Is My Dog Watching TV?

Ilyena Hirskyj-Douglas
University of Central Lancashire
CEPS, Fylde Rd, Preston
Lancashire, PR1 2HE UK
Ihirskyj-douglas@uclan.ac.uk

Huilan Luo
Jiangxi University of Science and Technology
86 Hongqi Ave, Zhanggong
Ganzhou, Jiangxi, China
louhulan@sina.com

Janet C Read
University of Central Lancashire
CEPS, Fylde Rd, Preston
Lancashire, PR1 2HE UK
jcread@uclan.ac.uk

Abstract
This paper presents a high-quality method of face tracking dogs from a Human Computer Interaction (HCI) standpoint. Dogs have continually been reported to view television screens but there is diminutive knowledge behind this phenomenon. Research here brings forward the possibility of animals having meaningful interaction with the TV screen and suggests ways to possibly quantify and build methods to create animal-computer-interaction.

Author Keywords
ACI; ACID; HCI; Animal-Computers; Dog-Interaction; CI; Facial Tracking Software; Design; Theory

Introduction
Humans inherently use their hands, body and voice to interact with the world around them outside of computers and yet for the last few decades, and from conception, only hands have been integrated into Human Computer Interaction (HCI) with keyboards and mice. This original philosophy has been challenged and advanced in Computer Interaction (CI), both within the academic world and in the consumer market, with the introduction of body and voice controlled machinery. While the CI for humans becomes more diverse so does the acknowledgement of computers for unintended

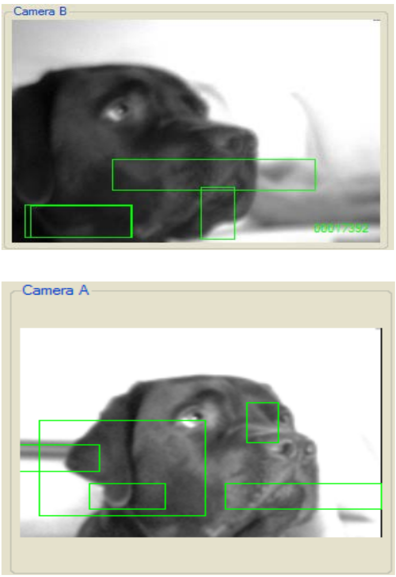

Fig.1: A dog face tracking experiment trying to use FaceLab with unsuccessful boxes of tracking markers

animal users, who unscrupulously use the same machines. With the rise of body governed machinery, could this methodology also be applied to these unintended users to enhance their lives? This paper brings a briefly explored prologue into the inauguration of machines made for humans controlled intrinsically by an animal shared in millions of our homes worldwide: our pet dog(s). This is referred to as Animal Computer Interaction Design (ACID).

Related Work

Animal Computer Interaction Design

The most notable early use of animal-computer-interaction (ACI) was Ham the Chimp in 1961 using levers to demonstrate the ability of task performance in spaceflight [1]. This use of ACI in working animals was continually exploited for the human benefit until recently when a concept has emerged to use the gained knowledge from HCI to empower ACI [2]. This is a simple notion that machines used by animals should be designed, in part, by animals and thus for animals. Dogs have reputably been seen to watch TV, with many researchers trying to unveil the meaning of this interaction [3]. This ACI could gain significance through the analysis of what dogs like to watch by enabling them to choose what to observe. With dogs' primary communication medium being motor-driven interaction, for a dog to use a TV this CI would also need to be head-based eye input and not the traditional human concept of a button operated remote. By face tracking an animal this allows research into a previously observed yet unresearched area, this being the dogs view, into human technology. It was with this reasoning that a baseline project was undertaken to build a face-tracking machine. This would recognize and react to a dogs' movement while watching a TV screen frame worked by previously explored HCI principals. Only through this ACID tactic of dog centered design could the question of 'What does a dog like to watch?' be scientifically answered.

Harts Ladder Framework applied to Dogs

Principals of Hart's Ladder, a model of participation on Children-Computer-Interaction (CCI), can be applied to ACID to quantify the ability to which a dog can design technology [4]. Whilst it is acknowledged that dogs will never reach rung eight (full participation) on Harts Ladder, it could be possible to reach rung three where a dog could be consulted through their behaviour (psychologically rather than vocally). Dogs are incapable to grasp that their feedback has consequences on the design process, but can realize that their actions have consequences on the human side of the design process so can potentially reach higher rung four. Through technology made to record their inputs (such as eye and body movements) dogs could take a greater role in participation, informing not only ACID but also the HCI knowledge base.

