Enhancing Whale Watching with mobile Apps and Streaming Passive Acoustics

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Abstract. Whale watching is a prime example of ecotourism services reaching millions of people worldwide. In this paper, we describe a prototype of a mobile application designed to enhance the whale watching experience. Integrating eco-acoustics and entertainment components, the authors designed an App that enhances customer satisfaction even in the case of distant sighing, which helps preserve animal well-being in this growing ecotourism activity. This paper presents the design and preliminary evaluation of the system, which involves many different components, from usability and presence known scales. We asked 12 participants to conduct several activities, including (i) report a sighting, (ii) classify a cetacean vocal call, and (iii) gather a cetacean photo. Because of the system's novelty, we report on an extensive evaluation framework, including usability and presence scales reported by 12 whale watchers. We discuss the implications of our findings on the design of future applications for ecotourism services.

Keywords: Whale watching · Environmental Sustainability · Mobile Entertainment · User Experience · Ecotourism.

1 Introduction

Environmental sustainability is one of the fastest-growing areas of activity in technology related-research [16]. Many research efforts are examining the opportunities to use computing technologies to promote environmental protection, and ecological consciousness from various angles, including entertainment [2, 23, 60, 10, 51]. This is a responsible reaction to the twin crisis of climate and nature, which is supported by overwhelming scientific evidence [43]. It is causing increasing public concerns [47]. Put simply, people and wildlife are at risk unless we take urgent action to mitigate and hopefully reverse the loss of plants and animals on which our ecosystems depend for food, clean water, and a stable climate [28].

Oceans are a crucial driver of earth ecosystems. They cover three-quarters of the Earth's surface, contain 97% of the Earth's water, and absorb 30% of the

carbon emissions acting as a buffer for global warming. Careful management of this essential global resource is a vital feature of a sustainable future recognized by the United Nations Sustainable Development Goal 14 - Conserve and sustainably use the oceans, seas and marine resources[4]. However, observe a continuous deterioration of coastal waters due to pollution and ocean acidification compromising ecosystems and biodiversity. The UN SDG 14 goal ambitiously targets to protect 10% of the ocean by 2020, preventing or significantly reducing marine pollution [12].

At the present scale, although 12% of the Earth's land is conserved through arrangements such as national parks, only 5% of the ocean has any protection at all[5]. Marine Protected Areas are a useful management tool towards conservation [17]. However, their size and scope are not always adequate for protecting marine megafauna, like whales, dolphins, and sharks [11]. Conservation measures for these large pelagic animals depend much on data acquisition in the open ocean to ascertain their population's status and detect temporal and spatial patterns in their distribution. Such an endeavor usually relies on dedicated monitoring and vessel-based survey programs, which are typically costly and time-consuming. Leading to often temporally sparse or sporadic and spatially patchy collected data. We can partially tackle these data gaps by taking advantage of the growing interest and offer of recreational whale-watching service providers, as these already spend time at sea, tracking cetaceans and other large animals. On the other hand, whale-watching activities engage people with cetaceans, one of the most charismatic fauna raising awareness towards the promotion of ocean conservation measures and actions [22].

1.1 Digital Entertainment for Nature Conservation

Digital technology is changing nature conservation in increasingly profound ways. Some have called this new movement "Wilderness 2.0" [53] or "Nature 2.0" [9] referring to the articulation of new media, mobile technologies, and locative media, with the practice of wilderness recreation [53] and online activities that stimulate and complicate the commodification of biodiversity and nature [9]. Digital technology is thus promoting a new reality (between the virtual and the real) where people connect and recreate a new social construct of nature and the underlying digital economy [53], reimagining ideas, ideals and experiences of nature [9]. In this new context, environmentalists have long expressed concern that increasing the mediation of non-human interactions [19] is contributing to diminishing support for conservation [18]. Consequently, digital entertainment is increasingly promoted by environmental organizations precisely for their potential to inspire more active commitment to environmental causes than the direct experiences most conservationists advocate [18, 49]. Using gamification and serious games promotes a similar strategy to engage consumers in pro-environmental behaviors for areas such as nature conservation [42], energy efficiency [37], transport [67], and sustainability [31].

