameter, 3m height). The door was made in the rhomboid shape, intended for visitors entrance and exit. Afterwards, several extremities were decorated, resembling the 5 marine megafauna species[1]. We intended the domes to inspire curiosity and to serve as triggers for the interactive content (e.g. marker for Cross Reality (XR) app). All domes were first designed as 3D models in Fusion360 (Figure 1), and then exported to Blender, allowing the rendered previews of planned future work (Figure 2). One such dome was successfully mounted (Figure 3). Below, we describe the "interaquatic" experiences as fictive but feasible application scenarios for all five domes, being co-designed with engineers, designers and marine biologists (alluding to marine megafauna concerns), during a course taught at the University of Madeira.

3.1 Turtle Dome - Bycatch Escape Room

Deployed on nesting beaches, visitors use their mobile phones to scan the dome, acting as a 2D marker, triggering an AR game. Outside of the dome, an animated 3D loggerhead turtle is shown, entangled in the fishing net, caused by fishery bycatch [22]), pointing to the entrance of the dome for visitors to assist by entering. An AR "portal" is mapped on top of the rhomboid physical entrance to the dome, allowing the user to step into the undersea habitat. Once inside, visitors assume the turtle POV, being surrounded with the fishnet. Using the app sensory input (GPS, accelerometer, etc.), they try to disentangle themselves.

[1] http://wave.arditi.pt/kits#domes

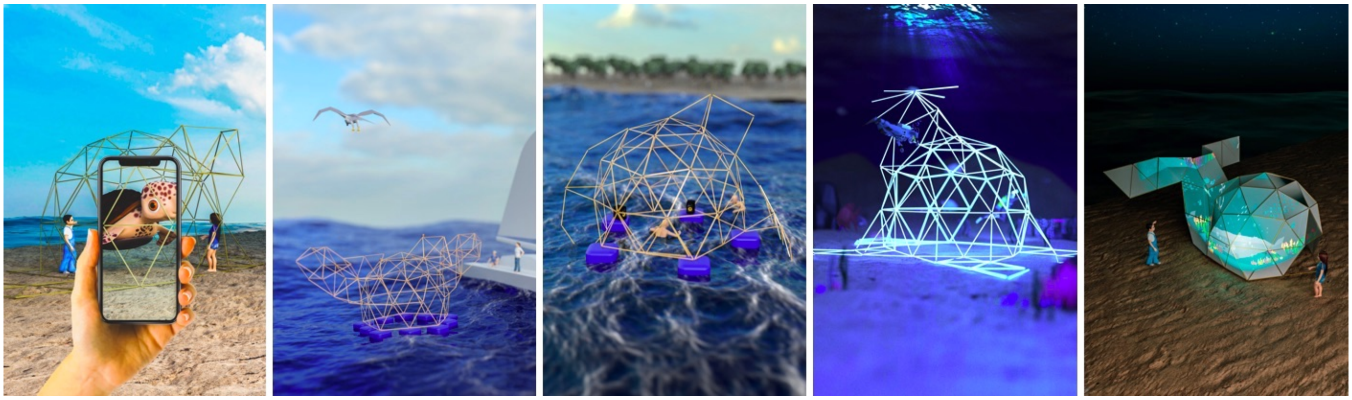

Figure 2: INTERAQUATICA Interaction mockups (from left to right): (i) Turtle AR nesting, (ii) Bird XR watching, (iii) Dolphin acoustic swimming, (iv) Seal night scuba-diving, and (v) Whale projection mapping

