

Emotion-Awareness Improves Human-Robot Collaboration

Mohammad Shayganfar · Charles Rich ·
Candace L. Sidner

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Abstract ...

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1 Introduction

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Mohammad Shayganfar · Charles Rich · Candace L. Sidner
100 Institute Road, Worcester, MA, USA 01609-2280
Tel.: +1 508-831-5357
Fax: +1 508-831-5776
E-mail: mshayganfar@wpi.edu
E-mail: rich@wpi.edu
E-mail: sidner@wpi.edu

2 Related Work

2.1 Emotions in Social Context

2.2 Social Functions of Emotions

2.3 Affect and Motives

2.4 Collaboration Theory

3 Example Scenario

3.1 The Backstory

The scenario transpires in a NASA's research center. Light, temperature and other environmental factors are simulated based on conditions on the surface of the moon. The mission is to finish installing the required solar panels to provide energy for the operation of NASA's science lab on the moon. Ninety percent of these panels have already been installed. However, the operation is now faced with low batteries which forces everyone to be cautious about consuming energy. The astronaut is inspecting the working conditions in the field and planning the installation of the remaining panels in collaboration with the robot. He determines that the sun will cast shadows over the installation structure, leading to potential difficulties. The astronaut asks control base to go through the final checks of the robot and prepare it for the operation.

3.2 Astronaut-Robot Interaction

The robot and the astronaut will collaborate with each other to achieve their shared goal, which is to install two solar panels. They will face various difficulties, ranging from the task being unpleasant and challenging to conflicts of their private and/or shared goals occurring because of a blocked or a protracted sub-task. The robot and the astronaut will go through a series of assessment processes to figure out a) how did the current blocking happen? b) why is the current task is blocked? and c) what is the next action they are going to take? The robot uses its cognitive abilities and its communication skills to overcome these problems and to motivate the astronaut to propose alternative tasks. The following is part of an interaction between the astronaut and the robot during their collaboration on installing solar panels.

A1. Astronaut: Oh no! Finishing the quality check of our installation with this measurement problem is so frustrating. I think we should stop now!
[Astronaut is frustrated.]

A2. Robot: I see. This is frustrating. But, I can help you with the measurement tool and we can finish the task as originally planned.
[Robot perceives Astronaut's frustration and acknowledges that.]

A3. Astronaut: Can you fix the measurement tool?

[*Astronaut's emotion is neutral.*]

A4. Robot: The next task is fixing the panel and it needs you to prepare and attach the welding rod to your welding tool. To save our time, I will fetch another measurement tool while you are preparing your welding tool.

[*Robot perceives Astronaut's neutral emotion, and tries to negotiate and provide a fair offer.*]

A5. Astronaut: That would be great!

[*Astronaut is content.*]

4 Affective Motivational Collaboration Theory

5 Computational Framework

6 Walk Through Computational Examples

6.1 Agreeing on Shared Goal (Emotion-Awareness)

6.2 Agreeing on Shared Goal (Emotion-Ignorance)

6.3 Delegation of a Task (Emotion-Awareness)

6.4 Delegation of a Task (Emotion-Ignorance)

7 Conclusion and Future Work

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