Animal-Human Digital Interface : Can Animals Collaborate with Artificial Presences?

Naohisa Ohta[1,2], Hiroki Nishino[1], Akihiko Takashima[2], Adrian David Cheok[1]

[1]Imagineering Institute, Iskandar, Malaysia. nohtaster@gmail.com

[2] Graduate School of Media Design, Keio University, Yokohama, Japan

Abstract

This paper presents research (work-in-progress) on animal-computer-human interactions. We explore how a computer system can actively mediate between animals (dogs and cats) and humans, aiming for enabling animals to collaborate (interact) with an artificial presence system, as well as with humans through the system. A concept of the system consisting of multi-sensory and active agent functions is discussed. We describe research plans to investigate how animals behave interacting with virtual reality systems and robot agents. An interactive video interface is used to investigate how the closed visual feedback loop (with partial depth cue perceptions) affects animals' behaviors. For interaction with robots, we investigate if we can establish emotional attachment between dogs and robots.

Introduction

Animals (dogs and cats) watch TV and sometimes seem interested in the displayed content [1-3]. A variety of visual media have been used as artificial visual stimuli in animal behavioral research. Some of them demonstrated that animals are able to treat images as real stimuli [4,5]. Other studies have shown that we can use life-size video images successfully for examining dogs' social communicative abilities [6-10]. Zeil [11] discussed that depth cues may be important factors in visual artificial stimuli so that animals respond to video images in the similar way as they do to real stimuli.

A robot agent is another interesting artificial presence that affects animals' behaviors. Animal-like or human-like robots will offer new possibilities in animal computer interactions. For example, in experiments testing if dogs recognize robots as social partners, it was found that dogs responded significantly better to dog-like furry robots than to remotely controlled cars [12]. Another research demonstrated that dogs appeared to develop social links with robot agents (showed sociality), which did not resemble a human, after having observed social interaction between the robot and a human [13].

The above previous animal research on the effects of artificial stimuli suggests that artificial presences could be used as part of animal-human digital interfaces in general. However, we do not know what essential factors are really effective and how much they contribute for a particular kind of animals. There seems to be no systematic research challenging this topic.

This paper describes our research (work-in-progress) to explore how artificial presences (focusing on virtual reality and robot) can actively mediate between animals and humans, aiming for enabling animals (focusing on dogs and cats) to collaborate with humans through the digital interface. Our final goal is to develop a system through which animals and humans conduct a collaborative task consisting of multiple interactions with the interface. The collaborative task is defined as work such as rescue or playful experiences such as new type sports. We introduce our concept, methods and some experimental procedures.

Concept

If a digital interface can induce animals to keep up their interest in artificial stimuli and to pro-actively behave against the stimuli, then we could go a step forward towards the goal to induce animals to collaborate with the

system and with humans, directly or indirectly through the interface. To design such a system, there are many related functions to be considered including animals' multi-modal cognitions.

One of the issues is that animals only keep up their interest in the artificial presence for a short period of time, even if the stimuli are realistic images of the animal's owner, or even if the stimuli are mouse-sized fake-fur covered toys [14]. So it might be difficult for animals to carry out collaborative tasks which may consist of a series of multiple interactions with an artificial presence. As an example, animals are interested in a Skype communication only for a short period of time even if they initially pay close attention to it. This is presumedly due to the lack of multi-modal presences such as olfactory or tactile sense, and appropriate active interaction schemes for animals [15]. In case of PetChatz [16], which is a commercial product, pets pay attention to and stay interested in the system because it has a remote feeding function. This implies that the system should work actively, not just communicating through multi-sensory information channels, but also through changing artificial stimuli interactively to keep the animal's interest up, and finally to induce animals to interact continuously.

We assume a general system model which would consist of multi-sensory communicative functions and active agent functions to affect animals' social behaviors.

Method

We plan to investigate which factors of artificial presences are effective for catching animals' attentions, to keep up their interest, and to induce them to interact consecutively focusing on characteristics of 1) virtual reality systems and 2) robot agent systems. We describe two research areas below.