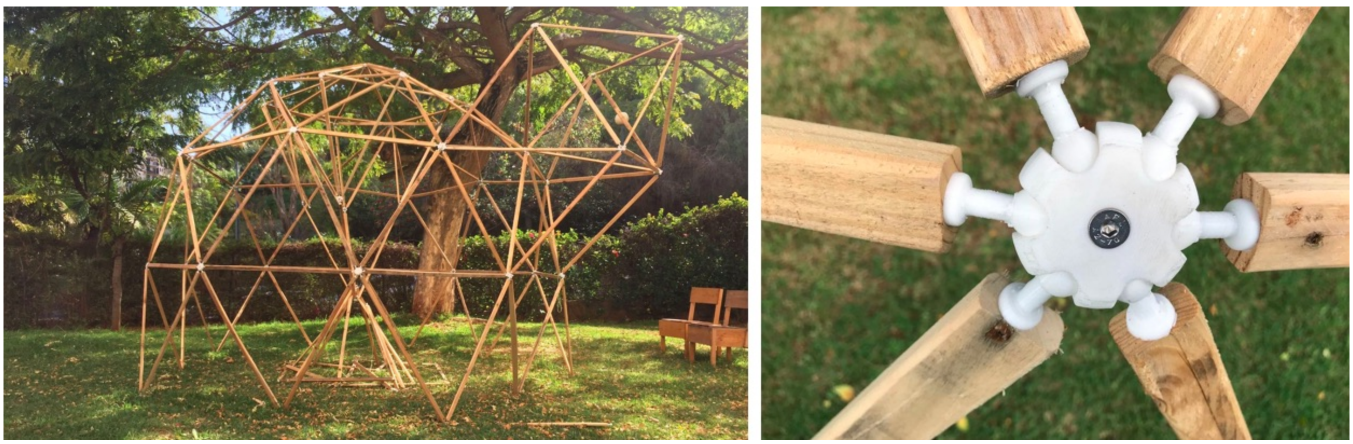

Figure 3: INTERAQUATICA Turtle Dome - Example of the implemented geodesic dome using the 3D printed joints

3.2 Seabird Dome - XR Oil Spills

Anchored to the seabed, dome is inhabited by the resting seabird population. Tourists use their mobile phones from the sea-vessel, pointing towards the dome, depicting the angry seabird in XR. Mechanics is based on proximity (within GPS perimeter): the more the vessel is closer to the dome, the more the seabird is covered with oil and agitated. Seabird exaggerates by throwing back the oil to the mobile screen, until the whole user interface suffocates, as seabirds in oil spills [3].

3.3 Dolphin Dome - Acoustic Noise Pollution

Since dolphins tend to be silent when there is anthropogenic noise from sea-vessels [2], the imagined structure is moored to the beach, resting against the pontoon support. A speaker is inside the dome, playing the dolphin vocal calls. Using the ambient noise collected by the microphone, interaction is made with the local swimmers: the more the nearby swimmers are loud, the less the acoustics will be played-back throughout the speaker.

3.4 Seal Dome - Lantern Contamination

Intended for night scuba-diving, proposed dome is anchored to the seabed, allowing the certified scuba-divers for exploration. Subject is the sleeping Madeira monk seal, recently found in having short naps on the seabed. Scuba-divers use their flashlights to "awaken" the seal, pointing them to the photoluminescent frame. This depicts the food diet of seals based on the Lanternfish (Myctophidae, known for their bioluminescence), prone to anthropogenic contamination [19]. Scuba-divers enter the dome using larger doors, located at the mouth and at the top side of the back of the seal, allowing all four emergency ascent procedures.

3.5 Whale Dome - Projecting Carbon Fixing

Proposed projection mapping installation depicts the whale pump, bringing evidence on how the greater whales capture the carbon using their body mass and carcasses [20]. Designed for the littoral settings and night-time environment, the audience explores the projection using their body gestures. Interaction is based on the proximity of the person towards the dome, which is equipped with sonar modules. Metaphor of human is depicted with the wildfire and carbon emissions. The closer the visitors are to the projection, the more the carbon emissions will be emitted, and the more the greater whales will appear to capture the carbon.

4 DISCUSSION

Certainly, with the proposed application scenarios, we introduce additional limitations and more challenges yet to be found. Nevertheless, we argue that this "interaquatic" concept enriches both the HCI and HCBI, challenging their limited efforts for aquatic settings. Regarding future implementation, after discussion in a multidisciplinary setting, provided concepts may turn to be feasible for deployment. Authors of the research successfully implemented one of such domes from 100% recycled pallets and 3D printed connections (Figure 3). Several tests are pending, from long-term exposure to the weather (water- and sun- proofing), to audience behaviour (e.g. climbing a structure). Since most of these domes are conceptualized as open structures and with limited technological input (in contrast to the literature review), further effort still needs to unveil the complete security aspects. Planned research to be carried out using such HCBI apparatus leaves some open questions: How would the audience interact with and within such structures? Would such digital interactions also result in the global anthropogenic footprint? Would such medium make the audience care about the anthropogenic impact?

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