Increasing Captive Elephant Exercise with Automated Feeders

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Abstract

The purpose of this research is to promote increased exercise for elephants in zoos. This research aims to design and construct an automated feeder, which will allow for the randomization of elephant feeding times in zoos. Coding will be implemented into the design of the automated feeder in order to research elephants' responses to secondary positive reinforcement. Knowledge about how elephants can be conditioned to respond to music and food cues via secondary positive reinforcement may be a step towards decreasing human-elephant conflict near farms in Africa.

1 Introduction

Elephants present a threat to the lifestyle and wellbeing of farmers in Africa. Adult elephants are capable of eating up to 600lbs of food per day, and a main source of this food is crops from farms. Crop raiding describes when elephants invade farms and eat the crops. This can account for a large loss of profit for farmers. As a result, the farmers will attempt to harm or even kill the elephants. The overarching goal of the project is to develop a mechanism that will protect farms in Africa from elephants in a manner that is humane, affordable, and lasting.

Elephants are extremely intelligent animals. Many methods that have been used to keep elephants out of farms have been unsuccessful due to elephants' amazing problem solving abilities. Using a combination of solutions may prevent elephants from habituating to a solution. The team looked at using the combination of a chili fence and a threatening noise to deter elephants away from a desired food prize. Both chili fences and threatening noise have been studied independently with limited success. It is hypothesized that a combination and/or rotation of the two solutions may increase their effectiveness. This experiment seems promising, and the team is hopeful that it can be carried out in the future.

Another experiment that the group designed is to use positive reinforcement in the form of a feeding device to encourage elephants to move away from farms. A positive or neutral sound would play indicating the release of food in an area far away from the farm. The team will be testing this experiment in a modified form at Zoo Atlanta, which is discussed below in the background section for Spring 2020. Positive reinforcement has not yet been tested, and may offer a plausible solution to crop raiding. However, there are cons to positive reinforcement that need to be recognized. Feeding wild elephants may teach the elephants to rely on the feeding device and could be viewed as a domestication of the animals. Furthermore, feeding elephants is not affordable. Therefore, using positive reinforcement in the form of a feeding device is not a long term solution to the problem.

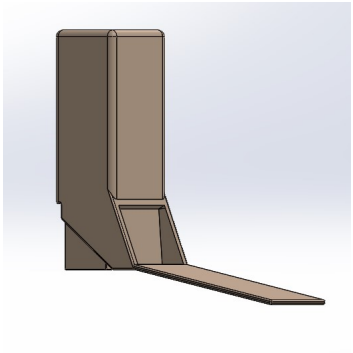
In addition to benefiting wild elephants, this research also seeks to benefit elephants in captivity. A major concern in elephant husbandry and management is that captive conditions may not encourage the same degree of exercise as that of their natural conditions. Elephants in captivity have been reported to much shorter distances on average than their wild counterparts, and may be restricted in their movements due to space (Genin et al., 2010). In fact, a recent body condition index determined that nearly three-quarters of North American zoo elephants were classified as having body condition suggestive of being overweight or obese (Morfeld et al., 2016). This sedentary lifestyle has other impacts on the zoo elephants' heath, one major concern being their predisposition to foot problems. Exercise has long been recommended as a major method to rectify this, as while the environmental conditions do have an effect, healthy feet require exercise of all joints, tendons, and ligaments (Lynch, 2001). In American zoos, foot care and exercise programs have been made mandatory–the latter often involving engaging the animals in staff-directed exercises such as A to B's (directed walking from point A to point B), calisthenics, and stretches (Greco et al., 2016).

Therefore, the focus of this project for the past few semesters has been developing an experiment using secondary positive reinforcement. In this experiment, a sound is assigned to each elephant. When the elephant's sound is played, if they correctly respond and go to the location where the sound was played from, they will receive food as a reward. The hope is to increase elephant exercise using music and sounds as a secondary positive reinforcement. Due to COVID, the testing of this experiment has been delayed. However, the team has transitioned to modifying an existing horse feeder to implement in the experiment in place of zoo keepers. The focus this semester was to modify the design of the feeder and begin constructing it.