[4] https://sustainabledevelopment.un.org
[5] https://sustainabledevelopment.un.org/frameworks/ouroceanourfuture

1.2 Enhancing the Whale Watching Experience

This project aims to test how digital entertainment could be used in whale watching to engage participants in this form of ecotourism and enhance their experience while promoting more environmentally friendly behaviors. From Moby Dick to Free Willy, the conceptualization of whales in entertainment and their societal representations and understandings have changed dramatically in the last century [63]. Lawrence and Philips propose that whale watching is one key example of an economic activity emerging from the radical changes that occurred in societal understandings and representations of nature and animals [29]. Humans have been hunting whales since the beginning of history, but it was not until the 1930s that saw the development of international regulations to control the number and type of whales harvested [58]. Notwithstanding, these regulations were developed to manage oversupply and later overexploitation and still conceptualized the animals as "whale stocks" of valuable human resources and not as animals or species [30]. Changes in the regulatory discourse impacted the image of whales in popular culture. Most movies until the 1970s present a negative image of whales as "man-eating and ship destroying monsters" of which Moby Dick (1956) and 20,000 Leagues Under Sea (1954) are the most known examples. The movies produced after 1980 present a very different image of whales and their relationship with people. Perhaps the most emblematic example is Free Willy (1993), which is responsible for an increase in cetacean-related tourism activities like dolphin swimming and whale watching as well as visitations to marine amusement parks [63].

Our project aims at digitally enhancing the whale watching experience, while raising awareness about ocean sustainability concerns, such as stressing and disturbing the animals in their habitats. Whale watching is a USD 2.1 billion global industry, attracting more than 13 million people worldwide [11]. However, this activity is usually reasonably expensive for participants who, due to the elusive nature of these animals in the wild, often fail to see their (submerged) full-size body. At the same time, whale watching activities and pressure do affect animal behavior, and noise pollution impacts these animals as they much rely on sound to communicate, navigate, and even locate prey [44]. Our motivation for this research is to provide on boat activities that enhance the whale watching experience, allowing tourists to perform fulfilling interaction with the cetaceans while minimizing stressful situations for the animals themselves. For this purpose, our prototype enhances the whale watching activity by signaling the presence of cetacean and bringing the experience of their sounds and location to the tourists, preserving distance from the animal, and minimizing the invasion of their territory. In the remainder of this paper, we position our work against the state of the art of, describing the prototype design and preliminary evaluation on system usability and presence scales of whale watchers. Our results inform a discussion on the future of applications for nature engagement and sensing.

1.3 Research Questions

This work builds on other reported case studies designing novel interactive systems and services for tourism related applications[56][3][41][42][48]. In our previous work [46], we designed a ubiquitous mobile system to enrich the whale-watching activities with passive acoustics. Our reported study was proof of concept in performing the real-time machine learning classification of cetacean vocal calls using low-cost sensing and communication. Here, we expand the work, allowing users to actively report the sightings, sounds classification, and media gathering while not approaching the animals beyond stress generating proximity. In this study, we obtain participants' feedback and the overall results of the systems' usability and presence. Therefore, this research mainly explores how successful the system is in providing a whale-watchers fulfilling and entertaining experience. Throughout several diverse usability and presence scales, we verify the collected feedback from the participants and discuss results in light of the application's future refinement.

2 Related Work

We situate this research in-between different three main areas of prior work: sensing and engaging nature, digital entertainment, and nature and whale watching as a form of ecotourism. In the following subsections, we address each one in turn.

2.1 Sensing and Engaging Nature

The advent of low-cost, ubiquitous sensing and computing leads to increased use of these technologies in biology, ecology, and environmental sciences, e.g., research on Eco acoustics [54]. These efforts build on empirical evidence of biotic and non-biotic sounds used as a reliable proxy for investigating ecological complexity [26], including biodiversity loss and climate change. These technologies enable the identification of several thematic priorities for research programs that take advantage of novel computer sciences and technologies. One notable example is AudioMoth [21], a low-cost, small-sized, and low-energy acoustic detector. The device is open-source and programmable, with diverse applications for recording animal calls or human activity. AudioMoth deployed globally reached in 2019 more than 700 projects worldwide [21]. The device also facilitated public engagement, including citizen science projects for bat surveys[6], biodiversity distribution assessments[7], BirdsScience[8], cetalingua[9], and engagement of the general public in wildlife monitoring programs[10].

