Emotionally Driven Robot Control Architecture for Human-Robot Interaction

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With the increasing demand for robots to assist humans in shared workspaces and environments designed for humans, research on human-robot interaction (HRI) gains more and more importance. Robots in shared environments must be safe and act in a way understandable by humans, through the way they interact and move. As visual cues such as facial expressions are important in human-human communication, research on emotion recognition, expression, and emotionally enriched communication is of great importance to HRI and has also gained increasing attention during the last two decades [1],[3],[4],[6],[8]. Most of the existing work focuses on the recognition of human emotions or mimicking their expression [1],[6] and emotional action selection [3],[5]. Less work is done on the role of emotions in influencing human behaviour in HRI [4].

The goal of our work-in-progress is to further explore the idea of emotion as a strong influence of action selection and to analyse the role of emotion in HRI. We present here a model for incorporating emotions and emotional expressions into POSH dynamic plans[2] based on Behaviour Oriented Design. Emotions are represented as a factor for dynamic action selection, and an emotional expression is used in conjunction as a visual cue for communicating the current emotional state to a human before and during the execution of actions. We hypothesize that robots expressing emotions in a human-understandable way will improve the quality of communication and therefore collaboration between a robot and a human. We thus hypothesize that such emotional expressions can empower robots to influence humans behaviour in an HRI task.

The first phase of the emotional action selection includes detecting specific internal and/or external conditions that comprise the robots emotive response and thus are able to influence the emotional state of a robot. We use a list of conditions proposed by Breazeal [1]: presence of an undesired stimulus, presence of a desired stimulus, a sudden stimulus, delay in achieving goal. For determining an appropriate emotional state we use a two-dimensional representation for expressing basic human emotional states, proposed by Russell [8]. Here, *arousal* represents the strength of a stimulus, and the *valence* shows a positive/negative value of a stimulus. All the detected conditions influence both valence and arousal of a robots emotive response. We also use *intensity* as an additional property of an emotion. Intensity depends on time, number of detected stimuli, and an impact factor of an executed behaviour. We use impact factor as a property of a behaviour that depresses the intensity of the emotion this behaviour was triggered by.

Each emotion calls a specific behaviour of a POSH plan. While the selected behaviour is being executed it inhibits the intensity of the emotion it was triggered by, i.e. intensity of an emotion is a function of a behavioural impact over time. Emotional intensity in our model is an internal state of an agent, which is changed dynamically while robot is experiencing an emotion. ‘Feeling’ an emotion is a latched process [7], during which an intensity of the emotion is increasing over time from zero value until the maximum threshold of 100, and is reducing back to zero after the executing behaviour inhibits it. The expression of emotion starts after an increasing intensity of the emotion reaches the specified level and stops when the same level is reached while the intensity is decreasing. Emotions are expressed by a robot using two basic movements of its body: moving the ‘neck’ forward/backward, and raising/lowering ‘eyebrows’. The execution of the selected behaviour starts when the intensity of an emotion reaches a specific level which is above the level of the start of expressing the emotion and below the maximal intensity level. The execution of behaviour, if not interrupted, stops when intensity of the emotion is zero.

We have collected data showing that the set of these two simple movements in a robot are recognised by people as expression of several basic emotions. In our future experiment we plan to apply the described model of emotional action selection for a human-robot interaction task where the robot must solicit assistance to achieve its goal. We intend to measure all three conditions: emotional action selection with and without expression and emotion free action selection, to observe whether emotional communication will empower the robot to influence a humans behaviour.

References

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