

# Animal Computer Interaction: Otters and Beluga Whales Project

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## ABSTRACT

Aquariums have long been a source of happiness and memories for people and children; however, the health and wellness of these animals is not always clear. We often talk about designing for HCI (Human Computer Interaction), but often glance over animals as a "user" of technology. However, animals and especially intelligent animals can often be a beneficiary of wearable (and playable) technology as a means of tracking health, performance, and other KPIs. Georgia Tech's FIDO project [3] was able to discern changes in health for dogs using the ideas above, however, this can be further implemented in tracking the play behavior of sea otters and their interaction with certain toys as a means of monitoring behavior and identifying anomalies. The Animal-Computer Interaction Lab has already conducted an exploration into this technology through a partnership with the Georgia Aquarium, and our team looks to carry forward their research providing novel approaches and solutions to previous pain points.

Keywords: Sea Otters, Animal Computer Interaction, Wearables

## 1 AIMS AND OBJECTIVES

Our main objective as a team is to develop a prototype of a new toy that resembles Kelp which is a material familiar to Sea Otters and one which they have been empirically shown to play with. The development of this prototype can be broken down into a few discrete steps:

1. **Field Research:** Initially our team needs to conduct research centered on identifying *how* sea otters naturally play with kelp. This will inform the design of the physical toy as well as decide which sensors need to be embedded in the toy in order to capture the full range of interaction.
2. **Theoretical Design:** The theoretical design component of this project involves creating a sensing pipeline for the sensors that will be incorporated into this toy, designing the physical toy itself, and solving the extremely pertinent technical challenge of creating a

robust data transmission and storage facility.

3. **Physical Design:** The physical design of this project is critically important given the use case. Firstly, this toy is intended to be used with Sea Otters which in turn means that it has to be physically robust, the materials need to be food grade, and also the technology needs to operate optimally amphibiously.
4. **Implementation and Testing:** This project has real world applications and the performance in that real world scenario will inform iterative design changes. A critical component of this project is getting real world feedback through user feedback.
5. **Maintenance:** Optimally, the system would eventually be deployed in a way that requires low/no touch from the team at Georgia Tech. Correspondingly, that depends on an intuitive data analysis and reporting framework.

## 2 BACKGROUND

Animal Computer interaction is part of the natural progression in computing as a domain of knowledge. Designing systems for animals presents unique challenges, but also presents unique opportunities in communication, research, and beyond. The field seems new but has roots in history. Animals have been used (ethical concerns aside) in research experimentation mostly in Skinner's operant conditioning, Pavlov's classical conditioning, and beyond [1]. The process of designing complex computing systems for animals presents unique challenges. Namely, one can't provide an animal an operating manual for a technology or conduct interviews to get vital user feedback. These complications make the process of field research even more important. Even though this field of work presents challenges the potential outcomes justify the additional work. As conservationism and animal advocacy becomes more mainstream it is the right time to consider how to use animal-centered technology as an additive tool to improve life expectancy and quality of life in animals, not unlike similar technologies for humans. Certain animals have a special place in the animal-human symbiosis have a special place in our hearts, and for them the benefits of creating a way of communicating and creating shared understanding is critically important [1]. Overall, design for animals is not dissimilar to design for humans [1]. Humans benefit from health tracking software, and benefit from creating communication tools. If our team could take inspiration from the designs already implemented to help humans, we could see the same benefits for animals of all shapes and sizes. Such an idea has picked up at the Georgia Institute of Technology with the FIDO project, or Facilitating Interactions for Dogs with Occupations [3]. This study faces similar issues to human wearable technology in ensuring easy, appropriate usage for the user that can transmit valuable information once collected. In this case, occupation dogs alert their owners of notices by activating sensors on their own bodies [3]. This technology therefore explores the struggles of wearable technology through a different type of user that will help identify ways of ensuring successful animal-computer interaction with our own testing group of otters. By the same idea, a large portion of this study will base its methods on the research done to explore occupation dog health factors such as stress through interaction with toys [4]. Toy and experiment design will be considered when developing such design for experimentation with otters. Smart toys that measure interaction

levels for sea otters are currently in development. A prototype of the toy was filled with food and was given to the otters to play with [7]. The otters proceeded to play with the toy by smashing it to get to the food, and the accelerometer inside the toy was used to collect data on the otters' interactions with the toy [7]. Through testing, the SD card in the toy did become loose after the otter shook it vigorously [7], so this is something we will have to keep in mind while designing our toy.