[6] https://www.bats.org.uk
[7] https://www.soundscapes2landscapes.org
[8] https://www.wesa.fm/post/pitt-researchers-are-eavesdropping-birds-name-science
[9] https://www.cetalingua.com/citizen-science/
[10] https://www.nocmig.com/audiomoth

Similarly, the HCI community saw an opportunity to apply the same concept to camera traps. My NatureWatch Camera is an inexpensive wildlife camera designed for people to self-build a way to promote environmental engagement and produce digital content [20]. My NatureWatch Camera includes a smartphone interface that allows a facile setup and retrieval of images. The authors of the project worked closely with a TV Show and social media outreach to highlight the importance of co-development for research projects to circulate at scale. The users of the device also reported increased awareness about local nature and animals. POSEIDON [46] is a low-cost passive acoustic monitoring system for citizen science in nautical/marine settings, which provided whale-listening to whale-watching. Collectively, with other projects focusing on different taxa such as insects [45, 61] or birds [55], it illustrates the possibilities of applying the low-cost IoT technologies to sense nature and engage with the public.

2.2 Digital Entertainment and Nature

Entertainment and gaming approaches are increasingly used to raise awareness about serious issues in a wide range of fields, including biodiversity conservation [49]. At the same time, environmentalists express concerns about the increase in technological mediation of human and non-human interactions, keeping people away from nature, and interacting with digital artifacts instead. This phenomenon could be contributing to a growing "nature-deficit disorder" (NDD) and thereby diminishing support for conservation [24, 18]. These concerns are grounded in the premise that direct experiences in "natural" spaces, especially those gained in childhood, will inspire people to "love" non humans [36] and subsequently act in support of environmental causes [64].

Nevertheless, digital entertainment artifacts approaching environmental and animal preservation of natural premises are many. Examples range from Defend Your Territory[11], a game inciting player to kill evil animal poachers; Camera Birds[12] which requires the player to take photos of birds in a virtual forest; Wounded iWhale Rescue[13] inviting players to "save" (i.e. catch) whales. Deep water hero[14] a digital puzzle game demanding players to break up an oil slick to save animals; WilderQuest[15], targeting 5 to 8 eight years old children, placing them in an immersive 360 degree virtual environment to encourage them to observe and discover the nature around them by holding the iPad like a camera.

On the other hand, addressing Milton and Kareiva concerns [24, 36], digital games encourage players to go into nature in order to interact with it. For example, with Wildtime App children or parents use their mobile phones to discover enjoyable activities in nearby green space[16]. Dionisio et al. developed a rich trans-

[11] https://www.geekwire.com/2015/game-about-killing-poachers-vies-for-50000-prize-in-microsoft-student-tech-competition/
[12] https://appadvice.com/app/camera-birds/520656685
[13] https://gamefaqs.gamespot.com/android/701348-wounded-iwhale-rescue
[14] https://www.amazon.com/Deep-Water-Hero-HD-Free/dp/B007TXSCV0
[15] https://wilderquest.nsw.gov.au/
[16] https://www.thewildnetwork.com/wild-time-ideas

media entertainment experience to promote the natural capital of a biodiversity-rich tourist destination while physically exploring its real settings [15]. Loureiro et al. propose a mobile game to be played in real parks and green spaces supporting the biodiversity awareness through bioacoustic data validation of local species [34].

In summary, mobile apps designed to support nature immersed recreation are emerging. They frequently integrate GPS and compass functionality with maps to support navigation, record observations and send alerts of unusual sightings to other users. The App is ActInNature Hunting, is an excellent example, which adds a social dimension to the above-described functionalities. A minority of Apps associated with visiting attractions (e.g. museums, botanical gardens and parks), provide augmented reality enhancements of exhibits [62, 35, 39].

