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# RADIO CAT COLLAR SYSTEM

## CAT TRAINING RESEARCH

Research has shown that cats do not respond to corrections the same way as dogs do. Where as a dog has a hierarchical pack mentality that humans can take advantage of, cats are more solitary creatures. This means that correcting a cat the same way you correct a dog will not work. Correcting a cat requires you to immediately correct the cat as it performs undesirable behavior. Repeated corrections will be needed often to discourage the behavior as cats will attempt the actions until they are repeatedly stopped and loose interest. For example, if you have an indoor cat that is trying to get outside, repeatedly stopping the cat from succeeding will discourage the behavior while even once letting the cat out will encourage the behavior and possibly destroy all previous training (see Escaping on <http://fanciers.com/cat-faqs/behavior.shtml>).

Also, physical harm would not be an efficient way of training a cat. As backed up by the veterinarian interview, the research showed that hitting a cat just teaches fear and does not correct behavior. (see Cats Inside on <http://fanciers.com/cat-faqs/behavior.shtml>).

For the purposes of this project, it is important to note the audible ranges of cat and human hearing. Cat hearing is 45 Hz to 64 kHz and human hearing is 64 Hz to 23 kHz. As humans are susceptible to hearing loss of repeated loud sounds, such as a rock concert, cats are even more sensitive (<http://cats.about.com/od/healthfaqs/f/hearingsense.htm>).

## CUSTOMER NEEDS

Two Outdoor cats are fighting, one owned by the customer, the other by a neighbor. This behavior is to be discouraged by a sonic device that will be worn by both cats. This allows both cats to roam unrestricted yet if they come face to face, discourage coming close enough to fight. Ideally a low power, small and lightweight solution is envisaged, so as to fit on a cat's collar and not need battery replacement or recharging often. Possible use of rechargeable or standard batteries should be appreciated. Due to the hearing sensitivity of cats, a volume control will be needed. Because of volume control, it may not be possible to use frequencies outside the range of human hearing, as owners will want to hear how loud they are making the device for the cat so as not to hurt the cat.

The system concept is to have 2 collar devices, one on each cat, that respond to each other. Either one or both makes a startling sound that scares away both cats. The devices should be able to emit a warning sound about 10 feet away from each other and emit a 'startling' pulse of noise starting at 5 feet from each other.

## PROFESSIONAL OPINION

A Veterinarian's opinion was necessary to determine some cat behavior and for reliability in research results. Three offices local to Rochester, NY were contacted for assistance. Dr. Sarah Gebbie of Suburban Animal Hospital returned our call and kindly answered our questions.

The offices contacted were as follows:

1. Suburban Animal Hospital - (585) 334-4230
2. Companion Animal Hospital - (585) 424-2900
3. Banfield, The Pet Hospital - (585) 272-8046

Dr. Sarah Gebbie was interviewed and the following opinions and suggestions were formed:

- Human hearing range would probably be best due to the need of volume control.
- Startling noises should be used, something to surprise the cat. This translates into a low duty cycle sound, such as when an owner yells 'STOP!' or 'NO!' or the cat's name.
- Tones are currently used on dog collars and could be adapted for cats.
- Other deterrent methods to keep cats from fighting are using vanilla extract behind the neck. This makes the cats smell similar and makes them seem unified and less likely to fight. Also, Pheromone products are used as wall plug ins, making the cats feel more calm and friendly. These products are odorless to humans.
- Electric shock collars are made for offender cats in multi cat households.
- A dog collar technology for bark training that might be worth looking into sprays the face of the animal with a citrus scent to annoy the animal and discourage a particular behavior.
- Both sent based and collar based products are used primarily on indoor cats and the recommended approach for outdoor cats is to keep them indoors. Sent based products might not be usable outdoors.

## MARKET RESEARCH

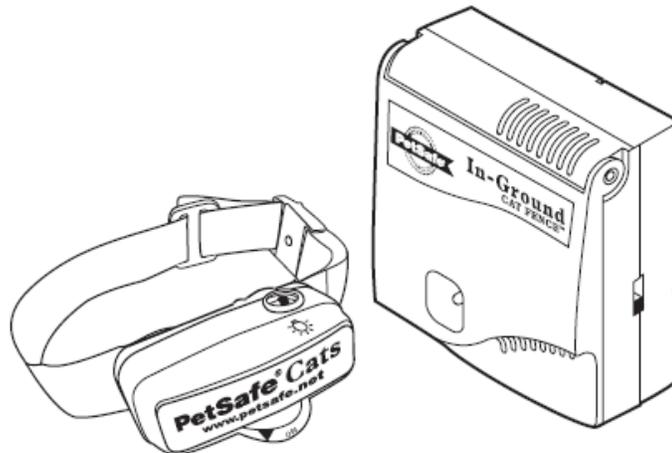
Systems used to repel or train cats are not very common on the market. However few systems exist and are very similar to the dogs systems which are much more common.

