Early Explorations of CAT: Canine Amusement and Training

Chadwick A. Wingrave
University of Central Florida
Department of
Electrical Engineering and
Computer Science
Orlando, Florida 32816 USA
cwingrav@eecs.ucf.edu

Jeremy Rose
University of Central Florida
Department of
Electrical Engineering and
Computer Science
Orlando, Florida 32816 USA
eklipsej@gmail.com

Todd Langston
Pack Life K-9 Behavior Solutions
Canine Behavior Expert
http://ocpacklife.com
Orlando, FL 32817 USA
todd@ocpacklife.com

Joseph J. LaViola Jr
University of Central Florida
Department of
Electrical Engineering and
Computer Science
Orlando, Florida 32816 USA
jjl@eecs.ucf.edu

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Abstract
Cross-species computer applications have a history of blended science and humor, despite the real potential for improving the canine-human bond. New activities available to humans in the electronic age can be used to improve this bond. By using a serious games approach, this project motivates the human to spend time with their canine in healthy and informative ways. An iterative design process, with a canine behavior expert, has produced a prototype focused on calm, healthy and enjoyable games for both canine and human. Formative results and guidelines are reported, as are current and future directions.

Keywords
Serious games, cross-species, canine, training, dog

ACM Classification Keywords
H5.m. Information interfaces and presentation (HCI): Misc.

General Terms
Design, experimentation

Introduction
Maintaining a balanced, happy, healthy canine requires exercise, life-long training and an informed human

owner. This takes time and knowledge however, and today's canine has to compete for a human's time against the distractions of TV, streaming videos, music, gaming, online worlds, social sites and general Internet browsing. Without working on the human-canine bond, it will become stressed, resulting in unhappy canines, unfulfilled humans and at worst, a canine relinquished to a shelter. For those canines relinquished to a shelter, the largest factors reported are canine behavioral issues along with owner knowledge deficits [7].

The Canine Amusement and Training (CAT) project was created to reclaim time for the human-canine bond, with a set of real-world, cross-species, calm, mini-games focused on teaching the human how to interact and train their canine, while emitting calm and controlled energy. This is not about automating exercise and play, such as by a treadmill or automated ball-thrower, or serving purely human needs, such as Internet monitoring. This is a tool to allow the canine to join the human in electronic gaming to produce happy and well-trained canines and humans.

A set of problem questions were derived to guide the design of the approach:

- How do we make games that both humans and canines enjoy, motivating quality bonding time?
- How do we make games that teach humans to train canines in ways canines understand?
- How do we design a game cheaply that can potentially be disseminated for a real impact?

Using a serious games approach [6], the same technologies that entertain humans are enlisted to bring the canine and human closer. Considered key to the success of this project are the motivating factors of games, externalization of human anxiety through physiological measures, physical interaction for exercise, useful instructional content and collaboration with a professional canine trainer for canine-centric design (a trainer interprets for the canine).

Background and Related Work

This work touches on several topics with each unified by the motivational aspects of serious gaming [1].

Canine Relinquishment

According to the Humane Society of the United States, between 6-8 million canines and cats enter animal shelters each year [3]. Comparisons between relinquished canines and randomly sampled canine-owning households showed that the most important risk factor was failure to enroll in a canine obedience class [8]. In addition, the same study showed that households that relinquished a canine were nearly twice as likely to think they needed advice on canine behavior.

Canine-Human-Computer-Interaction (CHCI)

CHCI games need to serve the needs of the canine as well as the human in species-appropriate ways [5]. Canines need physical activity, human interaction and healthy behavior training. Humans need to be entertained and taught how to properly interact with their canine (physical activity is a plus!). While examples of CHCI in the past have invoked ideas of good-natured fun [4], they do not necessarily address the needs of canines and humans. In fact, games that

use a computer to mediate the canine-human interaction can lead to anxiety or confusion in canines if not careful. Games and activities that allow one-sided interaction such as remote fetch, feeding, treadmills and web monitoring [2,4], support some human needs but not necessarily those of canines.

Canine Training Philosophy

Our canine behavior specialist provided the training philosophy of the project. This philosophy was achieved through a study of psychology, energy healing and training in a pack of 20 rehabilitated canines with an apprentice of Cesar Millan (the Dog Whisperer). The philosophy focuses on the creation of a strong human leader, confident and aware of what their energy and body language communicates to a canine. For this to occur, the human must learn to communicate with their canine through the rules of the pack; that is, in ways that canines communicate and to communicate calmly, with patience and balanced energy. A human that understands their canine and behaves properly will raise a well-behaved canine. Force and food rewards are not motivators in this philosophy (no canine has been witnessed handing out doggie treats to other canines for proper pack behavior!).