Our App, designed to support the recreation of the users while immersed in nature, builds and extends on state of the art by proposing the combination of acoustic sensing and animal sighting while connecting users in building a local database of data, open to a public of scientists and non. We paid particular attention to designing an application that would not stress or endanger animals while enhancing the whale watchers' experience while immersed in nature.

2.3 Whale Watching and Ecotourism

Whaling was an essential element of the industrial revolution, providing one of the first commercially viable commodities used as a source of energy. The charismatic nature of these giant mammals played an essential role in supporting the rise of environmentalism and NGOs like Greenpeace [6]. More recently, cetaceans embody one of the prime examples of ecotourism services, with the whale watching industry reaching 13 million people worldwide (conducted in more than 119 countries) and accounting for more than 2 billion USD revenue [52].

From Moby Dick to Free Willy, the conceptualization of whales and their societal representations and understandings have changed dramatically over time [63]. Lawrence and Philips [30] propose that whale watching is a key example of an economic activity, which emerges from the radical changes that occurred in the societal understanding of nature and animals [6]. Humans have been hunting whales since the beginning of history. However, it was not until the 1930s that international regulations were developed to control the number and type of whales harvested. Notwithstanding, these regulations were developed to manage oversupply and later over-exploitation, which still position the animals as a valuable resource to humans. The argument provided by Latour [7] is that we can witness in human-whale entanglements a demonstration of a more general transformation of society referred to as "ecoligisation" [6] (a hybrid world in which the co-production of humans and non-humans are constantly renegotiated) [7]. Whales are thus prime examples of non-human actors, individualized in their "actorhood" and acquiring "personalities", which became increasingly plausible [57].

Focusing on the design of sustainable interactions with whales, we need to consider the debate between the "short-term" impacts and the "long-term" con-

sequences of whale watching [13]. Indeed, some authors have argued that whale watching corresponds to a metabolic rift of whale hunting, problematizing the pervasive assumption that whale watching correlates primarily and directly with conservation [38]. Also, there have been other systems proposed to question the impact of climate change in the distribution and abundance of whales [27]. Lambert and colleagues developed a resilience framework of whale watching to these changes. They defined resilience as the degree of change in cetacean occurrence experienced before tourist numbers fall below a critical threshold [27]. Their framework combined likelihood of observing a cetacean, trip type and tourist type, which, when quantified, could identify which operators are more likely to experience a change in tourist numbers, given a specific scenario of changing cetacean occurrence. While these studies provided system and insight into the environmental consequences, Bentz and colleagues studied the satisfaction with whale watching tours in relationship to expectations and demographic variables and identified tour aspects that contribute to satisfaction [5]. Their study was based on expectancy theory, which suggests that participants engage in recreational activities expecting that this will fulfill their needs and motivations [25]. It then compared importance-performance analysis and performance-only perspective to measure satisfaction of whale tour participants. Environmental friendly conditions were the most important expectation: Seeing one whale, seeing lots of whales, the cost of the trip and the boat type were the most influential factors contributing to satisfaction [5].

3 System Description

In this section, we briefly describe the whole system setup, extending POSEIDON [46] with a custom made, on-boat mobile application, designed to support and enhance the whale watching activities. The system provides additional ad-hoc scientific information supporting awareness and inspiring conservation of marine megafauna.

3.1 Sensing Hardware and Mobile Application

The eco-acoustic sensing station is encapsulated in an autonomous, buoyant Styrofoam sphere, which contains the microcomputer with the WiFi connection, powered by the solar panels and containing the media equipment (Figure 1). Once at the whale-watching spot, the capsule is thrown into the water, and dragged from the sea vessel with a common cable. The acoustic buoyant system was previously described and discussed in [46].

The novel POSEIDON mobile application (Figure 2), completing the POSEIDON system, is designed to provide users with three diverse types of information: (i) general information about cetaceans; (ii) media gallery (showcasing the collected sound and images); and (iii) three action windows (report a sighting, classify a sound, and gather underwater and surface photos). The Watkins Marine Mammal Dataset [50] inspired the cetaceans used in our application. Our



(a) Microcomputer with the power bank, Wi-Fi dongle for communication with GoPro, audio jack and stereo cable, and a hydrophone.

(b) Assembled buoyant capsule including all components. Tripod is used for exhibition.

