

A Framework for Animal Slider Interfaces

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ABSTRACT

Animal-computer interaction interfaces have mostly focused on tactile interfaces or simple button driven digital interfaces. Here, we present a familiar interaction that has not previously been adapted for dog users. The slider is meant to determine the efficacy of different kinds of feedback as well as the complexity of interaction a dog can achieve. The framework we developed collects usage data including touch paths and durations to quantify the dog's experience.

Author Keywords

Touchscreen; framework; user interface; animal-computer interaction

INTRODUCTION

Touchscreens are ubiquitous in our daily lives, from our phones to our watches we have made great use of touchscreen displays to explore many use cases. Good touchscreen interactions are the focus of much HCI research because of its ubiquity. As with most other forms of technology though, interfaces have been developed with a human audience in mind. However, dogs are frequently able to take many complex tasks upon themselves and have demonstrated ability to interact with touchscreen displays among other technologies [1,2,15,16,18]. With the rising field of ACI, more and more interfaces will be designed for animals on touchscreen devices. Though, which interfaces can be transferred between species and methods for evaluating these interfaces from an animal's perspective is relatively unknown. This problem severely limits a designer's ability to design an application focused on the user. Fortunately, cognitive scientists have found new interest in the domestic dog and the field of Animal

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Computer Interaction is growing so previous attempts and insights can be used.

Animal Cognition

Animal cognition research has recently recognized dogs as being worthy of study. Now, the perception of dog cognitive abilities has improved so much that many researchers use dogs exclusively. There are several contributing factors to this relative ubiquity of domestic dogs as study subjects. One such factor is that obtaining subjects is easy as a large part of the population owns dogs and cognitive studies have low injury risk. Additionally, all one needs to run a dog study is an empty room [10].

With the increase in dog cognitive studies, more evidence has arisen of dogs' reasoning abilities. Aust et al. investigates inferential reasoning in dogs by providing dogs a set of stimuli known by the dog to not give a reward and one unknown stimuli. This is accomplished using a touchscreen interface with icons both known and unknown by the dog. They found that dogs chose the unknown icon when there were two known poor icons and were less likely to attempt the unknown icon when a good icon is present. This is evidence that the subjects were able to reason that if the other stimuli are poor choices, the unknown one has a higher chance of giving a good result. In addition to giving some evidence of dogs' cognitive ability, this experiment also illustrates that dogs are able to assign some meaning to digital interface parts [1].

Range et al. added to the evidence of dogs' discriminatory ability by evaluating dogs' categorization performance when introduced to images with different items. The study uses a touchscreen on which dogs are shown images with either only landscapes or only dogs which are categorized by the subjects with high accuracy. To ensure the dogs are not identifying the full image but its contents, a photo editing tool is used to extract the dogs in the images and post them over the landscape images. This led to a decrease in accuracy however categorization was well above random chance indicating that dogs are able to discriminate objects in a two dimensional representation [13].

Cognitive science may give an indication of dogs' abilities to use existing technology, but one must consider not only

if an animal can use an interface but also if the interface is properly designed for the animal. This is the thought in human technology that led to the rise of Human-Computer Interaction (HCI) as a discipline within computer science, and now it has extended to Animal-Computer Interaction (ACI).

Animal-Computer Interaction

Technology has long been the new evolutionary force for humankind, allowing us to no longer need to adapt to our environment but create environments amicable to us. Companion animals have enjoyed some of the comforts afforded to us, even if tangentially so, such as air conditioning, clean water, and complex medical procedures. However, all user-centered technology is developed for humans, with little thought given to the animals we live alongside. One may argue that this is because animals lack the skill to make proper use of tools created for them, to which one can point to studies that find animals make and even exploit human tools for their ends [6]. Service animals have been trained to take on tasks that are difficult for their handlers to perform such as operating light switches or washing machines [9]. Ultimately, it seems that animal-centric technology has not been created not because of a lack of skill on the animal's part but because of a lack of urgency to enhance animal lives with technology.

This is not to say there have been no technologies developed for use by animals: automatic milking machines, GPS collar trackers, and interfaces used for behavioral experiments are all technologies that have been in use for decades [3,5]. Additionally, consumer devices ostensibly made for companion animals have also appeared on the market in the form of teleconferencing systems, automatic feeders, etc. with the promise of improving the animal's life. All these technologies, though, are created by humans to enhance their ability to work with the animal or care for it and does not enhance the experience or activities of the animal in any meaningful way.