2 Results

2.1 Elephant Feeder Mechanics

The design of the feeder proposed last semester proved to be a challenge as it was over engineered and not practical for repeated use. The design was made to be simplified down from a catapult design into a slide design where the food would be dumped into the enclosure from a higher elevation. To begin designing this slide, specifications had to be take on the existing horse feeder in which this slide is to be fastened to. There was no scale present to weigh the feeder but the basic dimensions were able to be obtained by using a tape measure. The overall length x height x width are as follows (25.5in x 73.5in x 24in). These dimensions allowed the slide to be made in alignment with the bottom of the feeder in which was made to be 2ft by 8ft. Next the height that the slide must be angled to had to be obtained and was found by sliding elephant food down the decline and noting what was the minimum height the slide could be angled at while still successfully depositing the food into the enclosure. It was found that 32in is the minimum height needed to allow for a successful feeder, thus the declined slide should be angled at 19.5 degrees. A solidworks model of the feeder with this declined slide can be observed in



3 Discussion

3.1 Software

Last semester, the idea of implementing a software portion to the feeder was introduced; in this way, the feeder could work on a timer that was powered by an Arduino that would help avoid time lags in the experimental design and make the product more efficient and desirable for the zookeepers. To reach this point, a starter code was developed with a breadboard connected to ensure that the Arduino could initiate a pumping method for the pneumatic actuator at the given time intervals.

However, when re-evaluating this design and considering the newly proposed elephant feeder and its mechanics, this purpose of the Arduino was no longer necessary. Furthermore, the slide could be elevated at such an angle that the food could be dumped into the elephant enclosure, such that it would not need to be activated by the pneumatic actuator connected to the Arduino. With this simplified design, the new goal of the software team is to implement a Raspberry Pi to assist with the automation of the experimental procedure of the project.

The Raspberry Pi can be coded with Python to act as an alarm clock that creates a sound using downloaded mp3 files at inputted time intervals. The Pi can be connected through a breadboard to a speaker; this would make the experimental aspect of the project more systematic and desirable. Furthermore, another goal of the Pi is to use it for the feeding process of the elephants; thus, the Pi should be connected to an arm on the feeder that triggers food to fall when the sound is played. With these implementations, the experimental procedures can be entirely automated and much more efficient.

3.2 Future Engineering

The declined slide design was selected as the best possible design modification for the feeder as it provided the least amount of moving (and thus breakable) parts with the food distribution step and it should be relatively easy to assemble and replicate. As of now, only the slide is completed, but all of the specifications for the height the feeder must be lifted to and angle the slide must decline have been gathered. The only remaining engineering that needs to be completed is creating a base for the feeder to sit on that has a maximum height of 32in and a means of fastening the slide to the feeder. The feeder is relatively heavy so a sturdy base is needed to ensure it does not tip; a large concrete encasing will probably be used here. In addition, the slide will probably be fastened with ring links threaded through holes on both the feeder and slide allowing for the slide to give if interacted with by the elephants or environment.

4 Conclusions

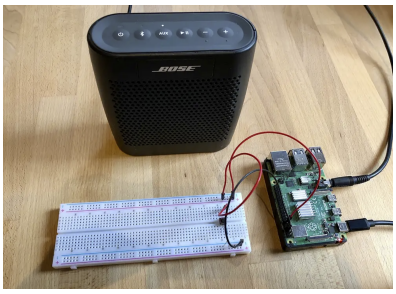
4.1 Elephant Feeder

This research found that the horse feeder can be modified to function as an automated feeder for elephants by adding a slide and elevating the feeder. A slide made out of plywood and covered in Teflon sheets enables hay to fall down with limited resistance. The feeder should be elevated to 32in in height and angled at 19.5 degrees.

4.2 Secondary Positive Reinforcement

Currently no research has been conducted with the elephants to analyze their response to secondary positive reinforcement. However, it has been concluded that the elephant feeder can be used in conjunction with a Raspberry Pi to conduct the research on secondary positive reinforcement. The raspberry pi can be connected to a speaker and trigger the automated feeder to release food, therefore simulating the methodology of the proposed experiment on secondary positive reinforcement.

5 Supplementary Materials



```
import vlc

vlc_instance = vlc.Instance("--input-repeat=999")
player = vlc_instance.media_player_new()
song = vlc_instance.media_new("/home/pi/Music/song.mp3")

player.set_media(song)
player.play()
```

The above pictures demonstrate the software of our project. On the left, the Raspberry Pi is connected to the speaker to act as an alarm clock for the experimental process. The Pi is able to play music as the starter code on the right with Python uses uploaded mp3 audio.

6 Acknowledgements

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