PROOF OF CONCEPT

A proof of concept was created to explore the design space, to communicate our ideas and elicit greater feedback when approaching potential collaborators. This was necessary as canine behavior experts and animal shelters are not necessarily familiar with the potential of 3D applications.

Commodity hardware was used in this design. A 55" TV sat on a table for the human while a projector was mounted on a tripod and projected on the floor for the canine (see **figure 1**). To interact with the system's 2D interface, the user held a spatially convenient device [9], a Wiimote, used to emulate a mouse and control the games. A stereo surround speaker system was used for spatial sounds.

figure 1: Pictured is the proof of concept setup. The screen on the right is the game's interface and a projector is mounted on a tripod and a Wiimote is mounted higher in the environment on the ladder.

Two canines participated in this evaluation and due to their sizes, were instrumented with two separate sensors (see **figure 2**). Both sensors were attached with a custom harness made of Velcro and spandex. Canine A was a beagle/foxhound mix and was large enough to support a Wiimote in the harness. Canine B

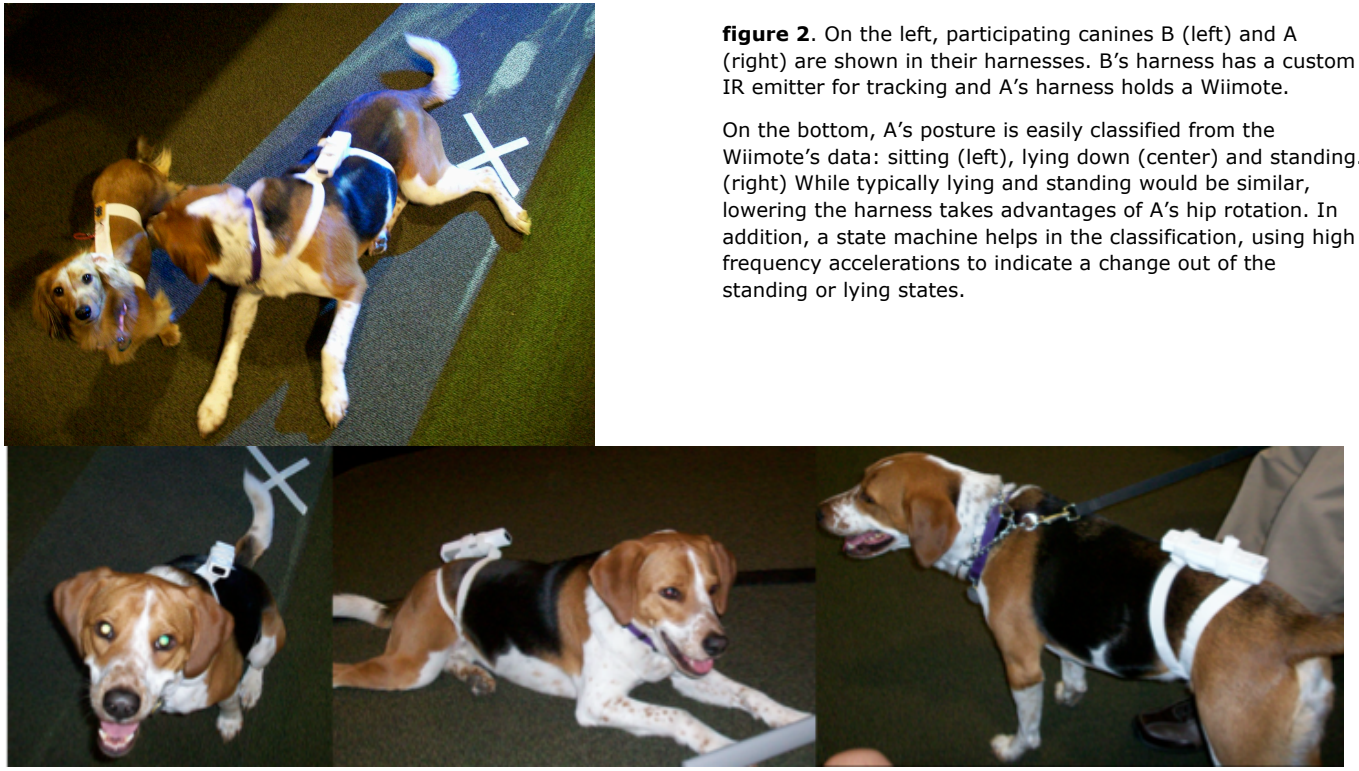

figure 2. On the left, participating canines B (left) and A (right) are shown in their harnesses. B's harness has a custom IR emitter for tracking and A's harness holds a Wiimote.

