An *Antisocial* Social Robot: Using Negative Affect to Reinforce Cooperation in Human-Robot Interactions

Hideki Garcia Goo, Jaime Alvarez Perez, & Virginia Contreras
College of Engineering & Computer Science, *The University of Texas Rio Grande Valley*
{hideki.garcia01, jaime.alvarezperez01, virginia.contreras01}@utrgv.edu

***Abstract*—Inspired by prior work with robots that physically display positive emotion (e.g., [1]), we were interested to see how people might interact with a robot capable of communicating cues of negative affect such as anger. Based in particular on [2], we have prototyped an *anti*-social, zoomorphic robot equipped with a spike mechanism to nonverbally communicate anger. The robot's embodiment involves a simple dome-like morphology with a ring of inflatable spikes wrapped around its circumference. Ultrasonic sensors engage the robot's antisocial cuing (e.g., "spiking" when a person comes too close). To evaluate people's perceptions of the robot and the impact of the spike mechanism on their behavior, we plan to deploy the robot in social settings where it would be inappropriate for a person to approach (e.g., in front of a door with a "do not disturb" sign). We expect that exploration of robot antisociality, in addition to prosociality, will help inform the design of more socially complex human-robot interactions.**

***Index Terms*—Antisocialtiy; design; soft robotics**

Overview

Nonverbal cues of emotion such as facial expressions, gestures can affect/facilitate human-robot interaction (e.g., [1]). Existing literature appears to largely focus on positively valenced and prosocial robot behaviors (e.g., [3]). Because negative emotion, in addition to positive, can be important in human social dynamics (e.g., [4], [5]), we designed a prototype for a robotic platform to explore interactivity communicative of negative affect. The physical design and behavior of our robot is inspired by [2], who demonstrated a "goosebump" and "spike" interaction mechanism integrated into the "skin" of a zoomorphic robot. While [2] focused on the haptic experience of the robot's deformable skin, we are interested in using a similar spiking mechanism to communicate anger in situations where a person may be acting inappropriately.

Design & Implementation

Our robot's primary means of communication is an LED display containing two ovular shapes to resemble eyes, a concealed speaker, and a ring of flexible inflatable spikes around its circumference. Ultrasonic sensors for proximity and sound level sensors are integrated into the dome structure to detect approaching entities or a loud environment, and trigger the inflation and deflation of the robot's spikes, as well as a warning sound through the speaker. The spikes are operated through the use of a displacement pump. For the material, we elected to use silicon as it provides sufficient flexibility for inflation and greater durability for returning to its original shape over many uses. To inflate all spikes using just one input from the pump, we designed a canal between each spike to provide sufficient volume for air flow. Finally, we decided on the dome-based design based on the expectation that it would be effective in variety of real world settings. Figure 2 shows are initial prototype of the system and the adjusted prototype post-testing of preliminary materials and their assembly.

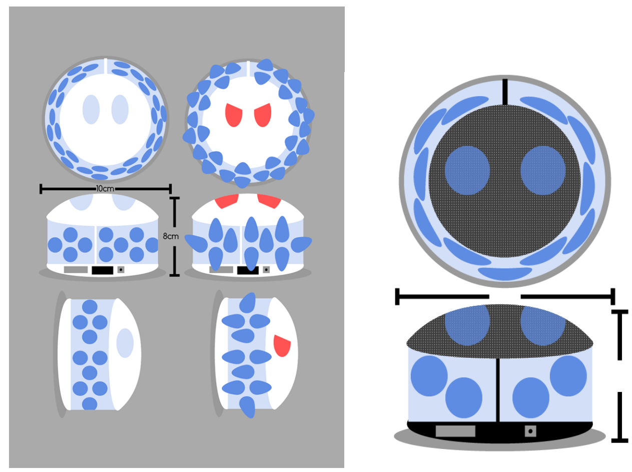

Fig. 1. Initial prototype (left) and updated design (right), following testing of preliminary materials.

Team

We are a multidisciplinary team of three undergraduate seniors at The University of Texas Rio Grande Valley, advised by Dr. Megan Strait. *Hideki Garcia Goo* (team lead, engineer) is majoring in Electrical Engineering and minoring in Computer Science. Her primary contributions to the project, in addition to project coordination, are in the robot's hardware and physical implementation. *Jaime Alvarez Perez* (design/hardware) is majoring in Computer Science. His primary contributions to the project are in the robot's visual design and software, as well as in providing regular encouragement and social support to the team. *Virginia Contreras* (design/software) is majoring in Art and minoring in Computer Science. Her primary contributions to the project are in the implementation of 3D models of the robot's design.