Two types of systems exist:

- System using static impulsion on the skin of the animal
- System using ultrasonic transmitters

## STATIC IMPULSION SYSTEMS

One example of this kind of systems is produced by PetSafe. It's a fence system which allows the cat to stroll around peacefully in a fixed perimeter. When your cat reaches the Warning Zone, the Receiver Collar gives a warning beep. If your cat continues into the Static Correction Zone, a safe Static Correction will be delivered through the Contact Points to get his attention until he returns to the Pet



Area.

Figure 1: PetSafe Fence Collar

## CONCLUSION

Although the reviews of this system seem to indicate that it is an efficient system to annoy cats, it doesn't really provide a "safe" way to do it, because the main objective is to hurt physically the cat to make him understand he did something wrong.

## ULTRASONIC SYSTEMS

Cats have a very interesting behavior towards sounds because their frequency hearing range is more extended than the one we have. Humans are able to hear from approximately 64Hz to 23KHz. Cats on the contrary have an extended range from 45Hz to 64KHz, which is also larger than the dog's range (65Hz to 45KHz).

Based on this fact ConTech has developed a system which emits an ultrasound noise in order to make it avoid the watched zone by the sensitivity sensor.



Figure 2: ConTech CatStop Ultrasonic Outdoor Cat Deterrent

## CONCLUSION

Based on the large amount of mitigated reviews found on this specific product (on amazon), we are not sure that this is a reliable solution for this system. It seems that this solution using ultrasounds doesn't affect all the cats with the same efficiency. It provides sometimes a very good solution to annoy the cat but it sometimes seems to be completely inefficient. However, most of the users have encountered a significant improvement of the efficiency of the system after few weeks of usage.

## COLLAR BASED SYSTEM

<http://www.hitecpet.com/hushpuppy.html>

This is a dog training collar that uses tones to discourage barking. It has an adjustable input sensor for the dog's voice, and adjustable output speaker to tune to the dog's hearing, and is light weight.



Figure 3: HUSH PUPPY Sonic Bark Control Collar

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## CONCLUSION

This technology shows that it is feasible and possible to develop a system to emit noise in a lightweight package using standard batteries. The design team should look into the technology of such devices. However the same issues with cats ignoring the sound might occur as with the previous device.

## GLOBAL CONCLUSION

Both of us agree that **a sound system should work** to separate the two cats.

The professional opinion that we received lead us towards sound that belong to the human hearing frequency spectrum. In addition to this advice, such a system would allow the user to adjust the amplitude of the emitted sound and then control easily the impact of the collar on the subject while being sure that the sound won't be painful for the cat. On another hand, the main issue with this system doesn't concern the subject itself but the owner of the cat because using the hearing range of humans could make this system very unpleasant.

The second option found was the use of ultrasonic systems. The reviews made on the system created by ConTech indicate that the use of ultrasound works to annoy cats. Although this system seems more interesting for the ownership because he won't be disturbed by the noise, it seems that its efficiency is not immediate and could vary with the subject.

We consider that one of the main needs for the customer is that the system doesn't have to be unpleasant for him. Since then **we recommend to use a system that operates just above the 23 KHz frequency** which is considered the limit of the hearing spectrum for humans.

## POSSIBLE IMPLEMENTATION

In this part we have listed some ideas which could be used for a possible implementation. However it's just a suggestion showing that such a system is feasible to realize.

### SPEAKER

The generation of the sound could be done using a high frequency speaker. Most of the tiny speakers sold on the market provide a output frequency range which belong to the human frequency range and doesn't exceed 20KHz.

However the company Kobitone has designed high frequency speakers and some of them works at 25 KHz, which match the suggestion we did. These speakers don't exceed 2.5 cm of diameters and are therefore tiny enough to take place in a collar system.



Figure 4: Kobitone Ultrasonic Speaker

Since the amplitude of the emitted signal should vary depending on the distance between the transmitter and the receiver, a controller is required to assure this feature.

The ultrasonic speakers created by Kobitone are only available on [mouser.com](http://www.mouser.com), because mouser seems to be the official distributor in the US.

Kobitone provides 4 different speakers at 25 kHz. The most interesting ones are the smaller ones, which have a diameter of 15.7 mm.

For example the [255-250SR16P-ROX](http://www.mouser.com/ProductDetail/Kobitone/255-250SR16P-ROX/?qs=sGAEpiMZZMuNFJvCI6tQp%2fJ6O6f0fAmx2lg0RprvSo%3d) speaker is interesting for its tiny size compared to the other ones.