On the bottom, A's posture is easily classified from the Wiimote's data: sitting (left), lying down (center) and standing. (right) While typically lying and standing would be similar, lowering the harness takes advantages of A's hip rotation. In addition, a state machine helps in the classification, using high frequency accelerations to indicate a change out of the standing or lying states.

was a mini Dachshund, too small to wear a Wiimote so a custom IR emitter was created of 7 IR LEDs and powered with a 9V battery. This emitter easily transfers between harnesses, attaching by Velcro. The emitted IR was tracked using a ladder-mounted Wiimote.

Tracking of canine B's harness was achieved by a simple linear registration step between the projector and Wiimote's coordinate systems. In the registration step, single "X" targets were projected on the ground at the corners of the projection. We used an IR emitter with a switch to emit a single pulse over each target that was registered with the Wiimote's IR camera. This was repeated for all corner targets and a linear scaled mapping created.

The initial set of tasks included basic training commands, tag and a chase game. For the training commands game, the game issued commands for sit, stand and down. The time it took for the canine to respond was recorded and used to score the canine. The various states of the canine were identified by

manually classifying the features in the accelerometer data of the Wiimote [9]. For the tag game, a target was displayed on the ground for the canine to chase. When the canine neared the target, the projected target was moved to a new location. Scoring was the time it took to tag the targets. In the final chase game, the target animated between positions. For both the tag and chase games, the target was green and purple, colors visible to canines, and jittered and pulsed so as to be more attractive to chase.

The proof of concept was shown to a local animal shelter operator and a canine trainer (the third author). This resulted in project interest, collaboration and several suggested improvements. First and foremost, the games were very human centric and potentially damaging to canine behavior as the tag and chase games motivate a canine to chase reflections and other shiny lights. Second, the emphasis on speed can increase the levels of canine anxiety, also contributing to poor behavior. Third, the tasks were doing little to teach the canine calm behavior or to listen to the human. Lastly, it was suggested we track human anxiety as canines respond to this. Technical issues were also identified:

- The keystone effect of the projector created a poor projection, limiting floor projection.
- Canine A did not chase projected targets, possibly due to the breed and the lack of scent in the targets.
- Canine B was small so classification of the canine's movements during training commands was difficult.
- There was poor tracking accuracy due to the Wiimote's angle but canine B's short stature reduced this.

PROTOTYPE

With these new ideas, our proof of concept experience and new collaborators, we created new games, healthier for the canine, informative for the human and yet still motivating and fun.

Prototype's Configuration

The hardware setup changed (see **figure 3**). The projector moved higher, placed first on top of a ladder and then into the ceiling. This higher vantage reduces the keystone effect and widened the projected field of view, removing the floor projection limitation. Also, the environment-mounted Wiimote was placed directly above the projected area in the ceiling, improving the tracked area's size and accuracy. Lastly, a canopy was added to surround the game space and elevate the cables, removing them from harm. A short throw projector could be mounted to this frame in the future.

Physiological Sensing

Physiological feedback is being collected from the participants as shown on the left in **figure 3**. A ProComp respiration sensor is used to capture breathing rates and an I-CubeX BioWave captures skin surface voltages of the brow. These are run into a Phidgets board. In the games, the human is made aware of their physiological state through a series of vertical bars showing current activation. A horizontal line distinguishes between user calm and anxious states and the projection changes color if elevated.

figure 3: The current design incorporates physiological sensing (left), a canopy and ceiling projection/sensing.