In all these technologies, the animals have little input during the development process. Humans are making the devices in the way that best serves their needs with only some consideration given to the animal using it. Key questions from HCI are therefore ignored when development is shifted to animal users. Rather than questioning how the interaction would influence the animal's capabilities, activities, and experience we think in terms of how it will affect the owner's life.

The discipline of ACI hopes to change the state of animal centered technology and make animals key participants in development. As HCI researchers pioneered this field, they brought their core user considerations and made them principal to the field. Of the considerations brought from HCI, the most important is that of user experience. User-centered and participatory design are also key components of HCI that are core tenants of ACI [4,11]. There are many more roadblocks for these considerations in ACI as there is

no obvious objective way of obtaining an animal's opinion on an interface.

Another major obstacle in developing with animals is that humans by necessity are the ones developing the interface. This creates a disassociation between the proponents and intended beneficiaries. It is arguable that the interests of humans and other animals are not always aligned and are often in direct competition. Also, human interpretation of animal interests is significantly biased with the human's experiences and world views. Lawson et al. argues that the inability of animals to easily communicate their thoughts on an interface or design leads to technology that is exploitative. [7]

To overcome these obstacles, several frameworks have been proposed to conceptualize the animal interaction with technology and their involvement in the design process. Resner extended traditional design concepts to develop a remote dog training system. [14] Paci et al. and Mancini et al. reviewed interaction design principles to improve animal biotelemetry wearability and accessibility of canine interface. [8,12]

Animal Interfaces

Byrne et al. introduced an interface that is mounted on the dog's harness which vibrates on either side. This study found that dogs can be taught to discriminate between the vibrations and react with some action when prompted by the motors. This study not only introduced a usable interface but also gave insight into some unexpected considerations that need to take place when developing and testing interfaces. This is especially true of dogs who are able to quickly learn triggers, even if subconsciously expressed. [2]

Zeagler et al. presented another wearable device that is mounted on the dog's harness. This device has a capacitive sensor on either side that the dog can touch with its nose for communication purposes. Through subsequent trials, it was found that the sensor could be accidentally activated by a dog's ear or surrounding environment. This was an interesting finding as it gives more information to more considerations that need to be taken when working with dog physiology. [16]

Most relevant to this work however, is the work done by Zeagler et al. on an emergency alert system that is operated by a service dog when at home. The authors identified several pitfalls when designing a digital interface for dogs. First, that a capacitive touchscreen after some use will become non-responsive because of accumulated slobber. To fix this, an infrared-based touchscreen is advised. Additionally, it was discovered that a constantly emitting display such as an LED monitor is preferable to say a projector which, because of its method of color emittance, caused the dogs to lose the button positions. Finally, the authors find that larger buttons are preferable as the dog is

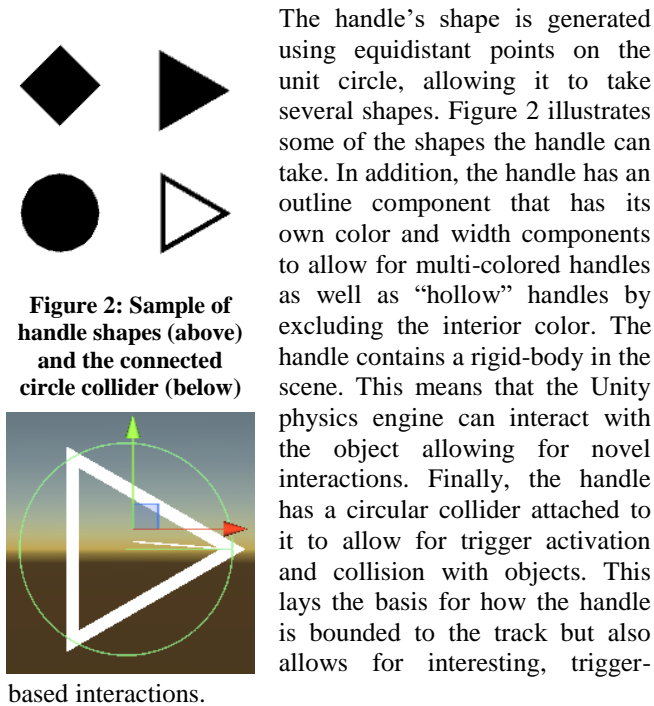
interacting with its nose and therefore does not have a full view of the screen. [17]

FRAMEWORK

This framework provides a means for creating a slider interface in many configurations with the purpose of exploring optimal means for animal interface creation. It is meant to be approachable and require little development overhead. It is a way to quickly create proof of concepts for sliders and test efficacy. The Unity game engine serves as the base of the application and can be configured both in the editor and at runtime.

