Project Proposal: Affective Communication for Assistive Robots Using Social HRI

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Abstract

1 Aims and Objectives

1.1 Aims

The overall aim of this project is to investigate emotional expression in robot to human communication. Specifically of interest is the potential for robot to human emotion transfer and the potential benefits this might have. This can be expressed as two key project aims:

1. Demonstrate whether robot to human emotion contagion can occur
2. Demonstrate the consequences of affective robot communication

The first aim deals specifically with emotion contagion, i.e. whether a human's emotional state can be changed through interaction with an emotionally expressive robot. Regardless of the result, the second aim is to demonstrate how such emotional expression might impact on human-robot interaction (HRI); specific aspects for consideration are listed under Objective 3. Generally it is the robot's effectiveness that should be considered; however the definition of effectiveness depends on the purpose of the robot.

1.2 Objectives

In order to achieve the project aims, a list of specific objectives has been derived as follows:

1. Study affective communication and emotion contagion
2. Create a parameterised model for creating emotional robot expression
    - Conduct a model evaluation experiment for refinement
3. Conduct a HRI experiment to test the effects of affective robot communication
    - Consider human/robot task performance and human emotional state

2 Motivation

The psychological phenomenon of interpersonal emotion transfer (IET) between humans is still not fully understood; however it is believed to include social appraisal and emotion contagion effects [1]. In this context social appraisal describes a person's judgement of something being affected by the emotional response of another (i.e. affecting what they think), whereas emotion contagion describes a change in their emotional state (i.e. affecting how they feel). For example, it has been demonstrated that listening to a neutral text spoken happily or sadly can induce similar feelings in the listener [2] and that the same household object will be rated differently if it is presented alongside a picture of a smiling or disgusted face [3]. In addition, there is growing evidence that emotional expression is an important and subconscious part of human communication which has evolved as a mechanism for quickly communicating a range of information such as social stature and level of threat (see [4] for a review).

Based on this there are at least two major reasons for wanting to design a robot with IET capabilities. Firstly, if emotional expression is an important part of human communication, then a robot with such capabilities might be more lifelike, more likeable and more natural to interact with. Secondly, the effects of IET described above, e.g shaping people's judgement or decision making and impacting on how they feel might be beneficial in a range of HRI applications just as it is in human-human interaction (HHI). In fact, example HRI scenarios where emotional expression might be useful might follow directly from those we can imagine in HHI, e.g. in encouraging children or care of the unwell. As a speculative example, endowing an assisted living robot with IET capabilities might offer the following functionality benefits:

- the robot could provide more realistic and enjoyable social companionship
- the robot could 'cheer up' the user by being cheerful itself
- the robot could give the user a positive impression of potentially undesirable tasks, e.g. taking medication or doing exercise
- the robot could provide more effective encouragement during activities like those above
- the robot could appear empathetic and caring, leading to a better human-robot relationship

However, this reasoning assumes that IET occurs equally well in HRI as HHI and that the effects on the human partner would be the same as if it was a human rather than a robot they were interacting with. Arguably, given the well known effect of the 'uncanny valley'[REFERENCE?]; this assumption might not be valid and hence warrants further study. Research done so far suggest demonstrates that recognisable emotional expression is certainly possible in a range of robots (e.g. X X X from lit review), however the impact of this on a human's own emotional state and the robot's effectiveness is less well documented.

In summary, the potential benefits of robot emotional expression and robot to human IET are clear. However, there is still significant uncertainty and a lack of evidence surrounding whether IET from a robot to a human can occur and, if so, what impact this might have on the robot's effectiveness and/or the human's task performance. Addressing this uncertainty and lack of evidence in order to evaluate the real-world potential of robot-human IET forms the main motivation for undertaking this project.

3 Literature Review

Lim et al. demonstrated a framework for mapping the emotion in a speech sample to robot gesturing based on four parameters; speed, intensity, regularity and extent (SIRE) [5]. This is based on the concept that the way a gesture is executed rather than the actual shape of the gesture can convey emotion and is more realistic for natural communication. A major benefit of this approach is that the robot requires no internal state model and can hence produce a continuous emotional spectrum which is pose-independent. The authors reported that, when implemented on a XXX NAO programmed to do a simple arm extension movement, emotion recognition based on movement alone was above 60% and combining the parameterised movement with the original speech sample led to increased ease of understanding for happiness and sadness.