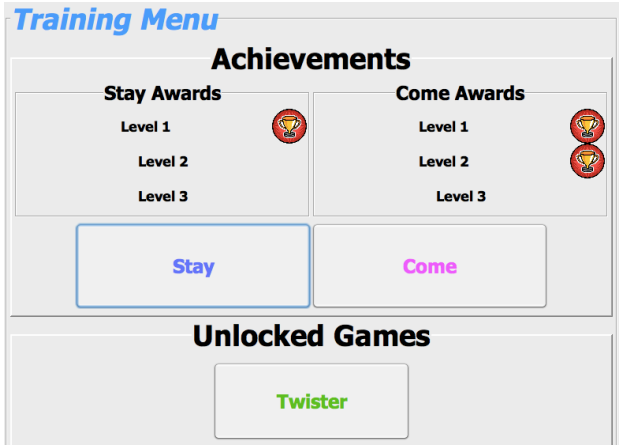

figure 4: Shown here is the tree of games with Stay and Come games showing levels 1 and 2 completed respectively.

Prototype Games

A new series of games was created (see **figure 4**) and by completing simpler games, advanced games are unlocked. Unlocking of game features is commonly used to motivate gamers to continue to play. Importantly, our trainer also told us it can prevent the human from the common practice of pushing their canine too hard too fast, and thus to failure and a poor experience. The first game is Calm and the human must lower their physiological readings, learning to remain calm, making them aware of their emotions for future games.

figure 5. A participant playing the game Stay is standing next to and on the foot and paw targets with the red timer bar counting down on the left, behind the human's legs.

The second game, unlocked when finishing Calm, is Stay (see **figure 5**). In this game, a pawprint and footprint are displayed on the floor for the canine and human to stand on and remain calm. After walking to the spot and telling their canine to sit and stay, the canine must remain motionless and the human calm as a timer counts down. The timer is shown in the corner and displayed in red, a color not easily visible to the canine. If successful, a new spot is given and this repeats. With five successes in a row, a level is completed. Extending the stay times and adding distracting content such as barks, chain rattling, doorbells or other common sounds increase the difficulty. Unlike the proof of concept that was seen as too rigid, only rapid canine movements result in failure so the canine can shift slightly for comfort.

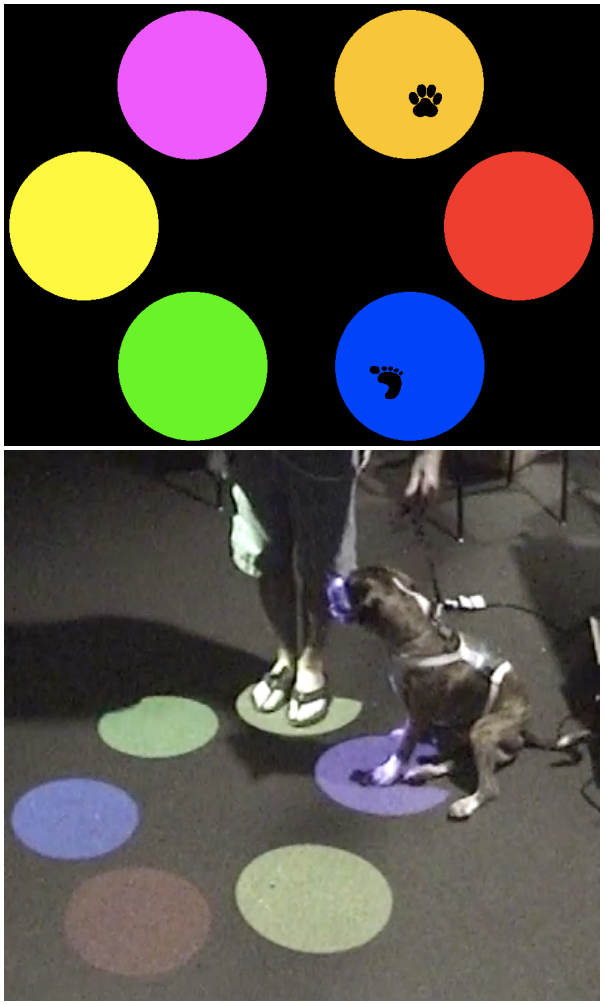

figure 6: The projected Twister (top) board shows where the canine and human stand by a pawprint and a footprint. On the bottom, a participating human and canine play Twister.

The third game, unlocked when finishing level 2 of Stay, is Come. Much like Stay, Come requires the canine to remain motionless and the human to remain calm. However, instead of staying by the human's side, the canine is told to stay and the human moves to a new location as indicated by a projected human footprint. In this way, the canine must "come" to where the human moves them and then stay. The same ways to improve difficulty in Stay can be used for this game.

