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Jelle Saldien, Kristof Goris, ... (2010): Expressing Emotions with the Social Robot Probo, International Journal of Social Robotics. <https://link.springer.com/content/pdf/10.1007/s12369-010-0067-6.pdf>

Motivation

A study has shown, that only 7% of affective information is transferred by spoken language, 38% is transferred by paralanguage, and 55% of transfer is due to facial expressions. A social robot Probo was developed, to do further research on the recognition of emotions .

Animal assisted therapy/-activities are expected to have useful psychological, physiological, and social effects on people. For different reasons attempts are made to replace these animals by robots.

Prototype

Probo is a huggable robot and looks like an animal. It has its own identity, including a name, a history. Probo is equipped with animated ears, eyes, eyebrows, eyelids, mouth, neck, and an interactive belly-screen. The special thing about Probo is his eye-catching trunk to intensify certain emotional expressions. The robot has 20 degrees of freedom (DOF) in its head. The robot is covered with a foam layer and a removable fur-jacket. For some online-tests, a 3D virtual model of Probo has been created.

To represent the emotions, Ekman and Friesen have defined the Facial Action Coding System (FACS) to define for each emotion-specific Action Units (AU), which correspond to muscles in the face.

The basic facial expressions are represented as a vector in the 2-dimensional emotion space based on Russel's circumplex model of affect (valence-arousal). To have a smooth transition between emotions, the current emotion could always be interpolated with the neutral emotion, which has to be used when switching.

Method

In a first pilot study, the virtual model was used to test the recognition of facial expressions. For other tests, Probo was used uncovered or covered. A questionnaire displaying pictures and a multiple-choice of emotion words were used. Children and adults were taken as subjects, respectively.

Main Result

For the evaluation of the virtual prototype adults and children have been conducted to classify 8 emotions (Ekman + neutral + tired). Adults had an accuracy of 67% and children 60%. Further evaluation for the Ekman emotions has been done with children. For the virtual prototype, they reached an accuracy of 88%, the uncovered 83%, and for the covered one 84%. There has been no significant difference found based on the gender or age of participants.

Other prototypes (more mechanical appearance) received a lower score: Kismet 73%; Eddie 57%; Aryan 69%; Felix 45%.

Critical Reflection, Limitations

The initial development was done with the virtual avatar. Therefore the recognition is very good. The last evaluation is done with the mechanical prototype. This one is different because the fur behaves differently than in the virtual world. The mouth e.g. is very hard to recognize because it

is covered compared to the uncovered/virtual prototype. Without the trunk some emotions would be very hard to be recognized for example disgust and sadness have very subtle changes. Adding more activation units could solve this problem.

The prototype was only evaluated for facial emotions, but body-language like gestures are completely ignored. This would further improve the recognition.

The robot has already implemented several input types. Using the inputs to detect the emotional state of users is a hard, but crucial step towards automation.