Modulating the Non-Verbal Social Signals of a Humanoid Robot

Demonstration Submission

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ABSTRACT

In this demonstration we present a repertoire of social signals generated by the humanoid robot Pepper in the context of the EU-funded project MuMMER. The aim of this research is to provide the robot with the expressive capabilities required to interact with people in real-world public spaces such as shopping malls—and being able to control the non-verbal behaviour of such a robot is key to engaging with humans in an effective way. We propose an approach to modulating the non-verbal social signals of the robot based on systematically varying the amplitude and speed of the joint motions and gathering user evaluations of the resulting gestures. We anticipate that the humans' perception of the robot behaviour will be influenced by these modulations.

CCS CONCEPTS

• **Human-centered computing → User models**; • **Computing methodologies → Computational control theory**; • **Computer systems organization → Robotic autonomy**;

KEYWORDS

Social signals, social robotics, human-robot interaction

ACM Reference format:
Amol Deshmukh, Bart Craenen, Alessandro Vinciarelli, Mary Ellen Foster. 2017. Modulating the Non-Verbal Social Signals of a Humanoid Robot. In *Proceedings of ACM International Conference on Multimodal Interaction, Glasgow, UK, November 2017 (ICMI 2017),* 2 pages.
https://doi.org/10.475/123_4

1 INTRODUCTION

Humans use social signals without conscious effort to convey feelings, inner states, personality, and other socially relevant information [1]. Correspondingly, expressiveness is one of the key abilities of social robots because it enables them to sitmulate the attribution of the same socially relevant characteristics as those mentioned above [2]. For this reason it is necessary to develop approaches capable of selecting the social signals appropriate for a given situation and shaping them in the same way as a human would do.

Social signals must be expressed in a way that people can identify and understand [3]. This work proposes to achieve such a goal by first identifying the parameters underlying the variability of an observed social signal and then by measuring how the interpretation of the social signal changes as a function of these parameters. In particular, the work focuses on gestures and on how their interpretation changes when modifying their amplitude and speed, the two main parameters that characterise a given gesture.

2 BACKGROUND

Some of the most popular social robots are not equipped to display facial expressions. Thus, the use of gestures and other bodily cues plays a critical role [4]. Social robot body expressions such as raising both hands to show joy, anger, fear etc. have been studied in [5–7]. However, to the best of our knowledge, no attempt has been made to identify the factors that underly the variability of a gesture and to investigate whether there is a relationship between such factors and the meaning that people attribute to the corresponding gestures. This work shows that the two factors that contribute to the variability of the gestures are amplitude and speed and proposes to investigate how people interpret the same gestures when these two factors change.

3 SCENARIO

This work is being carried out in context of the MultiModal Mall Entertainment Robot (MuMMER) project, a four-year, EU-funded project[1], with the overall goal of developing a humanoid robot, Pepper, that can interact autonomously and naturally in the dynamic environments of a public shopping mall [8]. The overall concept underlying MuMMER is that for a robot to be successful in such a situation, it must be *entertaining* and *engaging*: that is, they must possess the social intelligence to both understand the needs and interactive behaviour of the users, as well as to produce appropriate behaviour in response. When the robot is able to support such smooth interactions, this should provide a sufficiently engaging experience that will stand up to repeated visits in a long-term deployment context.

Our specific aim in the current study is to develop a repertoire of social signals aimed at supporting this sort of effective interaction with users. In a loud and noisy environment like a shopping mall, verbal behavior can be less effective, so we focus our work on non-verbal communication. In particular, non-verbal behaviours that can be useful in this context include on attracting attention when the users are not engaged, disengaging when the interaction requires termination or there is overcrowding near the robot, pointing to give directions, and signalling failure or success in performing a task or interacting with the human.

ICMI 2017, November 2017, Glasgow, UK

ACM ISBN 123-4567-24-567/08/06…$15.00
https://doi.org/10.475/123_4

[1] www.mummer-project.eu/

4 APPROACH

We use the humanoid Pepper robot by Softbank Robotics as our research platform. The Pepper robot has 17 degrees of freedom (DOF) in total (see Figure 1). From the default animations provided with the Pepper robot, we shortlisted a set of five which we anticipate to be useful for the shopping-mall scenarios addressed in the MuMMER project: animations for Engage/Gaining attention, Disengage/Send-away, Directions/Pointing, Failure/Disappointment, Success/Happy.

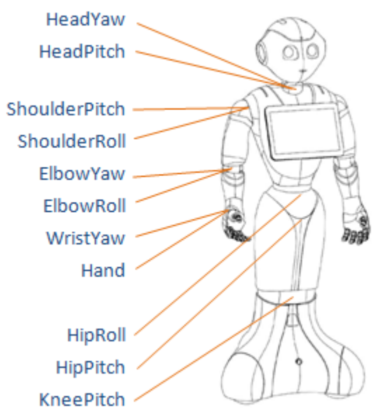

Figure 1: Pepper robot joints, 17 DOF

We then produced a set of modified versions of each animation by independently manipulating two features: the speed and the amplitude. To change the speed, we used either the default framerate of 25fps, or alternative framerates of 15 and 35fps. To change the amplitude, we modified the joint angle values (degrees) for all joints in the animation by applying a factor α to produce a damped variation of the same animation, where α was set to {0.5, 0.7, 1.0}.

$$\Delta = Joint_{preval} - Joint_{val} \quad (1)$$

$$Joint_{val} = Joint_{val} - (\alpha \cdot \Delta) \quad (2)$$

$Joint_{val}$ is the current joint angle value, while $Joint_{preval}$ is the previous angle value. We apply α to Δ, the change of joint angle values. Figure 2 shows the various α values applied to an example animation of gaining attention[2]. By controlling these two features independently, we have produced a total of nine different variations of each animation, in a parameterised manner [9].