(<http://www.mouser.com/ProductDetail/Kobitone/255-250SR16P-ROX/?qs=sGAEpiMZZMuNFJvCI6tQp%2fJ6O6f0fAmx2lg0RprvSo%3d>)

## RF TRANSCEIVER AND CONTROLLER

The communication between the two collars should be done with a RF transceiver. Texas Instruments has developed some Low Power RF System on Chip (SoC), combining a microcontroller and a transceiver for low power applications.

Combined with a chip antenna, this circuitry should be small enough to be embedded into the collar.

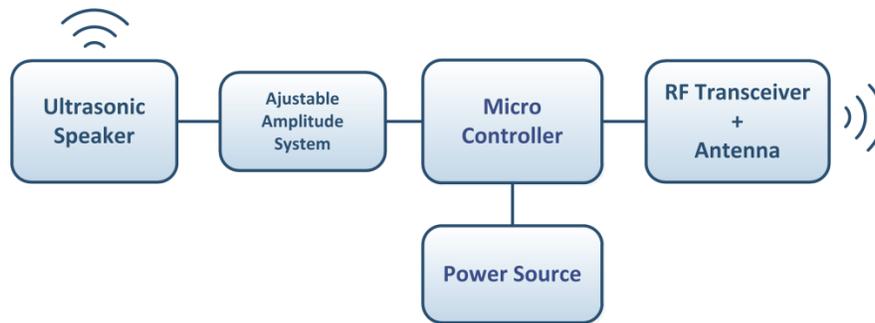


Figure 5: Suggested High System Level Block Diagram

Three families of SoC are currently offered by Texas Instruments:

- The CC111X Family which combines a 8051 processor with a ChipCon sub 1GHz transceiver [http://focus.ti.com/paramsearch/docs/parametricsearch.tsp?family=analog&familyId=935&uiTemplateId=NODE\\_STRY\\_PGE\\_T&startIndex=11&endIdx=16#rt](http://focus.ti.com/paramsearch/docs/parametricsearch.tsp?family=analog&familyId=935&uiTemplateId=NODE_STRY_PGE_T&startIndex=11&endIdx=16#rt)
- The CC253X Family which combines a 8051 processor with a ChipCon 2.4 GHz transceiver [http://focus.ti.com/paramsearch/docs/parametricsearch.tsp?family=analog&familyId=936&uiTemplateId=NODE\\_STRY\\_PGE\\_T](http://focus.ti.com/paramsearch/docs/parametricsearch.tsp?family=analog&familyId=936&uiTemplateId=NODE_STRY_PGE_T)
- The CC430 Family which combines a MSP430 processor with a ChipCon transceiver at 20 MHz <http://www.ti.com/corp/docs/landing/cc430/index.htm?DCMP=CC430&HQS=Other+BA+cc430-bthp>

Each of these families is designed for low power wireless communication and can be used with different wireless protocols (ZigBee, RF4CE, SimpliciTI). These protocols allow a point to point communication with a specified identifier for each point. **In this case, the system will not interfere with another wireless system and therefore avoid false alarm.**

The main differences between these 3 families are the frequency used, the type of microcontroller and the possibility to use USB (functionality offered by the CC2531 and CC1111 SoC).

The frequency chosen for this application won't be an issue because the system needs a small range. The 2.4 GHz frequency will create higher path losses than the Sub 1 GHz but it won't be an issue for the application. I can say that without amplifier and with the maximum output power allowed by the transceiver you can reach 200 meters with the CC2531 system on chip.

Since the system won't need USB **we would personally recommend the CC430 family** which seems to have lower power consumption.

The **CC430F5135 SoC** with 16kB of Flash and 2 kB of RAM would be a good choice for the application. It's right now available on Mouser

<http://www.mouser.com/ProductDetail/Texas-Instruments/CC430F5135IRGZT/?qs=sGAEpiMZZMvix4Kz%252byXAvecYYbbVG05x>

Datasheets and Design notes can be found on Texas Instruments website at the following address:

<http://focus.ti.com/docs/prod/folders/print/cc430f6135.html>

Texas Instruments offer some reference designs with the CC430 family based on the CC430 Wireless Development Tool (EM430F6137RF900).

<http://focus.ti.com/docs/toolsw/folders/print/em430f6137rf900.html>



Figure 6: Texas Instruments CC430

## PROXIMITY SENSING AND ADJUSTABLE AMPLITUDE

The proximity between the transmitter and the receiver could be processed from the signal strength signal called RSSI which is often given by the transceiver as information in addition to the data we want to transmit. In this system no additional data should be necessary, so the only information useful must be this RSSI signal.

The adjustable amplitude of the speaker should be controlled by the microcontroller and another system between the uC and the speaker, which will certainly contain an amplifier. This system needs to be designed by the MSD team assigned to this project.