Empirical evaluation of human trust in an expressive mobile robot

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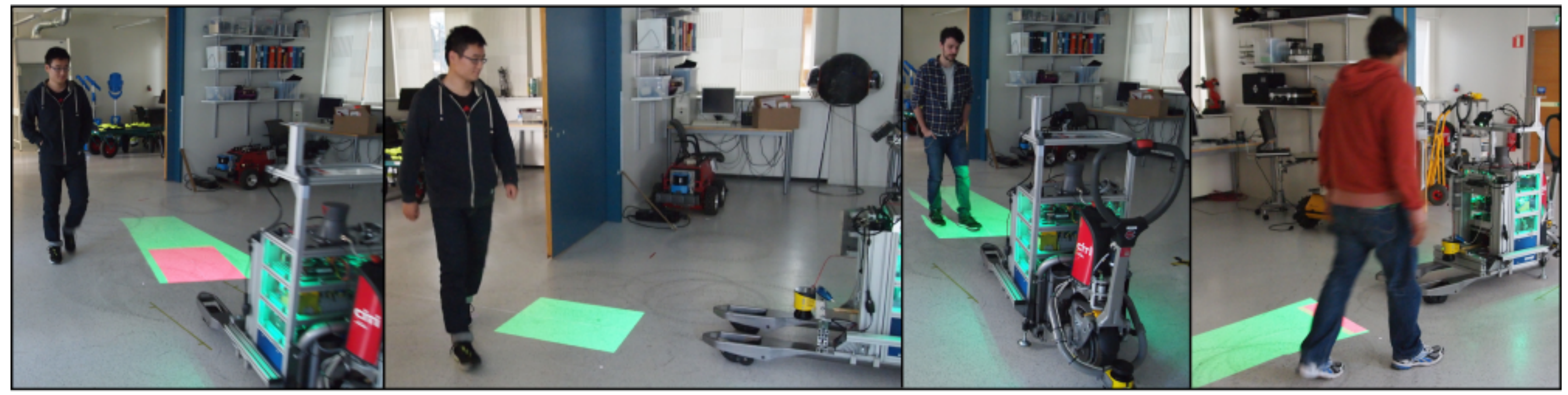
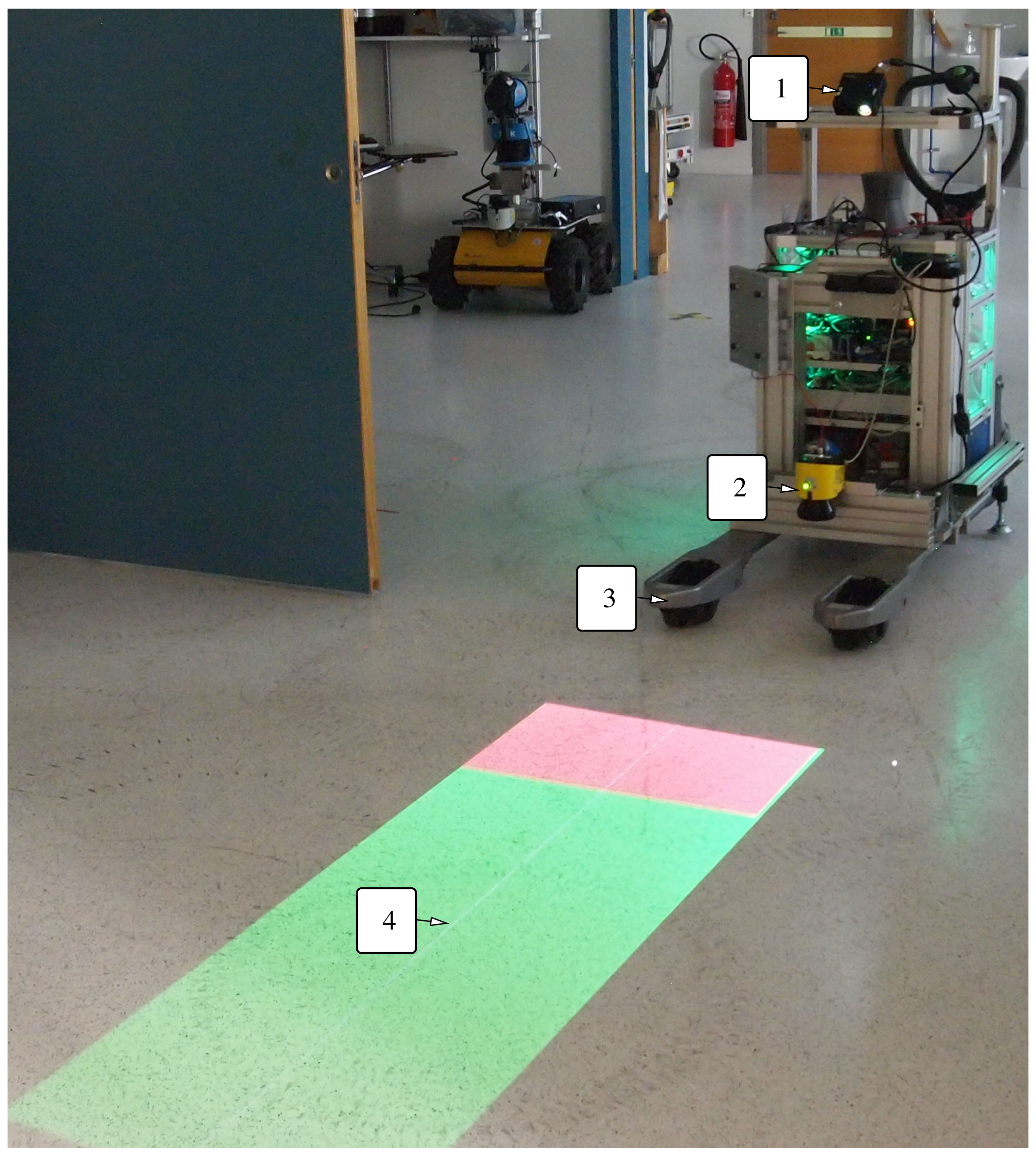
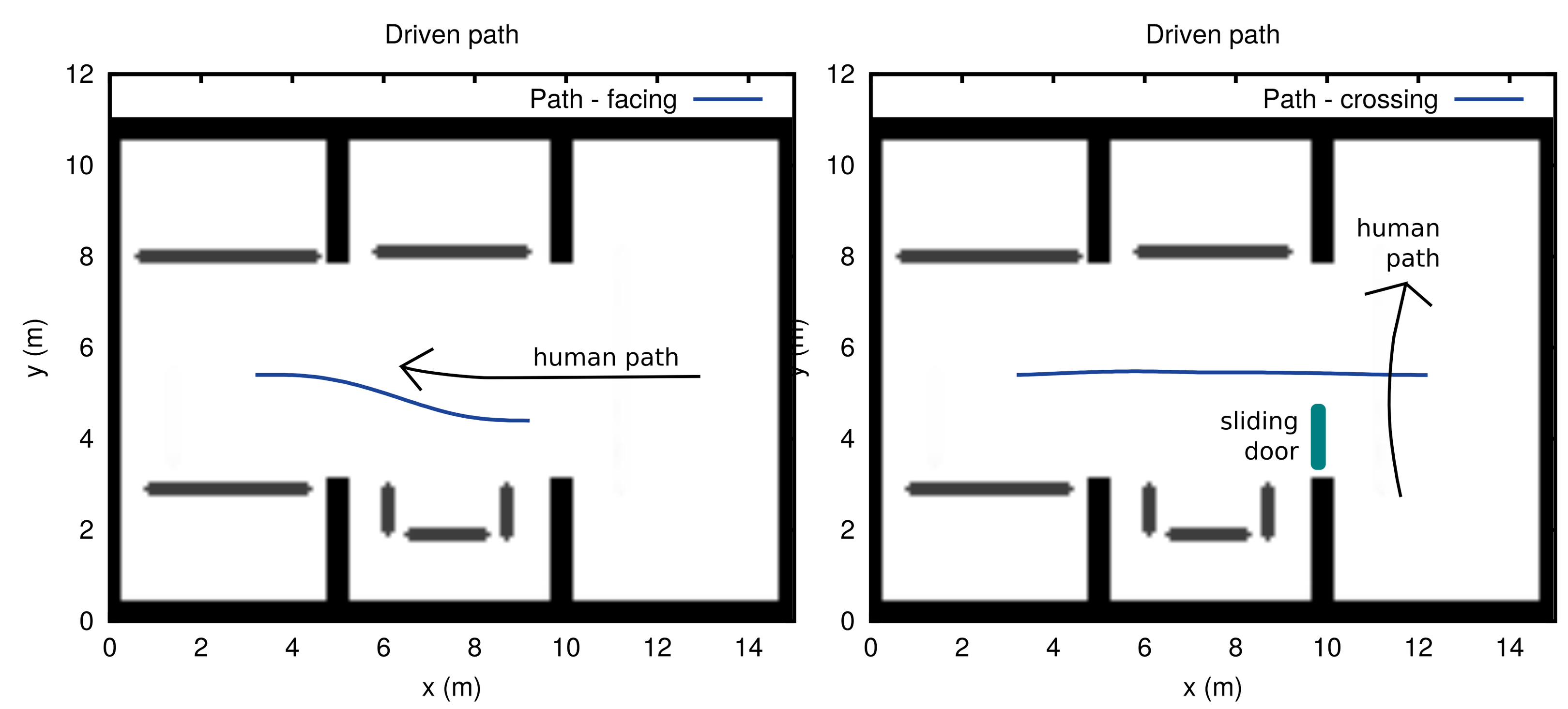
A mobile robot communicating its intentions using Spatial Augmented Reality (SAR) on the shared floor space makes humans feel safer and more comfortable around the robot. Our previous work and several other works established this fact. We built upon that work by adding an adaptable information and control to the SAR module. An empirical study about how a mobile robot builds trust in humans by communicating its intentions and responding to humans was conducted. A novel way of evaluating that trust is presented and experimentally shown that adaption in SAR module lead to natural interaction and the new evaluation system helped us discover that the comfort levels between human-robot approached those of human-human interactions.



