A Dog Tail For Communicating Robotic States

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***Abstract*—We present a dog-tail interface for communicating abstract affective robotic states. We believe that people have a passing knowledge to understand basic dog tail language (e.g., tail wagging means happy). This knowledge can be leveraged to understand affective states of a robot. For example, by appearing energetic, it can suggest that it has a full battery and does not need charging. To investigate this, we built a robotic tail interface to communicate affective states of a robot. We conducted an exploratory user study to explore how low-level tail parameters such as speed influence people's perceptions of affect. In this paper, we briefly describe our study design and the results obtained.**

***Keywords*—human-robot interaction, animal-inspired interfaces, affective computing.**

I. Introduction

In the present world, many robots are being designed to help people in their day-to-day lives (e.g., iRobot Roomba robotic vacuum cleans the floor autonomously). For these robots, it will be important to have effective interfaces to allow interaction between people and robots. One aspect of such interaction is peripheral awareness of the robot's motions and actions. Also, it will be important for these robots to make users aware of when and how they should interact with the robot. For example, a microwave oven displays a timer to let people know when that their food will be ready.

In human-robot interaction, many people have worked on affective computing trends to communicate via human or animal affect and emotions. Leonardo, for example, was designed as a fantastical mammalian creature that communicated affective states via gestures and facial expressions [1].

Affect can also be communicated by robots by using animal-inspired interfaces such as puppy sounds or a dog tail. From zoological research, we know that a dog tail can communicate a broad range of states through their tails. For example, tail wagging means happy, tail raised means high arousal or self-confidence and tail lowered indicates fear [2, 4].

We believe that people have a passing knowledge of basic dog tail language such as wagging, and raised and lowered tail gestures. We believe that this can be useful in making people aware when and how they should interact with a robot. For example, when a robot is happy, it is currently doing its task and does not need the user's attention.

In our work, we are interested in communicating the affective states of the robot via a dog tail. Existing robotic pets such as the AIBO have used tail wagging [3] to communicate affect, however, it is still unclear how a wide range of behaviors can be integrated into robotic interfaces. To explore this, we greatly improved our previous robotic tail interface [5], to allow an iRobot Create to communicate its states (Figure 1).

Figure 1—A person notices the ambient tail state of our robot

II. An exploratory user study

We conducted an exploratory user study with 20 participants to investigate how people interpret different tail motions including: tail wagging - tail moves continuously in horizontal, vertical and circular patterns, static postures - tail keeps a pose and discrete gestures like raising and lowering of tail which can happen only at certain points. We further varied the low level movement parameters such as high, medium and low speeds, wag sizes and wag heights to obtain 24 distinct tail motions. Participants observed these tail motions and rated each of them using a psychological tool for rating affective states. The statistically significant results of this user study revealed that not only people were able to understand the robot behavior via the dog tail, but it mapped out how the different kinds of motions were interpreted. From the significant results, we formed tail descriptors which can be used by researchers in HRI for communicating the affective states of a robot.

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