Social-Task Engagement : Striking a Balance between the Robot and the Task

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Abstract. In this paper, we consider engagement in a triadic human-robot-task interaction. More specifically, we discuss why we need to perform 'online' differentiation and balancing of task and social engagement during human-robot interactions. The results of this work will help us to progress towards uncovering novel ways to design personalised human-robot interaction experiences. We start by defining the type of engagement that we are interested in, then we explain the methodology we are using to explore our hypothesis.

1 Introduction

At present, engagement is a broadly used term in human-robot interaction (HRI), typically characterised by an elements of concentration, enjoyment and flow [1] [2] [3] [4]. However, this umbrella-like definition is often used to explain aspects of engagement which are individually distinguishable as owing either to the task being performed or to the robot being interacted with [1] [5].

In this paper we begin with three clear and distinct definitions of engagement which are relevant to social HRI. We propose these definitions in an attempt to bring clarity and meaning to the exact type of engagement being considered in our work.

Imagine a scenario where you are asked to perform some task in a dyadic human-task relationship (Figure 1-b), such as that found in the typical one-player game scenario. The task could involve physical objects which you can manipulate, such as a board game or a block building task, or a virtually represented task hosted on a computer, tablet or phone. The task is considered to be an explicit task in which your input and the corresponding output caused by performing that task are intrinsically linked to one another. Now, lets say that you find yourself becoming immersed in the task, you are enjoying and concentrating on your inclusion in that task. This is considered to be 'task engagement'. Likewise, you can become disengaged from the task, but this is still considered to be 'task engagement', albeit, at its lowest extreme.

Furthermore, imagine another scenario where you are interacting with a socially capable robot where there is no task involved (Figure 1-a). An example might be a form of entertainment robot which is capable of sociable and friendly interaction. If during this scenario you become engaged with the robot, you are socially engaged. This is ‘social engagement’. Again, at its lowest extremes you would become disengaged from the robot.

Now to extend on this further, imagine another scenario where you are interacting with a socially capable robot, where both you and the robot work together to perform an explicit task (Figure 1-c). An example of this could be a collaborative task where both robot and human work together to build something. The question here is, if you become engaged in what you are doing, are you engaged with the task or are you engaged with the robot? It would be far too ambiguous to simply call this engagement, so we will need to define this phenomenon as ‘social-task engagement’. Furthermore, stating that one is simply engaged does nothing to help distinguish the proportion of engagement attributable to different aspects of the interaction. For example, lets say at some point during this scenario you become more engaged with the robot or less productive in the task. Was it the task or the robot which caused that to happen?

With this in mind, we hypothesize that engagement with the task must be separable from engagement with the social robot. Further still, ‘online’ differentiation and balancing of social and task engagement (i.e. updating both the task and the robot throughout the interaction) will lead to a more personalised and productive experience for both the robot and the user.

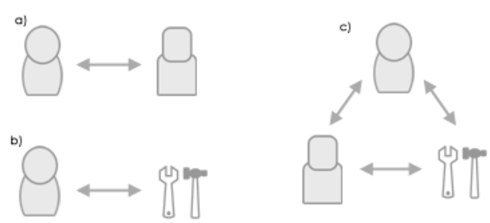

Fig. 1. a) Social Engagement, b) Task Engagement c) Social-Task Engagement

2 Engagement

Engagement is a much talked about phenomenon in HRI, but what is engagement really? A definition taken straight from a dictionary states ”the act of engaging or the state of being engaged”, but this does not help us to explain what engagement is. Digging deeper we find more functional terms related to engagement which might help us to characterise this phenomenon, such as participation, commitment, concentration, involution and immersion.

Engagement shares many of the same characteristics involved in flow [5], in education settings it has been found that the more challenging assignments lead to flow, whereas in the workplace having a clear concept of the goal and having immediate feedback was more effective. In terms of causality, the first thing that comes to mind is that engagement is the effect of an internal state, a low level desire or a state of being, such as curiosity, intrigue, interest, amazement, wonder or concern. It could be that these internal states act as incentives for becoming engaged. In fact, further studies involving flow have found that a "need for achievement" is a personal characteristic which fosters flow [6] [7].

In addition to this, engagement could also cause more affective aspects of conciousness, states of enjoyment or even provide some other form of arousal which is beneficial or at least pleasing to the recipient, therefore, warranting the initial investment of becoming engaged. One might hypothesize that engagement is driven by ones underlying motives for wanting to satisfy their own goals and desires.

3 Related Work

Further to our previous work, where we consider the measurement of task engagement during human-robot interactions [8], we have become aware of the need to perform 'online' balancing of social and task engagement during experiments. This has shown us that situations exist where the engagement the user experiences in a triadic human-robot-task relationship is associated with either the task, the robot or combinations of both. The amount of engagement experienced is scalar as oppose to being present or not.