The fourth game, requiring a completion of level 3 of Stay and Calm, is Twister (see **figure 6**). In this game, colored circles are displayed on the floor, laid out in a circular fashion. When a game trial begins, a roulette wheel sound is made and a random circle is chosen for the canine and human. The human must place their canine on the appropriate circle while they then move to stand on their own circle. As with Stay and Come, the canine must remain motionless and the human must remain calm. Scoring is based upon time and biofeedback, with time reintroduced for human enjoyment, difficulty and motivation.

Evaluation and Guidelines

The current system is undergoing formative evaluations that continue to refine the system and gameplay. Three canines have been evaluated in our system so far, all of fairly high energy levels. The evaluation protocol is to invite the canine and human into the lab, making sure the canine has had all shots, is in good health and has no aggressive behavior. On arrival, the canine is then allowed to explore the lab to reduce canine anxiety and importantly human anxiety about the canine in public. When settled, the canine is leashed and the harness is put on. The game is started and then, only after everything is ready, the human puts on the sensors.

This is performed last so they feel they can respond to the canine if needed.

The games are played in order of Calm, Stay, Come and Twister, with the unlocking feature removed. As the games were designed for long-term use, it was not expected that the canines would complete all levels or unlock Twister. The canine and human play as much as they both are able and when the canine becomes tired, play stops, typically 15-25 minutes. The evaluation is videotaped for later review and post-evaluation interviews are performed.

Participants enjoyed the games as evidenced by outbursts during play. Canines had an uncanny knack at moving at the last possible second, which further enhanced gameplay. Canines were seen wagging tails and showing happy body language. Some guidelines from this experience have been generated:

- Equipment failure is common but amplified by canines. For example, canines like to shake to remove the harnesses before they are used to them. As such, duplicating fragile parts, moving them out of harm's way and looking for ways to play with progressive equipment failure is a good design approach.
- Canines come in various shapes and sizes, not large and small. Though two sizes of harnesses were first created, Velcro extension straps were also used to further fit the different canine chest sizes and position the harnesses properly when they sit.
- The physiological sensors are not always accurate but this does not affect gameplay. So long as the human believes the sensors work, they work to remain calm.
- Humans have many styles of canine training. Canines operate differently on and off leash and not all canines follow basic commands (e.g. sit). The game needs to be adaptable and incorporate the earlier training commands so as to work up to the prototype's games.
- People don't like to receive instruction and instruction regarding their pet can be taken personally. Canine trainers are experts and need to train the researchers. Additionally, in-game tips might be a way to communicate without offence.
- Humans had fun but poor canine performance can feel like failure. Basic games, or games that reward what the canine does know, are needed. For example, one canine was not good at basic commands but had a series of tricks it knew how to perform. These need to be incorporated so success is achieved.
- The focus on calm was successful as even energetic canines were calm. However, the human enjoyment of the game can suffer so energetic periods need to be incorporated.

Conclusions and Future Work

The canine and human relationship can be strained in today's society. A serious games approach seems promising at reclaiming time but care should be taken to make the interaction calm and healthy. *For canine-human games, collaboration with a canine expert is a requirement*! Through rounds of iteration, we have produced a list of guidelines from our experience.

Work continues on several features. A scoreboard to display and track accomplishments, potentially between human-canine gamers, is being created for friendly competition. New physiological sensors are being

incorporated as are the use of multiple Wiimotes to compensate for tracking occlusion. Lastly, we are working with the A.R.F. Shack, a rescue shelter, to disseminate this work.

More advanced gaming features are also being created. This includes collaborative play and non-canine inclusive mini-games for more human-motivating play. A backstory is also being created to weave the mini-games together and allow role-playing in everyday canine trouble situations. This is important as we look for ways not just to build the canine-human bond, but to provide training instruction to humans and teach the meaning behind canine body language. Examples of this include training tips, what canine behaviors mean and how to read aggression and fear in canines. We also are looking at ways to educate humans on handling canine-specific trouble scenarios such as: approaching a canine for the first time, leash handling, jumping, doorways, etc.

The long-term goal for this project is to show the feasibility of a commodity system that can be widely distributed to improve the canine-human bond. Mounting Wiimotes and a projector with a shorter throw distance to the canopy can create a more portable system, taking the CAT project out of the lab and into canine-friendly spaces. We are also looking at ways to quantify canine levels of enjoyment using canine body language for summative evaluations.

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