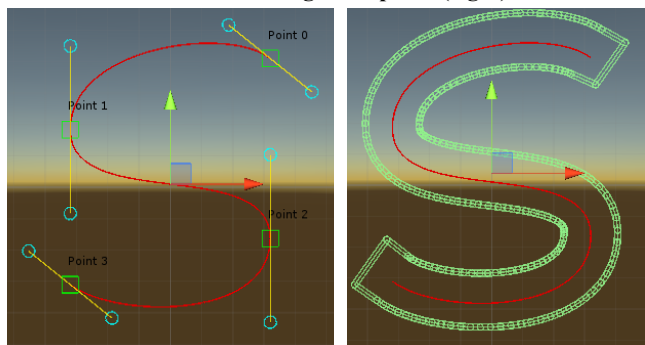
Slider

A slider is made up of two major parts, the handle and the track. The handle is the main interaction point that the user selects and drags along the track. The track is the path the handle must follow and determines the complexity of the interaction.



The track is developed such that a designer can quickly

Figure 3: Slider shape configuration using Bezier curves (left) and the resulting "bumpers" (right).



create any linear shape they wish and not be constrained to a straight line. This is accomplished by using Bezier curves. A Bezier curve is created using an arbitrary number of anchor points with associated tangents. When being rendered the algorithm samples points, at a provided resolution, between each anchor point on a line that curves to match both tangents. This algorithm allows the track line to be nearly limitless in configurability. In this custom implementation, when the curve is being drawn "bumpers", linear colliders, are placed along the outside of the slider. The distance of these "bumpers" from the edge of the track is configurable to allow for varying degrees of stringency.

Configuration Menus

The framework provides two main interfaces by which the slider can be configured. One inside the Unity editor and one that can be displayed during runtime. The configuration menu in the Unity editor provides more options but requires the program to be stopped and rebuilt. The in-game configuration allows for quick changes to the interface during runtime but with less options that are more cosmetic.

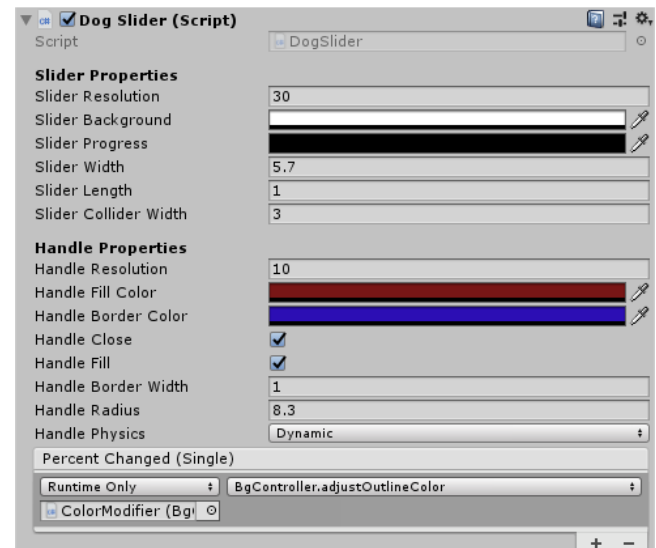


Figure 1: Configuration menu for slider in Unity editor.

The Unity configuration menu, as seen in Figure 1, exposes top level aspects of the slider and handle properties. This allows the designer to have less overhead while still having fine-grain control over the interface. Here, the designer can determine several cosmetic aspects of the interface as well as functional aspects such as the stringency of the track path and some physical attributes of the handle. The designer can also attach self-made scripts that make use of the percent value of the slider as it changes. This interface especially provides quick turnaround for interface feedback implementations.