Fig. 1: POSEIDON Hardware System components

study was pre-installed on the whale watcher's tourist phone and accompanied the user during the whale watching tour. The App comprises several features described in the ordered list below:

1. The App supports the storing and collection of reported marine megafauna sightings, shared by previous users. Once an animal is sighted, its GPS position and the sighted species, can be logged by the user on the map interface of the App (Figure 2. a, g).
2. The App reports sounds recordings of the sensing of megafauna underwater, portraying the live acoustic feed from hydrophone hardware. The sound reports can be access on a separate screen. A detailed description of this part of the app is provided in [46] (Figure 2. b).
3. The App stores the user's photos, captured by means of pointing and clicking the mobile device. Action triggers a contemporary underwater shot, performed by the buoyant hardware system and shared to the App (Figure 2. c).
4. In order to collect information regarding the App usability and the user satisfaction the App presents a screen Survey to be filled by individual users at the end of the experience (Figure 2. d).
5. The App presents the Watkins Marine Mammal Dataset collection [50] to facilitate users recognition and reporting of specific species. The user can select the animal that they think they have sighted at any given moment during the whale watching trip (Figure 2. e).
6. The App contains screens with scientific information and details of the species that have been sighted, according to the Watkins Marine Mammal Dataset collection [50] (Figure 2. f).

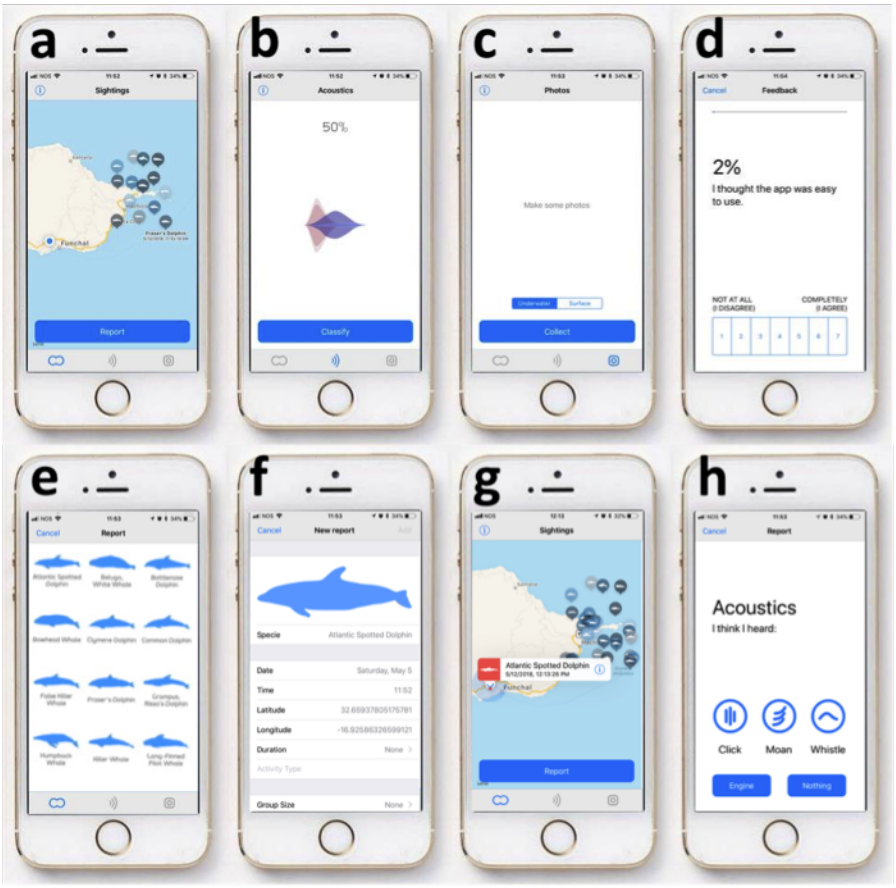


Fig. 2: Screenshots from the POSEIDON application. From left to right: (a) Sightings main screen, portraying the reported sightings; (b) Acoustics main screen, portraying the live acoustic feed from hydrophone; (c) Photos main screen, depicting collected underwater and surface photos; (d) Survey at the end of the experience; (e) Sighting report screen; (f) Sighting Reporting screen information collection; (g) Sighting reported at the GPS location. (h) Classification of acoustics with given options (click, moan, whistle, engine or nothing).