978-1-5386-8555-6/19/$31.00 ©2019 IEEE

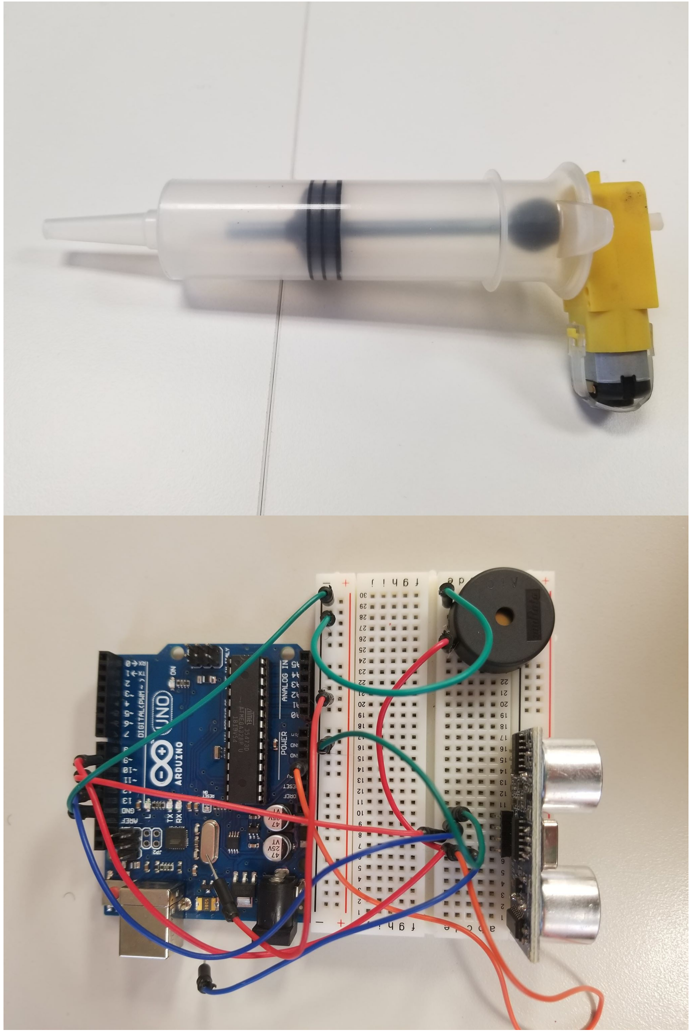

Fig. 2. Handmade air pump (top) using a motor to propel a syringe, and test circuit (bottom) for sensor and speaker.

IMPLEMENTATION & EVALUATION

Construction: We initially planned to use some form of infrared sensor to determine a person's proximity, but subsequently settled instead on using a system of three ultra sonic sensors to detect objects and movements around the general perimeter of the robot. We are presently iterating on a mold for the spikes following a process similar to that in [2], where each spike is connected via a canal. The dome is constructed with a 3D printed skeleton frame and covered with speaker mesh fabric, which should allow the ultrasonic sensors to detect interference reliably enough for our planned use cases. Thus far, we have chosen to use low density polyethylene but are also experimenting with other materials.

Hardware/Software Integration: We are also iterating on the integration of the physical materials and placement of the components internal to the dome (LED display, speaker, air pump, proximity and sound level sensors). Programming of the ultrasonic sensors and the speaker to trigger whenever there is a physical interference detected at a set distance is complete. We are additionally working to manually trigger the sensors remotely from a mobile application, in order to have more control in testing the robot with participants.

Evaluation: We are waiting on IRB approval for carrying out a study of people's interactions with the robot in three contexts:

- *Scenario 1:* Robot will be attached to a door where a do-not-disturb sign is placed. The infrared sensor will activate as a participants are reaching or getting near to a door. The robot will trigger the inflation mechanism as a form of warning.
- *Scenario 2:* Robot will be placed in a noise-regulated area (such as a library or study room) in visible display. When the robot detects loud noises for a certain duration, it will inflate its spikes. It will return to it's idle state as the noise diminishes.
- *Scenario 3:* We will use to the robot to stage a game of Statues, also known as Red Light, Green Light. The players will start at a set distance from the robot (4m) and as the robot makes an inviting (positive) sound they will be able to approach. Once the robot makes an aggressive (negative) sound it will measure the current distance of the player and if the player approaches before the inviting sound resumes they will lose. If the player manages to touch the robot without losing they will win and the robot will play a small melody.

We will record observations of people's behavior (of those who consent) and conduct post-interaction interviews to explore participants' perceptions and interpretations of the robot's spiking behavior.

REFERENCES

[1] P. Bucci, X. L. Cang, A. Valair, D. Marino, L. Tseng, M. Jung, J. Rantala, O. S. Schneider, and K. E. MacLean, "Sketching cuddlebits: coupled prototyping of body and behaviour for an affective robot pet," in *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems*. ACM, 2017, pp. 3681–3692.

[2] Y. Hu, Z. Zhao, A. Vimal, and G. Hoffman, "Soft skin texture modulation for social robotics," in *IEEE International Conference on Soft Robotics*. IEEE, 2018, pp. 182–187.

[3] M. Strait, C. Canning, and M. Scheutz, "Let me tell you! investigating the effects of robot communication strategies in advice-giving situations based on robot appearance, interaction modality and distance," in *Proceedings of the 2014 ACM/IEEE international conference on Human-robot interaction*. ACM, 2014, pp. 479–486.

[4] R. Blair, "Facial expressions, their communicatory functions and neuro–cognitive substrates," *Philosophical Transactions of the Royal Society of London B: Biological Sciences*, vol. 358, no. 1431, pp. 561–572, 2003.

[5] G. V. Bodenhausen, L. A. Sheppard, and G. P. Kramer, "Negative affect and social judgment: The differential impact of anger and sadness," *European Journal of social psychology*, vol. 24, no. 1, pp. 45–62, 1994.