Whilst engagement is often associated with learning performance [9] [10], and efforts have been made to explore social [11] and task engagement [12], very little work has been done to differentiate task from social engagement during a human-robot interaction involving a social-task. At present, social engagement is defined as "the process by which two (or more) participants establish, maintain and end their perceived connection during interactions which they jointly undertake" [1], and "the value that a participant in an interaction attributes to the goal of being together with the other participant(s) and continuing the interaction" [13]. Task engagement is derived from studies involving flow experience, characterised by elements of attention, concentration and enjoyment with the learning task [5].

Context is an important aspect in human-robot interactions, [12] consider its relevance during child and robot interaction involving a chess game, and [14] use task state information to classify interest of children interacting with a game.

Engagement is far more than a binary concept (i.e. engaged or disengaged), [15] considered the 'level of engagement' which details how much the user was looking at relevant objects at appropriate times, and the 'quality of engagement' where users were considered as being engaged, superficially engaged or uninterested in the scene/action space. Here, we intend to learn from and extend upon that concept by evaluating the interaction in terms of the task and social elements of the interaction.

Recent unpublished work by [16] showed that when a social robot interacting with a child in a shared physical space struggled to adjust the screen, the child without hesitation notices the problem and immediately moves the screen for the robot. This leads us to believe that the child was highly engaged with the robot causing him to do something of which he was not expected. At the same time the child was also performing well in the task.

Currently, we are unable to detect and differentiate between the level and quality of task and social engagement during such an interaction, but with the advances we intend to make during this project we will be able to look at social-task interactions in a completely different light.

4 Methodology

4.1 Pilot Study

Our first experiment is a pilot study involving adults. We have consulted with psychologists in an attempt to design the experimental conditions which will help us to identify the most pertinent indicators of both task and social-task engagement. The experimental set-up comprises of a large touch screen to run interactive tasks, several cameras detecting valence and affective display from facial expressions, an Affectiva Q Sensor[3] detecting arousal from galvanic skin responses and a Microsoft Kinect[4] for reading lean position and posture [17] through depth perception. In addition to this gaze direction will be clamped to either the task, robot or elsewhere using data derived from the users' head direction.

Interactive Tasks We are using three tasks and each one has been designed to elicit different states of engagement. The first is based on a simple Whack-A-Mole style game and is considered to be an engaging task which requires much effort and concentration. The second is a simple sequence following block tapping task, designed to be far less engaging. In the third task we use a memory game involving cards to observe social-task engagement during a novel human-robot interaction scenario.

Experimental Conditions Participants are divided into two groups, representing the two conditions in the study i.e. engaging and non-engaging. Participants from both groups are then divided again into two further groups, here, half perform task one followed by task two, and the other half perform the tasks in the opposite order. This ensures the data we collect is not biased by the ordering of the tasks. Furthermore, the user is not introduced to the robot until the third and final task involving the human-robot-task experiment, this is to prevent biasing the social relationship with the robot.

[3] http://www.qsensortech.com/, Affectiva Q sensor, Last accessed 25-4-2013

[4] http://www.microsoft.com/en-us/kinectforwindows/, Microsoft Kinect, Last accessed 01-09-2013

Robot Behaviours The engaging group experience a robot which is friendly, helpful and instructive, the robots behaviours are designed to be personable, pulling on the empathic strings of the participant. The robot describes why 'they' need to work together to build 'their' battery, looking directly at the participant and addressing them by their first name. In contrast, the non-engaging group experience a neutral and partially helpful robot which although provides some help is far less personable, refrains from mutual gaze and does not address the participant by name.

4.2 Wizard-of-Oz Study

Our second experiment is a Wizard-of-Oz study involving children aged between 11 and 13. The task is grounded in geography, more specifically map reading. The robot will be semi-autonomous and capable of social, empathic and pedagogical intervention. During the interaction we intend to experiment with different levels of task difficulty and various robot behaviours. Here we will utilise the same experimental design as the pilot study to collect a corpus of interaction data, yet we will have remote control of the robot, with the goal of giving the perception of realistic social intelligence as well as both task and situational awareness.

5 Conclusion

At present it is common to bundle all elements of engagement during human-robot interactions into a single classification, but without further research in this area we will be unable to design interactions that can be balanced and personalised towards the individual user.

In this paper we have described how we intend to explore engagement owing to differing aspects of the interaction. The results of this work will enable us to move forward and further explore both situational and contextual indicators of task and social-task engagement, helping us to progress towards uncovering novel ways to design personalised human-robot interaction experiences.

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