Proceedings Paper:

Fernando, S., Collins, E.C., Duff, A. et al. (3 more authors) (2014) Optimising robot personalities for symbiotic interaction. In: Biomimetic and Biohybrid Systems. Third International Conference, Living Machines 2014, July 30 – August 1, 2014, Milan, Italy. Lecture Notes in Computer Science, 8608 . Springer International Publishing , pp. 392-395. ISBN 9783319094342

https://doi.org/10.1007/978-3-319-09435-9_40

Optimising Robot Personalities for Symbiotic Interaction

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Abstract. The Expressive Agents for Symbiotic Education and Learning (EASEL) project will explore human-robot symbiotic interaction (HRSI) with the aim of developing an understanding of *symbiosis* over long term tutoring interactions. The EASEL system will be built upon an established and neurobiologically grounded architecture - *Distributed Adaptive Control (DAC)*. Here we present the design of an initial experiment in which our facially expressive humanoid robot will interact with children at a public exhibition. We discuss the range of measurements we will employ to explore the effects our robot's expressive ability has on interaction with children during HRSI, with the aim of contributing optimal robot personality parameters to the final EASEL model.

Keywords: HRI, symbiosis, neurobiological, robot tutors, facial expressions

1 Introduction and Core System

A key challenge in HRSI is to develop robots that can learn from interactions over time. Successful social engagement requires a robot to develop an engaging personality that is responsive and adaptive to its human user. Within the EASEL project we aim to explore such robot capabilities by basing our robot system upon the neurobiologically grounded *DAC* architecture [1], which will be used as the basis of the Synthetic Tutor Assistant (STA) model. The EASEL tutor assistant will also have an interaction manager which is responsible for the multimodal interaction with the student and determines how the STA delivers content and feedback to the user and how user questions are processed. A self-regulation system based on key identified variables will manage low-level interactions. This regulation system will be based on biologically grounded models such as the motivation and emotion control provided by the reactive layer of DAC, which has already been tested in large-scale interactive spaces [4] and with robots. Further stages will develop computational methods to extract knowledge from long sequences of behavioural data.

Employing the EASEL tutor assistant we aim to explore and develop a theoretical understanding of symbiosis in HRSI. Symbiosis is defined as the capacity of the robot and its human user to mutually influence each other's behaviour over different time-scales (for instance within encounters and across encounters). Symbiosis requires that the robot has social salience [2]. For instance it should be responsive to the behaviour and emotional state of its human user, and adapt its own behaviour to this in ways that have predictable effects on the person.

Within the EASEL project HRSI will be explored in the context of educational child-robot interactions in school classrooms and at natural history museum family events. We aim to determine what aspects of HRSI are most relevant to providing effective instruction and what level of human-robot affect is appropriate for communicating learning content in an ethical manner. We will frame the evaluative methodologies employed to explore this in a conceptualisation of attachment to humanoid robots taken from a taxonomy in development, which proposes that human-robot bonds can be analysed in terms of their similarities to different types of existing bond with other humans, animals and objects [3].

2 Initial interaction in the field

In an initial EASEL experiment we will use the Hanson Robokind Zeno R50 humanoid robot (Fig. 1) in a child-robot interaction activity at a public museum. A distinctive feature of Zeno is the platform's realistic face which is capable of displaying a wide range of facial expressions.

Fig. 1. The Hanson Robokind *Zeno* R50 robot with some facial expressions illustrated.

We will explore how Zeno's facial expressions affect a child's perceptions and interactions during a game of 'Simon says'. During the game Zeno will give spoken commands to the child to perform simple actions, such as 'Wave your arms', which the child is instructed to only perform if Zeno precedes the command with the phrase 'Simon says'. Zeno will then provide verbal feedback confirming whether the child's action was correct or not.

We will test two different configurations. Zeno will either maintain a static, neutral facial expression throughout game-play, or will alter its facial expressions to convey appropriate emotions alongside verbal feedback: producing a happy smiling expression with positive feedback and a sad/sympathetic expression with negative feedback. Interactions between Zeno and the children will be video recorded, whilst logs of spatial distance data will be gathered using the Kinect, and questionnaires will be used to ask parents/guardians and their child their opinions about the interaction.

We predict that children playing with Zeno during the emotionally expressive configuration will enjoy their experience more than children playing with Zeno during the neutral facial expression configuration. We predict that this will manifest in the following ways:

– Interpersonal distances will be smaller (measured with Kinect sensor data)
– The child will participate in game-play for a longer period of time
– Questionnaires will indicate a markedly greater level of game-play enjoyment
– During game-play the child will appear more animated (smile/laugh more)
– During game-play the child will be more likely to mimic *Zeno's* expressions

Zeno's configuration will be informed by recent work investigating the alignment of visual, vocal and behavioural affordances in social robots [7]. This work suggests that the voice, facial expressions and behaviours of the robot should be appropriate for its size and morphology and also consistent with each other - an alignment that is crucial to avoid the 'uncanny valley' effect [8]. Given Zeno's capacity to allow us to explore this alignment of robot facial expression and the response of its human user, our work will contrast with other recent HRSI work which has made use of the Aldebaran NAO robot, a technically advanced but facially non-expressive platform (e.g., [9, 10]). Initial EASEL experiments such as that presented here will extend this current HRSI research by measuring exactly what effects emotionally appropriate facial expressions have on human-users during child-robot interactions, allowing us to better understand how to optimise the expressed personalities of robot platforms in symbiotic interaction.

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