## 3 OUTCOMES

Our outcomes come in two forms, the questions that our design process will answer along with a physical prototype:

1. Fundamentally we aim to answer the question of how otters interact with objects in their natural environment along with the movements and actions of their interaction. From here we can design a sensing pipeline to track those actions.
2. Another question our design process aims to answer is the data transmission problem. The existing research conducted by the lab had complications with data storage and the environment of interaction (underwater) presents complications with real-time data transmission. Therefore, our team aims to provide a robust data pipeline that can operate for extended periods of time without loss.
3. The physical prototype of a novel toy based in existing otter-object interactions is the marque product of this project and should contain physical sensing components, accompanying software, and be built to the specifications of the environment.
4. Lastly, our team intends to conduct some usability testing and prototyping into the extension of this project and provide insight into how an interface can be created for the holistic application intended to be used by employees at the aquarium.
5. Throughout this process we will maintain thorough documentation in order to inform future work on this project.

The large-scale outcome of this project is to adequately explore the problem space of otter-toy interaction and provide a solidified and codified plan for future development.

## 4 CHALLENGES

The Otter Health Sensor involves many challenges ranging from structural to biological. One of the issues limiting the previous sensor was memory and structural integrity [7]. This issue arose from the energetic use of the toys by the otters; the memory card being used to track data was shaken loose during the activity, thus limiting the time of the data collected [7]. One may ask if the memory card is needed in a building that is guaranteed to have Wi-Fi connectivity, however the necessity arises when considering how signals and data can be affected when devices are underwater. Trying to find the ideal balance between storage and data transfer due to this limitation will be important to the final sensor. The structural integrity of the components of the sensor are not limited to electronic, they also include material enclosure. As mentioned, otters can be very energetic and can damage surroundings or devices/toys they are using, thus an enclosure must be able to handle the stress and strains that the users put on it. Furthermore, this enclosure must still be waterproof while being able to handle the pressure at the bottom of the pool. Another consideration that must be made is energy consumption and battery needs, the toy must be mobile as there are dangers associated with having a cable powered solution such as choking and electrical hazard. These are all important challenges; however, the greatest issues will be addressed when researching what real world behavior our toy will try to gather information from. Any object or animal our project tries to emulate will need to have a predictable interaction pattern with the otters such as biting or swinging around which the rest of the structural, memory, and sensing requirements will be determined by. Luckily, CS 4605 has taught us information on how to approach many of these problems, specifically memory and discerning behavioral patterns. Information learned on location and localization technologies has inspired ideas for using signal strength for methods of data transfer such as Wi-Fi that could be paramount when fixing the sensors memory problems. Information gained from sensing techniques will also be used to try and create the ideal form of data collection.

## 5 PROJECT PLAN AND TIMELINE

The project plan and timeline were developed with discrete steps detailed as part of our aims and objectives. The general team timeline will move as follows with these steps:

- Weeks 8 - 9: **Field Research**  
*Deliverable: Background Information*
- Weeks 9 - 10: **Theoretical Design**  
*Deliverable: Theoretical Design*
- Weeks 10 - 12: **Physical Implementation**  
*Deliverable: Physical Prototype*
- Weeks 12 - 15: **Application Testing**  
*Deliverable: Presentation and Demo*

Accommodations for when things go wrong are granted in transitional periods between major steps (Week 9, Week 10, Week 12). The Week 9 buffer allows for time when transitioning from field research to theoretical design should we need to gather more information before moving on to any designs. The Week 10 buffer allows for more time transitioning between theoretical and physical design in the situation that more thought needs to be put into physical design, such as changing specific features or sensor placements, before legitimately creating the physical toy and potential wasting resources. The Week 12 buffer allows for time when transitioning from physical design implementation to application testing in that there is additional time should implementation of the physical toy run longer than expected. We believe this buffer will satisfy development needs as it allows us time to work with the product while also not taking too much and avoiding iterative development through user testing. This is followed based on Agile methodology and recommended ubicomp practices [5, 6]. The general team timeline will guide team members during their own independent work and should be followed first and foremost before any individual planning. Changes to the overall team timeline will be made as a unit based on need with individual tasks changing on an independent as-needed basis.

## 6 REFERENCES

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## 7 APPENDIX

**Figure 1.** Gantt Chart - view the full chart here

