Enabling Awareness in Playful Environments for Animals using Body Tracking

Abstract
This paper explores the diverse possibilities for awareness that could be implemented in the development of intelligent playful environments for animals. These opportunities are described from the perspective of both the animal and the human playing, based on the interaction with the system through embodied interactions using non-wearable tracking.

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Animal Computer Interaction; intelligent environment; awareness; play; multimodal interaction.

ACM Classification Keywords
H.5.m. Information interfaces and presentation: Miscellaneous.

Introduction
Animal Computer Interaction (ACI) [2] is an emerging research area focused on studying animals’ interactions with technology. This discipline follows a user-centered approach with animals as the target users, with the aim of developing suitable methodologies and systems for them. Such systems could provide enormous benefits for both animals and humans: help blind people to understand what their guide dog is experiencing during a walk [4], automatically recognize sniffing patterns of cancer detection dogs when they are discriminating positive and negative samples [3], or provide intuitive

Patricia Pons
ISSI/DSIC
Universitat Politècnica de València
Camino de Vera s/n, 46022
Valencia (Spain)
ppons@dsic.upv.es

Javier Jaen
ISSI/DSIC
Universitat Politècnica de València
Camino de Vera s/n, 46022
Valencia (Spain)
fjaen@upv.es
mechanisms for assistance dogs who have to alert of an emergency in case their owner suffers an accident [10]. While the center of discussion so far has been giving the animal a voice in the design and implementation process, awareness mechanisms have been intrinsically bounded to ACI developments. The developed technology has to be responsive towards the animals’ interactions and also provide appropriate feedback for the animal and the human. This is especially important in one of the areas ACI research is showing interest, that of playful interactions with technology [1,6].

Play is one of the most natural and inherent behaviors among animals, and it is also a very important part of every animals’ life. It teaches them behaviors they need to acquire in their adult life. It also helps to keep their minds and bodies active, reduces stress and could be an indicator of well-being [7,11]. Technologically-mediated playful activities have the potential to provide mental and physical stimulation for animals in different environmental contexts. However, current playful technological interactions are mostly mediated by humans providing the activity, they follow a predefined flow or are focused on a specific artifact. But what happens when there are no humans around or when the animal starts to get used to the new device/activity? With the aim of improving animals’ wellbeing, we have proposed the design and development of technological playful environments comprised of different interactive elements, which could adapt and react to the animals’ playful interactions, or simulate humans’ playful behaviors with them, in order to create more engaging and dynamic playful activities [7]. As animals cannot provide verbal feedback or configure themselves the system they are interacting with in order to adapt it to their preferences, awareness mechanisms are required to make these playful environments suitable and adaptive.

**Body Tracking for Awareness**

In order to provide meaningful responses from the system while allowing the animal to interact naturally, we need to look at how animals intuitively interact and communicate with their surroundings. Animals communicate mostly based on body language. In non-technologically-based games between humans and animals, humans are full participants in the interaction and the game adapts to both players’ reactions over time. For example, in a typical catch the ball game between a dog and a human, the human adapts the intensity of the activity and the places in which to throw the ball depending on whether the animal is, how far it is from the ball and how eager we observe the animal is to keep playing. And this is what makes a simple activity very funny and entertaining for both actors. Therefore, a promising way of building playful systems for animals could be based on this same principle of observing and adapting to the participants’ interactions in a natural way, and support at the same time both the animals playing by themselves as well as animal-human games [6].

In this regard, non-wearable tracking systems would allow to detect the animals’ spontaneous behaviors during the game and extract information not only from the animal player but also from the rest of the environment, i.e. the context, or other participants such as human players [8,9]. This knowledge could be used to support awareness in several ways:

- A non-wearable tracking system could allow to gather contextual information from the animals spontaneous and intuitive interactions with the

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**Environmental Context for Playful Activities**

**Household**: These playful environments can be devised for pets who spend a lot of time alone at home. The system could play with them in a similar way a human would play, imitating human movements of the devices, etc. This would provide mental stimulation for the animals as well as foster physical activity.

**Shelters or zoos**: Animals in zoos or shelters also spend a lot of time alone and without human contact. Playful activities for them could be a way of improving the lack of new stimuli that usually happens in this kind of scenarios.

