ACOUSTIC & VISUAL ORIENTING ARENA

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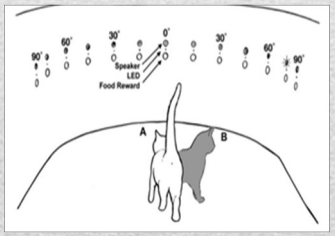
ABSTRACT

Dr. Tom Yin of the University of Wisconsin-Madison Department of Physiology has requested the design and construction of a feline acoustic and visual orienting arena. A similar arena has been used in previous studies. The goal of this design is to increase automation of the testing in an attempt to reduce human influence on results that may have been present in previous studies using this technique. Dr. Yin will use the arena as a control experiment for his current research question. Over the course of the semester the design team has put together design matrices for food choice, valve options, and switch options. Through collaboration with the client, decisions have been made on these options. Using the optimal choices for the design matrix, the team constructed and installed the acoustic and visual arena.

BACKGROUND

The client is seeking to determine what region of the brain is responsible for sound localization. This will be done using an implanted "cryoloop" that cools part of the brain until it becomes inactivated, then the cat will be placed in an orienting arena that requires the cat to locate the sound and move towards it (Malhorta et al. 2007). In order to test his hypothesis the client has implanted cats with internal coils and determines a vector for the direction of gaze with the use of an AC magnetic field. These sensors will allow the client to determine if a cat can locate the direction of a sound by only shifting its gaze towards the sound. The client would like to be able to replicate a separate experiment in which the cat is mobile and moves toward the activated speaker rather than just shifting its gaze toward that speaker. In order to perform this separate testing the client requires the construction of an arena with speakers located at different positions that the cat can walk to and receive a reward if it approaches the speaker that generated the noise. This experiment is meant as a control for the client's current research.



Visual orienting arena used by Lomber et. al. (1999). Each point is 15 degrees apart and contains a speaker, led, and food reward.

Cryoloop used by Lomber et. al. (1999)

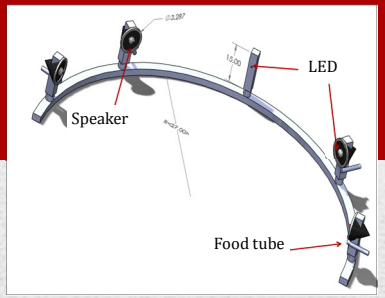
MOTIVATION

There are two major design flaws in the previous design:

•Human input was required twice while the experiment was being run, once to force the cat to focus on the center of the arena and again to administer a food reward.
•Because of the permanently fixed speaker location, there was the possibility of the cat to locate sound from memory instead of pure sound localization. Fixing these design flaws by making the system more automated and allowing for speaker adjustments is the focus of this design.

DESIGN CRITERIA

CLIENT SPECIFICATIONS
•Design must be fully automated during the length of each individual replicate.
•The speaker that is turned on for each replicate must be randomly generated.
•After each replicate a second replicate must run without the need for human assistances
•Each speaker must be adjustable in its location around the arena and the arena should accommodate the use of more than four speakers, if necessary.
•The design must accommodate materials that can be manually cleaned easily.
•Materials used need to be non-ferromagnetic to avoid interference with the internal eye sensor.
•The design must be durable enough to easily handle 100-200 replicates in a testing session.



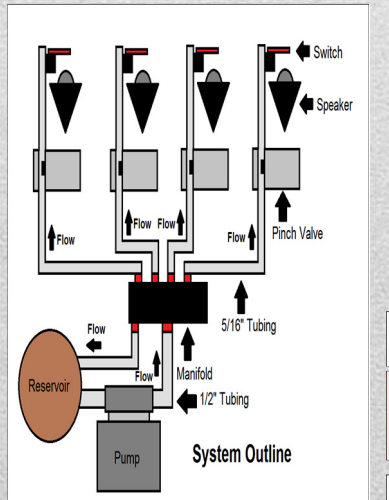
SolidWorks diagram of the 4-speaker general setup

Masterflex digital drive to drive peristaltic pumps within the setup, pump will deliver food to each speaker location with variable flow rate

FINAL DESIGN

The final design included two main components: physical design to actually create the arena, and programming design to determine how all components would work in unison

PHYSICAL DESIGN
•Four-speaker arrangement each with the ability slide along a raised, slotted hemi-circular track cut out of plywood
•Each speaker mount is attached using a 90 degree aluminum bracket
•Each speaker mount is adjustable to every position in the 180° hemi circle except 30° from the middle on either side where supports are located
•The speaker mounts are adjustable to two different heights, 10in. and 11in
•There is a switch located directly in front of the speaker and when correctly pressed activates the food reward
•A supply tube runs out of the sound proof chamber and connects with a peristaltic pump that pumps the food to the cat when the correct switch is selected



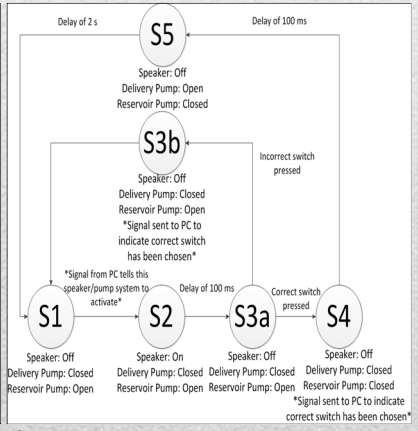
System outline of switch, speaker, pinch valve, manifold, pump and reservoir setup

FINAL DESIGN

Speaker mount attached to plywood hemi circle and switch located directly in front

Four speaker mounts located along the slotted plywood at 30,60,120,150 degrees. A post with an LED is mounted directly in front of the cat at 90°

ELECTRONIC DESIGN
•Solenoids are used to activate pinch valves
A "Hold Circuit" is used to minimize power use by the solenoid
•Transistor switches control both speakers and pinch valves
•An Arduino microcontroller is used to activate the transistor switches
•The microcontroller communicates with the PC via asynchronous serial communication over a USB port



State transition diagram to initiate test, determine if correct choice is made, and then administer reward

FUTURE WORK

- Replace normally open pinch valve to normally closed
- Perform Fast Fourier Transform on speakers
- More speaker mounts to increase the system to eight speaker locations

ACKNOWLEDGEMENTS

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