7. The App presents the users with an option of classifying the acoustic sounds collected by the hydrophone. The classification of acoustics is categorized within four given options (click, moan, whistle, engine or nothing) (Figure 2. h).



(a) Surface image of the pilot-whale sunbathing and taking a rest.

(b) Underwater images of the two breastfeeding mothers with one calf.

Fig. 3: POSEIDON images depicting spotted cetaceans during the user study.

3.2 Tasks Performed by Whale Watchers

In summary, the App enables tourists' whale watchers to perform a set of additional tasks that enhance the experience, without disrupting the animal's wildlife:

1. Reporting a cetacean sighting – Whale watchers are presented with the map of possible cetacean sightings (Figure 2. a) and they are asked to report if they spot a cetacean. Once the cetacean is spotted, the user proceeds with selecting the REPORT button (Figure 2. e) and is guided to insert the additional details with the help of the researchers on board (Figure 2. f). These details include the duration and type of the activity, group and calves' size, Beaufort wind scale and the boat type. Once the report has all the information, the user adds the report, which instantly appears as a red spot on the map (Figure 2. g).
2. Classifying a cetacean vocal call - Participants can hear the cetacean vocal calling, which is being recorded by the hydrophone and has been verified as one of the five second acoustic samples with the prediction of above 0.75. (click, moan, whistle, engine noise and empty water). Once the sound is played through the participant headphones, participant classifies the sound by pressing the CLASSIFY button. Participants are further guided to select one of the given five options: click, moan, whistle, engine noise and empty water (Figure 2. h). While listening to the sounds, the participants can see the visual wavelength of the acoustic samples (Figure 2. b).
3. Gathering cetacean images - Participants can gather the images from below and above the water surface. Participants select the type of camera they want to use and press the COLLECT button to obtain the photo (Figure 2. c). The underwater photo is captured from the action camera installed in the capsule component of the hydrophone, while the surface photo is from the actual mobile phone the participants are using. In the case of the underwater photo, participants need to wait approximately five seconds from when the image is shot to when it reaches the users' mobile phone. We opted for this waiting time in order to prolong the battery life and maintain the highest resolution photos images (Figure 3).

4 Evaluation

In this section, we describe the evaluation of the App's first working prototype, designed to enhance the whale watching experience. Because of the underlying context and the absence of previous work evaluating systems that combine enhancing user experience and engaging participants in conservation activities in the wild, we used an extensive evaluation framework which includes assessing the usability of the system (SUS [8]) and the presence (PRE [66]) of whale watchers.

The study was conducted in Madeira (North East Atlantic Ocean), a historically touristic island destination in the North East Atlantic which has a significant occurrence of cetaceans [14, 1]. Participants were invited to use the App during a whale watching trip to report the sightings. The data collected through sightings included:

Our sample size (N=12) included 6 males and 6 females. Their age was ranging from 16 to 45 (M = 30.08, SD = 10.93), from 6 different countries of origin: Portugal (3), France (3), Germany (2), UK (2), Netherlands (1) and Papua New Guinea (1). All of these participants expressed themselves as knowledgeable and experienced in using mobile smartphone applications. The study included mostly tourist visitors who came to the island on vacation and opted to go for the whale watching activity using sea-vessels. No incentives for recruiting participants were used. The study consisted of two separate tasks: (i) reporting a cetacean; (ii) answering the questionnaires. Both tasks were completed using the mobile application, which included electronic forms for the System usability scale (SUS) and Presence (PRE) questionnaires and also several study-specific questions.

4.1 Data Collection

To evaluate the App, we opted to collect participants' data according to two scales and several study-specific questions (listed below), resulting in 40 questions (10 SUS + 24 PRE + 6 study-specific). At the end of the experience, these questions were posed to users, using the mobile application to display seven points Likert-based scales (Figure 1. h). The averages of the participants' feedback are depicted below (Figures 4 and 5), while here, we briefly describe the used scales.