**Interspecies interaction**: Humans could participate in these playful experiences with their pets or other animals, either physically or remotely.
system, so that the features and reactions of the technological artifacts can be adapted to what the animal users’ need/want. The system could detect preference patterns or specific behaviors of an individual and tailor its interaction and responses to that. For example, some animals might be more shy or fearful than others. If the playful activity is comprised of digital projections on the floor, perhaps the movements of the projected elements should initially be slower and smoother for these animals, so that they can get used to them.

- Tracking the animals’ body movement could also allow to detect different activities, e.g., resting, running, walking, etc. The ways in which the system presents the interactive devices to the animal to play might depend on the observed activities. For example, if the system detects the animal is resting, it might be time to actively introduce an activity: the system could place a robot in front of the animal and start moving it to make the animal aware of the playful activity that is going to start.

- The detected body movements of the animal can be mapped to information presented to a human (owner, caretaker, player, etc). For example, if the system detects an abnormal or low activity level, the person responsible for the animal could be notified so that she could take action: connect to a webcam to see if the animal is feeling well, or start a playful activity with the animal in case the animal is bored.

Although very promising, there are many challenges to keep in mind when implementing awareness in these scenarios. Making the animal aware of the interaction will be highly dependent on the animal species. Different species have different behaviors and interact with their environment in a very different way.

Moreover, animals’ preferences towards the interactive devices they might want to interact with are likely to change across species and even between individuals of the same species. The way in which the system presents the information and triggers the playful activity will rely on this knowledge. Therefore, selecting an appropriate awareness language depending on the target species is extremely important: the digital artifacts to be used and the stimuli these will trigger should be adequate to the playful nature of the species. The interpretation of the detected behaviors will also differ from one species to another, and this should be taken into account when interpreting and presenting information to the human user. For example, some species are less active than others, and what is considered a low activity level will differ.

### Awareness Dimensions

Among the information that could be processed through body tracking and presented to the user (animal or human), there are several dimensions to consider:

#### Social awareness

Interactive playful environments for animals can be envisioned not only for single but also for multiple players. Humans might want to know what their animals are doing when left alone, and among this information could be whether the animal is socializing with other animals during these playful activities. For example, caretakers at zoos might want to know which animals within a group play together. This could help to pair them during cleaning of the enclosure, or for daily enrichment activities. The tracker could detect **gaming partners** (animals who usually play together) for this purpose. This could also be used to present playful activities which encourage **partners** to play together, using the devices and stimuli that both prefer.
**Space awareness**
Locating the animal within a predefined tracked space can allow to determine levels of activity through the day. This is an essential welfare indicator for zoos and shelters, and a very valuable information for pet owners. Intelligent environments for animals that use tracking mechanisms could monitor not only the animals’ movements but also their preferred places, or *hotspots*, for specific activities. These *hotspots* could have a special meaning within the context of playful scenarios. The playful devices to be activated could be placed in specific *hotspots* to maximize their impact. Humans could also be notified about these detected *hotspots* so that they could better understand their animals’ behaviors. We could also envision remote playful activities, in which the human is not physically in the same space as the animal, e.g. pet owners away from home, children in a hospital. The human could play remotely with the animal, getting notifications on where to use each device and how, using the animal’s preferred *hotspots* to maximize their engagement.

**Body language awareness**
Body tracking can provide more information than just detecting the animal as a point in the space. Non-wearable tracking systems can be used to detect animals’ body postures, providing us with more complete information [8,9]. Certain postures mean specific behaviors or predispositions, and this can also be linked to the personality of the animal, therefore improving and extending the acquired knowledge of the aforementioned dimensions.

**Collaboration awareness**
When envisioning collaborative playful activities between an animal and a human, awareness mechanisms should be provided so that both players understand how the system is responding to the actions of the other. This is especially relevant for remote collaborative activities: a child in a hospital, who cannot leave the room, playing with an animal inside a zoo, who needs varied enrichment activities. An animal is likely to play when it is in a specific mood, so the system could use body posture recognition to detect the specific behavior that indicates it is likely to play, and notify the child so that she could enter the game and start playing with the animal. The animal should also receive appropriate feedback from the child’s actions for the playful activity to be successful.

**Conclusion**
This paper provides a discussion of promising awareness mechanisms that could be incorporated in the development of intelligent playful activities for animals using body tracking. Several challenges and dimensions have been described, exemplifying ideas and possibilities these scenarios can enable.
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References