Face Tracking

There are many diverse means of Object tracking that have allowed the concept to be used in many applications leading to the subject being an important topic in computer vision with large human face datasets being created for Face Tracking [5]. Object Tracking has become commercially widespread with increasingly low resolution options thus a cheaper solution to computer input. This tracking is habitually done with markers to define certain characteristics (in humans' eyes, nose and mouth) and thus their position in related to the observing object (camera). More recently markerless tracking has been developed based upon

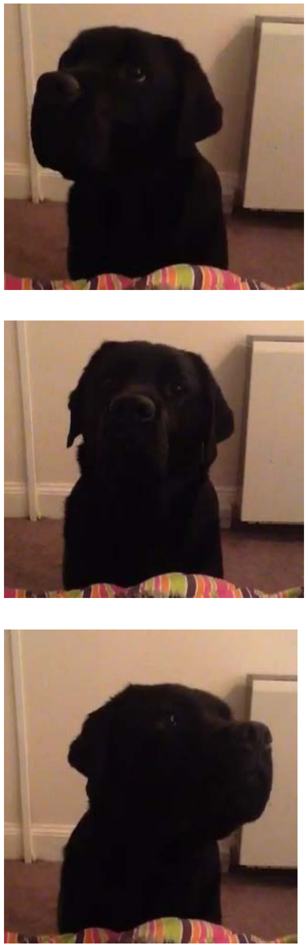

Fig.2. Images show example of the three classification criteria's with the dog for Matlab (Left, Center & Right)

boundaries [6] but once again, like marker tracking, this is also based upon skeleton tracking and the distance between shapes (colour boundaries). As it is the dogs' head, more specifically the eyes that require tracking, there can be, especially in dark dogs, no space (colour change) between the tracked objects. This is not to say this method could not be achieved in dog eye-tracking, but would only work where the dog had particular colour markings so that there could be 'space' between the markers, thus the algorithm would be dog-specific.

Face Tracking in Dogs

Dogs have vastly different and diverse characteristics than humans due to their skeletal structures so previous well documented face trackers, such as the low resolution Xbox Kinect, would not identify their features. In order for a computer to recognize a dogs' whole body movements a system would have to be developed to recognize the features of a dog and/or a dogs' skeletal structure i.e. its joints movements. Despite the above mentioned flaw, eye-tracking has been done on dogs watching images as their eyes having the same light reflecting properties as humans and training the dog to stay static [7]. This method of eye-tracking though is only possible through static training. In practical use therefor this could over shadow the natural response possibly forcing the dog to gaze at the television.

In our work High-end FaceLab face tracker was used to try and track a dogs' eye glare to get the eyes saccades and gazes (Fig. 1). However as mentioned above, even with markers placed on the face, the technology was unable to pick up the dog's features without training a static response. This lack of current technological solution is due to the diffraction of user requirements between humans and dogs. There is a need for a new low cost solution being built with a unique algorithm tailored for the dog rather than the human features.

Implementation

The implementation of recognition required the training of a machine to recognize dogs' features following the same pattern as humans using a Matlab system to create a sum used for classification: sifting features, creating codebook and finally training the system. Firstly a dog was chosen to build a system around and then 630 images of the dog looking left, right and center (Fig.2.), with 210 apiece were gathered. The sift method was then used to extract image features based upon the colour difference, a method in Matlab called "*bag-of-features*". A codebook was then created from these images that instructed the average features of an image to express the image within the classifications (left/ center/right). The concluding step was to utilize the created codebook to quantify the images, therefor effectively training Matlab. In essence the number of images was quantified to make a vector and train the classification system before the system is finally evaluated for accuracy.

Results

The number of randomly selected images for training Matlab were 63 (left class), 63 (center class) and 87 (right class). For training similar numbers were used with 62 (left class), 62 (center class) and 86 (right class).The final system was able to identify images where the dog was watching TV (classification=center) with an accuracy of >82%. Idneification of gaze for left and right was even higher as seen in Table.1. It can be seen that these figures compare well with the current

Class	Accuracy %	Images correctly identified from 210 images
Left	89.0476	187
Center	82.381	173
Right	94.2857	198

Table 1. Data table of Matlab results on identifying images of a dog in three classifications.

Fig.3. Image showing Infrared Thermal image of dog clearly displaying facial features

standard reachable human detection rate of 80% according to what can be found in literature [8].

Follow on Work

Clearly work could be done to strengthen the algorithm by increasing the corpus of images thus also increasing the accuracy of identifiable images. As this initial recognition was only done on one dog a more decisive process of this methodology would be to try the created algorithm with another differently featured dog. Another imperfection in this method is that it is not real-time tracking, which could be done by employing markers and training the classification system upon the marker movement. Tracking could be potentially use Infrared signatures from the dogs as this is relatively similar across the breeds (Fig.3).This method may equally demonstrate that a dog is interacting through testing the videos within the three mentioned classifications. It could also be possible with directional classifications to generate a history map of where the dog is looking for a possible interactive product. However rules would have to be made on how long of an interaction is meaningful interaction and to some extent it would have to be human observed in a 'wizard of oz' paradigm approach. This study of meaningful interaction is the next step for the current research project.

Conclusion

As technology advances for humans, it is only natural that it also advances for those animals that also habituate the same surroundings. This research demonstrates the ability of HCI technology and methodology to be applied to dogs and opens up the possibility of dog controlled machinery for solely their benefit. Using the algorithm made it is achievable to detect if a dog is watching TV (center class) and indeed within three classifications (left, center and right). This project is just one method of tracking a dog, but the interesting point is that you can track dogs and the next step in ACID is to see if they will pay attention and thus interact with the screen.

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