A similar approach is taken by Xu et al. who presented a parameterised behavioural framework for changing the appearance of functional behaviours (waving and pointing) through varying general parameters such as speed and amplitude, but also more specific gesture modifications (e.g. palm up or down), in order to express a positive or negative mood [6]. This was also demonstrated on a NAO. In addition to gesture specific variation however the head, which had no pre-defined functional behaviour for the waving or pointing activities, was also utilised as an effector with two pose parameters. The author's then conducted an experiment in which participants were asked to adjust the model parameters.

These works provided the inspiration to use a parameterised emotion generation model for this project...

4 Risk Register

Risk	Mitigation	Likelihood	Impact	**Score**
Emotional content of designed & implemented behaviours isnt recognisable	Pre-test of behaviours with time to update and refine before experiment	1	4	**4**
Emotion generation model not ready in time for final experiment	Hand script behaviours to allow experiment to go ahead	2	3	**6**
Issue with hardware of robot platform preventing experiment being undertaken	Some time in plan for rescheduling, or could implement reduced experiment using virtual agent	2	3	**6**
Cannot recruit enough participants for statistical significance in experiment	Start recruiting in sensible advance of experiment, use within rather than between subject design	3	3	**9**

5 Timeline

A Gantt Chart showing key project activities and their suggested time allocations is given in Figure 1.

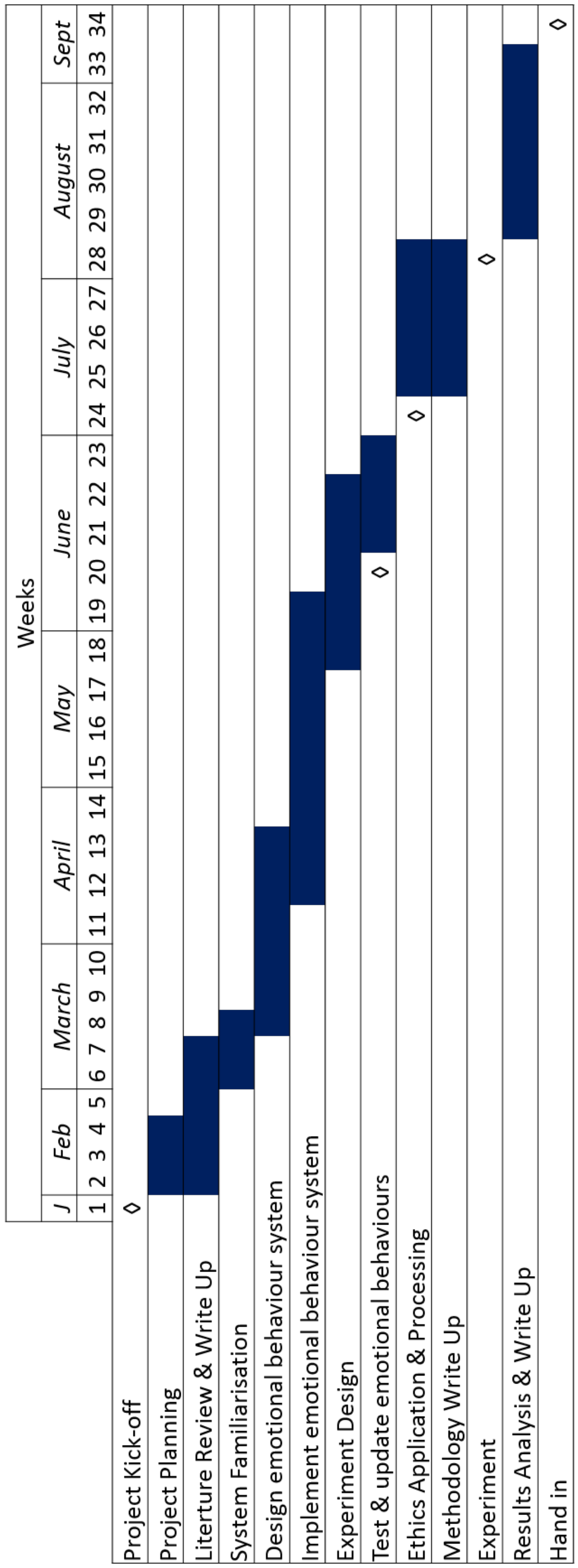

Figure 1: Project timeline - diamonds indicate discrete timing point events.

References

[1] Brian Parkinson. Interpersonal emotion transfer: Contagion and social appraisal. *Social and Personality Psychology Compass*, 5(7):428–439, 2011.

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