A human stepping on the green area, which is supposed to be safe for walking, will cause the vehicle to slow down (speed is 0.05 m/s compared to the normal speed of 0.6 m/s). Red area represents an emergency-brake region, where if a human steps, the forklift will immediately stop.



Platform used for the evaluations: A standard projector (Optoma ML 750) (1) is mounted on a retrofitted Linde CitiTruck forklift AGV (3). Two SICK S300 scanners are mounted in front (2) and back to ensure safety for human co-workers. A projector is used to project the intention of the vehicle on the ground plane in front of the truck (4). The white line represents the future trajectory of the robot. The green area indicates the occupied vehicle footprint over the next 5 seconds, the area needed for an emergency stop is shown in red.



Experimental Design: Pilot Experiment 1 (left) – the two interacting agents approach each other head-on; Pilot Experiment 2 (right) – the two agents meet at a junction-crossing. Blue line represents the robot's trajectory.

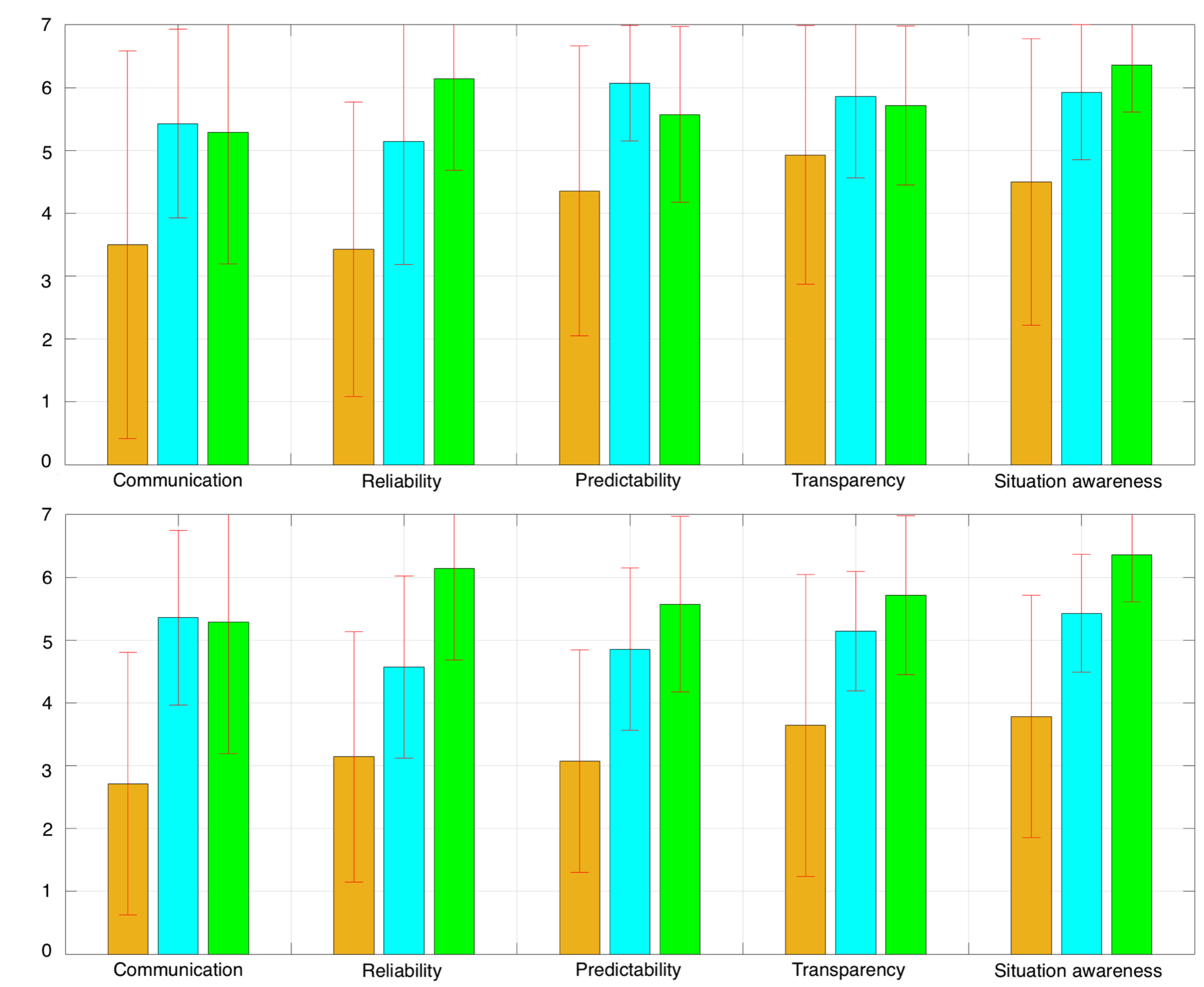
In each pilot experiment every subject had three tasks.

Task 1: Human-Robot encounter

Task 2: Human-Robot with projection encounter,

Task 3: Human-Human encounter.

Upon the completion of tasks, subjects were asked to rate their experience on a Likert scale against the chosen attributes. The task 3 where the human encounters another human was designed in order to create a benchmark for the evaluations. This way of evaluation is expected to bring in more originality to the ratings as the subject interacts with the robot in a similar situation.



Mean of Likert scale results from the pilot experiment 1 (above) and pilot experiment 2 (below) with 14 subjects. Orange, blue and green bars represent task 1, task 2 and task 3 respectively.

	$Pilot experiment - 1$	$Pilot experiment - 2$
One way ANOVA test	$F(2, 12) = 16.94470353$, p = .0003	$F(2, 12) = 50.51658291$ $p = 0.0000014$
Tukeys HSD test	$Group - 1$ $significantly different$	$Group - 1$ $significantly different$

Results from One way ANOVA test and Tukeys HSD test over three groups for two pilot experiments.

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