Animation of Parameterized Facial Expressions for Collaborative Robots *

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Abstract

In recent years, collaborative and socially interactive robots have been developed to aid people in daily tasks and guide them in environments such as museums or stores. We propose the use of facial expressions to efficiently convey information about a robot's inner state. This allows a natural and intuitive, and therefore efficient, interface between humans and robots. We developed a software prototype to render transitions between several facial expressions of a 3D face model. Parameters to specify the facial expressions can be passed by other processes running on the same system. In addition we developed a sample program to demonstrate a scenario and evaluate the applicability of the software.

Keywords

face synthesis, facial expressions, human-robot-interaction (HRI)

CR-Categories

I.4.8 [**Image Processing and Computer Vision**]: Scene Analysis; I.2.9 [**Artificial Intelligence**]: Robotics; I.5 [**Pattern Recognition**]: General

1 Design of a robot's face

Using facial features to enhance a robot's interface has several advantages. HRI researchers like Fong, Nourbakhsh and Dautenhahn [3] suggest that humans prefer to interact with machines like they interact with fellow humans. To provide an enjoyable interface that makes the user feel empowered and competent it is necessary to adhere to human social expectations. Facial expressions are a fundamental aspect of social interactions and can be rapidly recognized, enabling us to draw conclusion about the inner state of a human - or a robot, in addition to the already widely used text and voice output.

To design effective robot faces, certain aspects have to be considered. According to Broadbent et al. [1], human-like face designs can create expectations of human-like mind and abilities. It is therefore not advisable to design a robot's face as realistic as possible. The design should rather fit the tasks that the robot will perform.

For the prototype software, we chose to create a high-contrast face design with few details which is suitable for a wide range of robotic systems.

2 Implementation

To parametrize expressions for the software prototype, we adapt Russell's circumplex model of emotion [4] for a HRI use case. In Russell's model, emotion words are placed in a two-dimensional coordinate space with two axes to describe emotions: arousal and pleasure. Emotion words are placed in a circular pattern around the center, which represents a neutral emotion. The words act like the hues in a chromatic circle and can blend into each other. The distance between an emotion and the neutral center describes the intensity of the emotion.

We recreated the facial expressions on the 3D face model by employing the skeletal animation technique and saved every facial expres-

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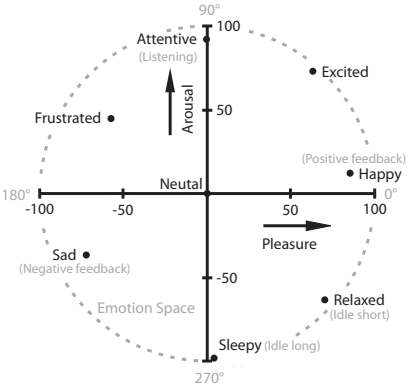

Figure 1: Reduced and adapted version of Russell's circumplex model of emotion[4]

sion as a separate resource, which we then placed in a two-dimensional blend tree of the Unity engine at the same positions as the emotion words in Russell's model. The software interprets UDP messages containing parameters, e.g. "arousal:25" or "pleasure:-50", and smoothly transitions the parameters via linear interpolation over a certain amount of time, which influences the expression of the 3D face model.

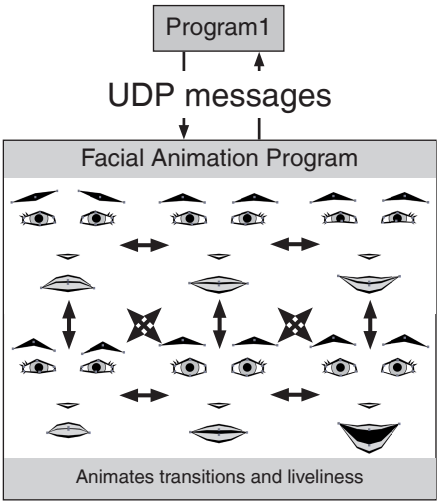

Figure 2: UDP messages are interpreted and transitions animated

Additional parameters include gaze coordinates, "talking" and "idle". Gaze coordinates cause the eyes and head to turn to the specified coordinate. The talking parameter activates or deactivates a generic talking animation. The idle switch starts the randomized change of arousal, pleasure and gaze coordinates.

3 Conclusion

To evaluate the software prototype, we implemented a Java program to send parameters via UDP messages by manipulating a user interface. Voice clips were recorded for a short scenario of a robot offering help to find an article in a store. These are played in combination with sending parameters to create accompanying expressions and gaze, to "point" to an article on a shelf. The scenario was performed in front of 12 students with the animate face projected onto a screen. They were asked to rate how they perceived attributes of the character via a questionnaire: The character was perceived as mostly sympathetic (8.18/10), trustworthy (8.0/10) and intelligible (9.18/10), but not as believable (6.77/10) due to improper lip movements. The software can be improved in this aspect by implementing synchronized lip movements. The facial expressions, which are currently designed "by heart" and evaluated via a questionnaire, could be replaced with a dictionary of Facial Action Coding System [2] values.

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