- Animal's Behavior and Virtual Reality (VR)

Our long-term research will encompass a wide field of VR systems. We will explore how each sensory impression (visual, auditory, olfactory, tactile, and taste) and their combinations affect animals' cognition and behaviors.

Currently, we are focusing on vision in VR, espcially interested in the effect of the closed visual feedback loop as part of a depth perception. Depth perception is an important factor in vision for animals' behavior but usually limited in 2D video images. As Zeil discussed [11], the lack of depth cues and the closed visual feedback loop are potential limitations of video stimuli.

We use an interactive video interface to investigate how the closed visual feedback loop (with partial depth cue perceptions) affects animals' behaviors expecting that the visual feedback would contribute to get animals' attentions and keep their interest up in 2D images. The interface is inspired by our observation that animals are sometimes watching outside through a glass window. From a conceptual point of view, the interface is a subset of "Fish Tank VR" which provides an interactive stereoscopic 3D workspace in front of the display with head-coupled perspective rendering [17]. However, in our study the system's purpose is different from that of Fish Tank VR. We design the interface to provide visual stimuli to animals with head-coupled perspective changes so that they perceive the displayed images as if they see outside through a glass window.

We plan to compare animals' reactions to a video content displayed on a normal 2D display with those to the same content displayed using the interactive video interface. We actually designed the interface considering the following conditions for animals: 1) to provide a smooth feedback that would work at a higher frame-rate (aiming at 60 frames per second), 2) to allow animals move freely without wearing any uncomfortable devices for visualization or sensing.

For the system implementation, we used a game engine, Unity [18]. We controlled a virtual camera in Unity to change the perspective according to the viewer's head position measured by a depth sensing mechanism such as Kinect [19]. As far as video quality is concerned, we considered factors such as spatial and temporal resolutions given in [20]. In our case, we need more display resolution, as the animal usually gets close to the display during experiments. So we use higher quality displays such as 4K (3840 x 2160 pixels) resolution with a frame rate of 60 Hz. While the animal is in front of the display within a certain region, the system detects its head position (horizontal, vertical and depth information), and then it can change the image perspectives interactively with the animal's movement. This could be achieved without using HMDs (head-mount displays) if we do not stick in a stereoscopic 3D visualization.

For the video content, we shoot an HD and/or 4K video with an appropriate view angle which is calculated by the viewer's position and the display size. We assume that the distance of subjects in the video is relatively further compared with the distance between the viewer and the display. In that case, steropsis in the video is not so important as a depth cue [11]. We decided not to use stereopsis as a depth cue in visualization of the interface. This specification finally helped to keep a high frame rate of images given to animals' eyes.

- Animal's Behavior and Robot Agent

The recent study by Lakatos et al. suggests that dogs understand social 'cues' even if it is given by robots, under certain conditions [13]. Such investigation has to be considered in order to understand emotional and/or social relationships between robots and animals. We consider this aspect as very important, since it is expected that our society will utilize autonomous agents such as robots and drones in the very near future. For instance, Softbank, a Japanese telecom company, already began selling their social robot, Pepper, commercially in 2015 [21]. In 2016, the MIT developed robot for home-use JIBO is planned to be shipped [22] and Amazon expects to utilize drones for delivery by 2017 [23]. An investigation of how animals can and will socially react to such autonomous agents physically integrated in our society can be one of the key factors for both human and animal welfare. It may also contribute to help guide dogs and rescue dogs with collaborating and interacting with such autonomous agents. Currently, we are particularly interested in the establishment of emotional attachment between dogs and robots, and investigating in what conditions dogs are inclined to help robots in danger.

Conclusion

We presented a research plan (work-in-progress) on animal-computer-human interaction aiming at enabling animals to interact with artificial presence systems such as VR systems or robots. For VR, we explore key factors to keep animals' interest up in artificial visual stimuli focusing on the effect of the closed visual feedback loop as part of a depth perception. We also investigate if we can establish emotional attachment between dogs and robots. We are still developing this research and looking for any collaboration with people who are interested in the related topics.