We are currently carrying out a user study where participants observe the animations and rate them using an online questionnaire. The ratings will include measures of personality [10] as well as human perception and cognition using the Godspeed questionnaire [11]. The results of this study will provide useful insights into how the amplitude and speed affect the users' perception of the robot, which will in turn help to choose appropriate social signals in the interactive shopping-mall context.

[2]Greeting animation video α ={0.5, 0.7, 1.0} : https://tinyurl.com/ycjdealm

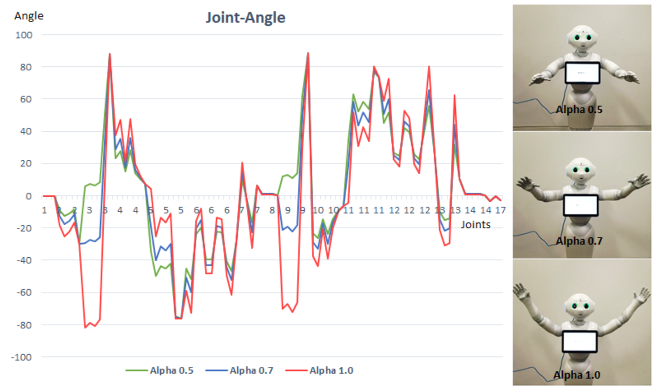

Figure 2: Joint manipulation, gain attention animation[2]

5 DEMONSTRATION

The demo attendees will be able to observe the different animation variants presented on the Pepper robot, and to give feedback on their perception of the animation using a similar feedback form to that used in the current user evaluation.

ACKNOWLEDGMENTS

This research has been partially funded by the European Union's Horizon 2020 research and innovation programme under grant agreement no. 688147 (MuMMER, mummer-project.eu).

REFERENCES

[1] Virginia P Richmond, James C McCroskey, and Steven K Payne. *Nonverbal behavior in interpersonal relations*. Prentice Hall Englewood Cliffs, NJ, 1991.
[2] Terrence Fong, Illah Nourbakhsh, and Kerstin Dautenhahn. A survey of socially interactive robots. *Robotics and autonomous systems*, 42(3):143–166, 2003.
[3] Cynthia L Breazeal. *Designing sociable robots*. MIT press, 2004.
[4] Cynthia Breazeal, Cory D Kidd, Andrea Lockerd Thomaz, Guy Hoffman, and Matt Berlin. Effects of nonverbal communication on efficiency and robustness in human-robot teamwork. In *Intelligent Robots and Systems, 2005.(IROS 2005). 2005 IEEE/RSJ International Conference on*, pages 708–713. IEEE, 2005.
[5] Massimiliano Zecca, Yu Mizoguchi, Keita Endo, Fumiya Iida, Yousuke Kawabata, Nobutsuna Endo, Kazuko Itoh, and Atsuo Takanishi. Whole body emotion expressions for kobian humanoid robot-preliminary experiments with different emotional patterns. In *Robot and Human Interactive Communication, 2009. RO-MAN 2009. The 18th IEEE International Symposium on*, pages 381–386. IEEE, 2009.
[6] Markus Häring, Nikolaus Bee, and Elisabeth André. Creation and evaluation of emotion expression with body movement, sound and eye color for humanoid robots. In *Ro-Man, 2011 Ieee*, pages 204–209. IEEE, 2011.
[7] Heeyoung Kim, Sonya S Kwak, and Myungsuk Kim. Personality design of sociable robots by control of gesture design factors. In *Robot and Human Interactive Communication, 2008. RO-MAN 2008. The 17th IEEE International Symposium on*, pages 494–499. IEEE, 2008.
[8] Mary Ellen Foster, Rachid Alami, Olli Gestranius, Oliver Lemon, Marketta Niemelä, Jean-Marc Odobez, and Amit Kumar Pandey. The MuMMER project: Engaging human-robot interaction in real-world public spaces. In *Proceedings of the Eighth International Conference on Social Robotics (ICSR 2016)*, November 2016.
[9] Junchao Xu, Joost Broekens, Koen Hindriks, and Mark A. Neerincx. *Bodily Mood Expression: Recognize Moods from Functional Behaviors of Humanoid Robots*, pages 511–520. 2013.
[10] Beatrice Rammstedt and Oliver P John. Measuring personality in one minute or less: A 10-item short version of the big five inventory in english and german. *Journal of research in Personality*, 41(1):203–212, 2007.
[11] Christoph Bartneck, Dana Kulić, Elizabeth Croft, and Susana Zoghbi. Measurement instruments for the anthropomorphism, animacy, likeability, perceived intelligence, and perceived safety of robots. *International journal of social robotics*, 1(1):71–81, 2009.