Figure 5: Runtime configuration menu

The second configuration menu presents itself as a hamburger menu that is activated using the button at the top left. This allows for quick cosmetic modifications and variations to be tested. Figure 5 shows the interface and the actions available to the user. Even though it does not provide fine-grained control over the interface, researchers can quickly determine what sizes and colors the animals respond best to. Additionally, this menu is separate from the slider and is fully extendable to add

options relevant to a certain feature or use case.

Metrics

An important aspect to ACI is the collection of metrics that can provide insight into how the animal feels about the interface. In this framework, metrics are collected with a focus on touch events.

The events are collected as each interaction takes place. When the first click event occurs the starting point and time are logged. If the touch event begins to drag along the screen, the path of the event is tracked at a given framerate. Finally, when the touch event ends the time and position are logged. While at first this does not seem like significant data, this allows us to determine what interactions looked like on a particular interface and how long it took the animal to complete it.

To prevent costly file-access time interfering with the ongoing interactions, interactions are placed into a FIFO queue that is written to file and cleared either after it reaches some maximum size or after a certain number of frames pass.

RESULTS

The efficacy of this framework for the design of animal-centered interfaces is tested by developing multiple interfaces that we believe to be interesting and could reveal insights into animal cognition and interactions.

Shape

An interesting observation that we have about humans is that they can apply concepts they have previously learned to understand new experiences they have. This extends to serious modifications of a well-known interface such as the slider. A human can understand what a slider is and how to use it even if it is strangely shaped, though we are unsure if dogs have the same cognitive ability. To this end, we create several sliders in increasing difficulty of interaction that will hopefully give some insight into an animal's ability to form and abstract concepts. The first shape is a simple linear slider, on which the animal is to be trained. Second, is a U-Shaped slider which is meant to be an intermediate step that will challenge the animal to apply their learned

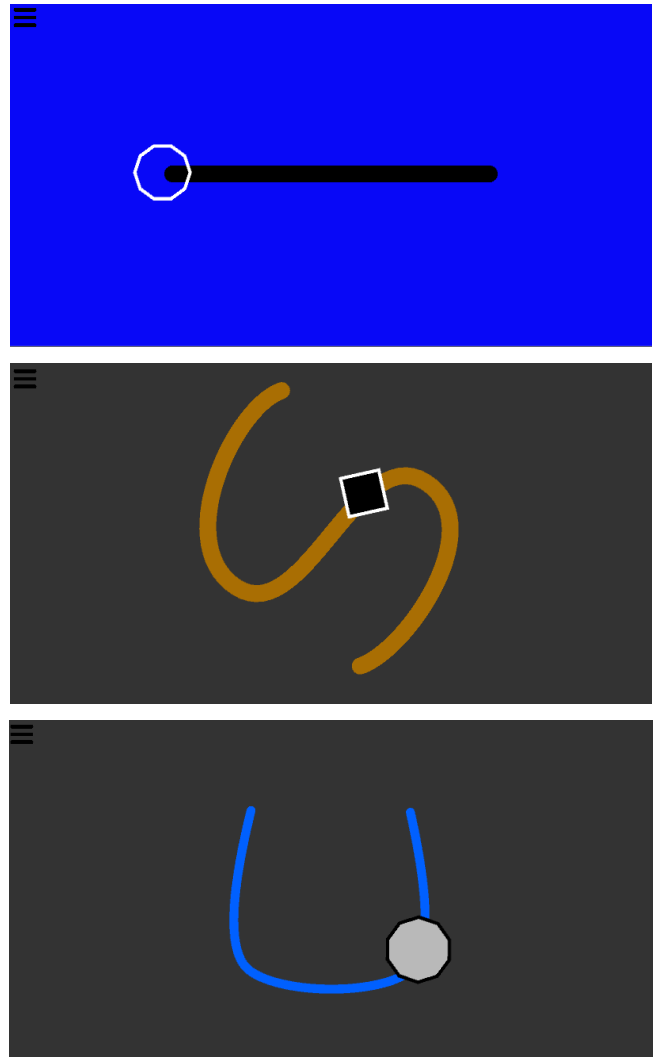


Figure 4: Example slider implementations created using the framework.

slider concept to an unfamiliar shape as well as introduce them to the idea that the shape can be curved. Finally, an S-Shaped slider provides a very difficult concept that would be presented without explicit training to study their ability for concept application.