References:

1. Hirskyj-Douglas, I., Luo, H., Read, J.C. (2014). Is My Dog Watching TV? *NordiCHI 2014*

2. Why Do Dogs Watch-and React to-TV? (2015) < http://news.nationalgeographic.com/news/2015/01/150111-animals-dogs-television-pets-science-tv-behavior/ > Accessed 22 January, 2016

3. DogTV (2015) < https://dogtv.com > Accessed 22 January, 2016

4. D'eath, R.B (1998). Can Video Images Imitate Real Stimuli in Animal Behaviour Experiments? *Biology Review, 73,* 267- 292.

5. Bovet, D., Vauclair, J. (2000) Picture Recognition in Animals and Humans, *Behavioural Brain Research* **109**, 143-165

6. Pongrácz, P., Miklósi, Á., Doka, A., Csányi, V. (2003). Successful Application of Video-Projected Human Images for Signalling to Dogs. *Ethology* **109**, 809-821.

7. Miklósi, Á., Pongrácz, P., Lakatos, G., Tópal, J., Csányi, V. (2005) A Comparative Study of the Use of Visual Communicative Signals in Interactions Between Dogs (*Canis familiaris*) and Humans and Cats (*Felis catus*) and Humans. *Journal of Comparative Psychology*, ***119****, No.2* 179-186.

8. Tégrás, E., Gergely, A., Kupán K., Miklósi, Á., Tópal, J. (2012) Dog's Gaze Following Is Tuned to Human Communicative Signals. *Current Biology, **22,*** 209-212.

9. Péter, A., Miklósi, Á., Pongrácz, P. (2013) Domestic Dog's (Canis familiaris) Understanding of Projected Video Images of a Human Demonstrator in an Object-choice Task. *Ethology **119,*** 1-9.

10. Müller, C., Schmitt, K., Barber, A. (2015) Dogs Can Discriminate Emotional Expressions of Human Faces. *Current Biology **25***, 601-605.

11. Zeil, J. (2000) Depth cues, behavioural context, and natural illumination: some potential limitations of video playback techniques, *acta ethologica, **3**, No. 1, 39-48*

12. Kubinyi, E., Miklósi, Á., Kaplan, F., Gácsi, M., Topál, J., Csányi, V. (2003) Social behaviour of dogs encountering AIBO, an animal-like robot in a neutral and in a feeding situation, *Behavioral Process **65*** 231-239

13. Lakatos, G.,Janiak, M., Malek L., Muszynski, R., Konok V., Tchon, K., Miklósi, Á. (2014) Sensing in dogs: what may make an interactive robot social? *Animal Cognition **17***, 387-397.

14. Hall, S., Bradshaw, J., Robinson I. (2002) *Applied Animal Behavior Science **79***, 263-271.

15. Goldbeck, J., Neustaedter, C. (2012) "Pet Video Chat: Monitoring and Interacting with Dogs over Distance", CHI 2012, May 5-10, Austin Texus, 211-219.

16. PetChatz Home Page (2015) < http://www.petchatz.com> Accessed 22 January 2016.

17. Ware C. Arthur K. Booth K.S. (1993) "Fish tank virtual reality", INTERCHI'93 Conference Proceedings, 37-42.

18. Goldstone, W. (2011). Unity 3.x Game Development Essentials, *Packt Publishing Ltd.*

19. Microsoft Kinect - Microsoft SDK(2016). < http://wiki.etc.cmu.edu/unity3d/index.php/Microsoft_Kinect_-_Microsoft_SDK> Accessed 18, March 2016

20. Oliveira, R.F., et al. (2000) Considerations on the use of video playbacks as visual stimuli: the Lisbon workshop consensus, *acta ethologica*, ***3***, 61-65.

21. Aldebaran. SoftBank to Launch Sales of 'Pepper' (2015) < https://www.aldebaran.com/ja/softbank-to-launch-sales-of-pepper>Accessed June 18 2015.

22: Jibo (2015) < https://www.jibo.com> Accessed June 18 2015.

23. Eadicicco, L., (2016) "Amazon Reveals New Details About Drone Deliveries", Time (Jan 19, 2016) <http://time.com/4185117/amazon-prime-air-drone-delivery/ > accessed 25th January 2016.