1. System Usability Scale [SUS] (7-point Likert scale) - consisting of a 10 item standard SUS questionnaire, which we converted from 5 to 7 point Likert-type scale to keep the consistency with other forthcoming scales. This scale was used to gauge the usability of the application and its interface.
2. Presence Questionnaire [PRE] (7-point Likert scale) - tailored for virtual reality environments, the scale is equally valid if used in real environments, where all subjects experience the same type of environment [59]. We used the PRE scale to understand the feeling of presence of users, while engaged with the App. Thus, to assess if they still felt presence in the natural setting of the experience.

3. Study-Specific Questions [STD] (7-point Likert scale) – several questions targeting the usage of the App: *i) Where you looking more to the actual whales and dolphins than the app?; ii) How important to you was the sound during the whale watching activity?; iii) How much you liked reporting the sightings?; iv) How much you liked classifying the cetacean sounds?; v) How much you liked gathering the cetacean photos?;* and *vi) Please rate your previous experience as citizen scientist.*

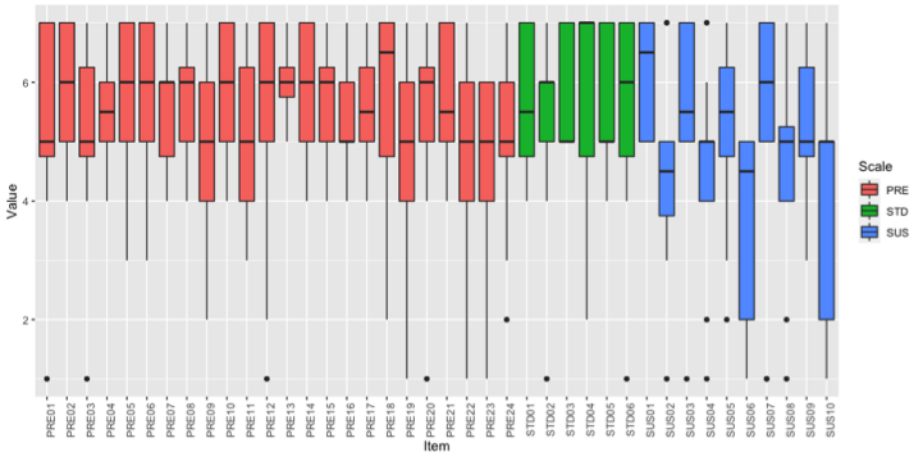


Fig. 4: Boxplot depicting the results of the three questionnaires (N=12). Red the PRE scale, green the study-specific questions and blue the SUS scale.

4.2 Data Analysis

The results of the three questionnaires are summarized in Figure 4. Overall the results from the 12 users are positive in terms of usability and presence. We calculated the overall SUS score according to [33] by determining each item's score contribution, from the range of 0-7 as follows: i) for positively-worded items (1, 3, 5, 7 and 9), the score contribution is the answered value minus 1; ii) for negatively-worded items (2, 4, 6, 8 and 10), it is 7 minus the answered value; iii) for missing values assign 5 (the center of the rating scale). To get the overall SUS score, we then multiply the sum of the item score contributions by 1,67 (100/60), thus adjusting the overall SUS score to 0-100. Calculating the overall score, we reached 60.83, which according to [4] fits on a grade C ("good") score.

For the Presence questionnaire, we obtained the overall score by averaging the results from the 24 questions, 7-point Likert scale. The final result ($M = 5.45$, $SD = 0.40$) is above average. We also performed a Cronbach's alpha to estimate the reliability, determine correlations between the questionnaires' items, and