Handle Configuration

Much of the configuration options of the handle serve the same purpose as the track configuration, however handle variations can also explore other ACI principals and cognitive abilities. First, a triangle shaped handle can provide a directionality to the interface, and by training the animal on a directional interface and then modifying the directionality we can determine an animal's responsiveness to suggestive design. Second, the concept of closure can be tested by training the dog on handles that have a center and then making them appear hollow and measure success rate and the locations of touch points and how they differ. Finally, it is unclear that when training a dog to use a touchscreen whether they understand that the projected

images represent actual objects or if they view the screen as an inanimate wall on which they act. We believe this arises from the screen interaction having no tactility and thus they don't consider the images to be representative of anything. The final handle configuration aims to explore whether adding physicality to the handle increases the dog's interaction with it. Examples of adding physicality includes retaining velocity after release or applying gravity to it. Additionally, this interaction could be useful for training easily distracted dogs to use the touchscreen as the movement could intrigue them.

Color Feedback

To illustrate the ease with which the slider framework can be augmented and to develop a truly interesting concept. We developed a feedback mechanism that interpolates the color of various parts of the scene based on the progression of the slider. Here, all we needed to do was create a script with functions that took floats between 0 and 1 as input and apply the percent changed event to them.

The idea behind this feedback method is that the animal will respond more to visual stimuli than others. In this interface, we have three possible settings for what item will change color. The first two is the handle and slider track, which when viewed from the human perspective makes sense. However, as the animal often interacts with the touchscreen using its snout, the change could be missed or misunderstood. To remedy this, another function changes the background of the entire scene which even when the animal is close by would be noticeable as it envelops its peripheral.

DISCUSSION

The development of interfaces that are natural to animals is still a problem in ACI. The major issue is how to incorporate animal feedback into design. HCI can hold focus groups and gather input on design mockups but ACI researchers need to build interfaces before beginning to obtain usability and preference data. This dynamic severely impacts the rate at which HCI principals can be studied on animals and the cognitive limits of animal interaction can be quantified.

The tools of interaction design are understandably designed with the elements suited for and familiar to humans and are not often made to be expanded upon. This was made especially clear after the first development attempt in which we aimed to use an existing UI library and modify it for our needs. It soon became clear that to create a robust framework, it needed to be built from the bottom up.

In considering the look and feel of the interface it is more useful to think in terms of what animals will notice or find interesting. For example, dogs are often distracted by movement in their environment, therefore to keep their attention we give the handle the ability to be affected by forces the dog intuitively understands like gravity. Also, changing the entire scene's background as the slider moves

along the track may seem unappealing to human users but for dogs it may prove to be a necessity.

Traditional touch screen interfaces are designed for beings with fine motor skills and digits. Dogs and other animals obviously lack this and thus animal centered interfaces need to be able to scale to the animal's size and form of input (paw vs snout).

Other concerns focus on the fact that there exists a language to interfaces that humans have learned that dogs do not possess intuitively. Through our time with computer interfaces it has become naturally intuitive for a human to know what a scroll bar does, or that an "X" would close something. When developing interfaces for animals we can no longer assume that the user knows these. For example, it's not immediately obvious that animals have a natural preference for sliding. Even with humans this is unclear as western societies feel more natural swiping left to right, following how we read, while other societies may be more comfortable sliding vertically or from right to left.

FUTURE WORK

First, with this framework created we hope to use it to create and study more interfaces that will give us insight into ACI principals and animal cognition. Second, the framework can serve as a model for the creation of more frameworks that implement other UI aspects like navigation. Third, the metrics from this framework will need to be studied for their efficacy and to see if more granular information will need to be collected. Finally, this framework could be integrated with an automated reward system to encourage interaction and perhaps give insight into a dog's learning process without direct instruction.

CONCLUSION

Research based on dogs, technology, and touchscreens has been in the works for a long time. With this project, we wanted to expand on the current research by creating a framework with which a variety of interfaces can be created to see how animals react and interact with them. This framework allows for fast prototyping allowing researchers to test dogs' capabilities with different interfaces to find what works best. By accelerating the prototyping process, ACI and cognition insights are more achievable. This opens the possibilities of what dogs will be able to do with technology in the future. Service dogs, police dogs, and even our pets can already aid us in so many ways, and with the progression of this research our companions will be able to take on greater roles in our lives and in our society.

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