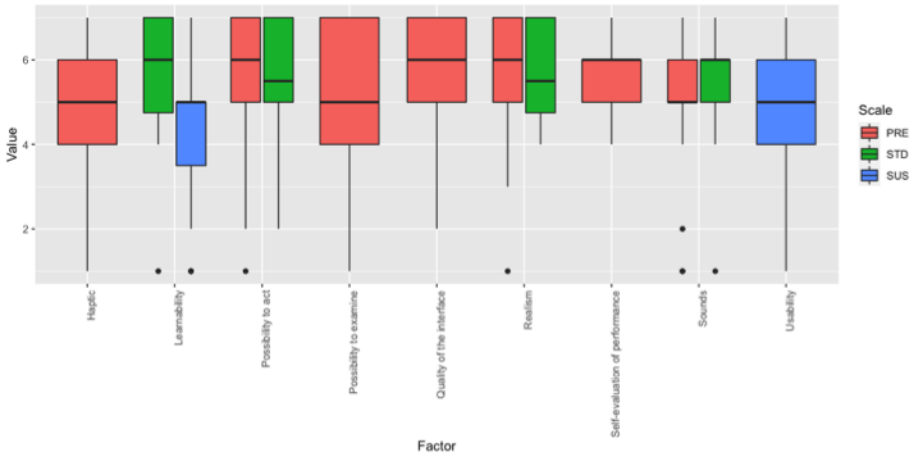


Fig. 5: Boxplot depicting the results of the three questionnaires (N=12) consolidated in the known SUS and PRE factors.

assess each questionnaire's internal consistency. The overall result was good at a = 0.827 (N = 12). We investigated further the results in terms of the known SUS [32] and PRE [65] factors. This structure is reported for SUS as usability (all questions except 4 and 10) and learnability (questions 4 and 10) [32]. For PRE the structure of factors includes realism (questions 3, 4, 5, 6, 7, 10 and 13), possibility to act (questions 1, 2, 8 and 9, quality of the interface (questions 14, 17 and 18), possibility to examine (questions 11, 12 and 19), self-evaluation of performance (questions 15 and 16), sounds (questions 20, 21 and 22) and haptic (questions 23 and 24). We included the study-specific questions in these factors as follows: realism (questions 1), sounds (question 2), possibility to act (questions 3, 4 and 5) and learnability (question 6). The results are summarized in Figure 5 and show that higher average scores are on factors: realism (M = 5.65, SD = 1.19), possibility to act (M = 5.60, SD = 1.35) and quality of the interface (M = 5.75, SD = 1.27). Conversely lower scores are on haptic (M = 4.83, SD = 1.52) and learnability (M = 4.69, SD = 1.92).

Finally, the study-specific questions showed that the App was not intruding in the experience (where you looking at the whales or the App?) with mean 5.58 (s=1.24). Users also reported an above average perception of the importance of the sound provided by the App via the hydrophone with mean 5.42 (SD=1.62). Users also reported liking to report the sightings (M=5.83, SD=1.03) and classifying the sounds (M=5.82, SD=1.70) both with higher mean values than gathering cetacean photos (M=5.58, S=1.16). Finally, users were almost balanced in terms of their experience with citizen science (M=5.50, SD=1.88).

5 Conclusions

Research efforts examining the opportunities to use entertainment technologies to promote environmental protection and ecological consciousness from users is a growing area of interest in research. In this paper, we expand previous work in trying to augment the experience of whale watching using a combination of sensors with a mobile application. Our App allows whale watchers to actively participate in reporting the sightings, sound classification, and media gathering while staying at a safe distance from the animals, so as not to induce stress in the cetacean. Here we report our first attempt to test such a system by combining known usability and presence scales with some study-specific questions to understand how fulfilling this new entertainment experience is. We asked 12 participants to conduct several activities, including (i) report a sighting, (ii) classify a cetacean vocal call, and (iii) gather a cetacean image.

We summarize our results against the know factors of the SUS and PRE scales. We observe that factors such as "quality of the interface", "possibility to act" and "realism" have higher mean values. While factors such as "haptics" and "learnability" have lower mean values. Although our study included the minimum number of participants required for validity of these scales (12), and our results are valid in terms of reliability and internal consistency, we would like to expand the sample to understand further how to evaluate these complex experiences. Future work includes comparing the results of the overall experience with and without the whale watching App and integrating environmental awareness scales into the evaluation framework. Another potential avenue for research emerging from this work includes designing applications that promote offshore whale watching experiences, either using holographic displays or combining sound and video from previous experiences. Ultimately our goals are to expand the state of the art in novel entertainment experiences that lie within this space of environmental conscious and sustainability in what we framed as eco-centric design [40].

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