Approach and Handover for Human-Robot Interaction

P. Basili[1], M. Huber[1], O. Kourakos[2], S. Hirche[2], T. Brandt[1], S. Glasauer[1]

[1]Center for Sensorimotor Research, Clinical Neurosciences, Ludwig-Maximilians-Universität München
[2]Institute of Automatic Control Engineering, Technische Universität München

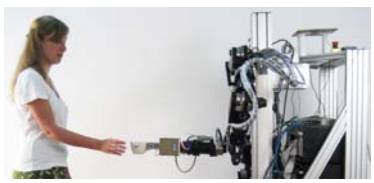
Introduction

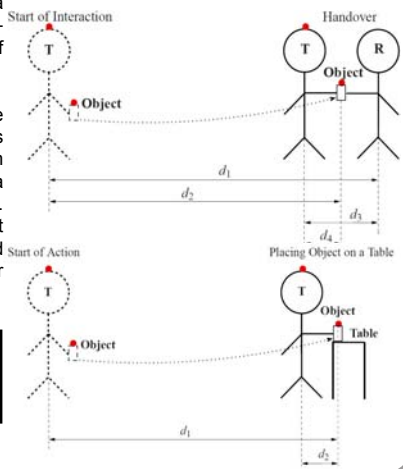
Humans interact safely, effortlessly and intuitively with each other. Human-centered human-robot interaction posits that humans can intuitively interact with robots, if the robots behave in a familiar, human-like fashion. To achieve an effective interaction in a human-robot approach-and-handover scenario, we thus analyzed how an approaching person hands over an object to a standing person [1]. We further investigated whether the observed behavioral patterns depended on two humans being present by replacing the receiving subject with a table. In a second experimental setup we analyzed the trajectory and gaze behavior of a person during a goal-directed approach. We aim to implement the respective behavioral pattern (inter-personal distances, trajectory, head and gaze movements) in a robotic assistant in order to improve and facilitate human-robot interaction.

Frontal Approach and Hand-Over

In order to validate the choice of behavioral parameters in recent studies on human-robot interaction [2], we investigated two inter-action scenarios: a frontal approach hand-over and a placement of an item on a table.

The position of the approaching person's head and of the item were measured with a motion tracking system. The distance at the start (d1,d2) and at end (d3,d4) of the handover were also measured.





T Transporting Subject
R Receiving Subject
Tracking Sensor

Results

Hand movement starts during the approaching phase: 1.2s before handover

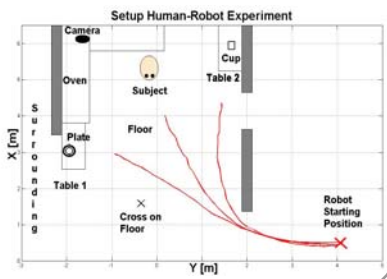
Approaching person is still walking at the moment of handover

Similar behavior in both scenarios. The only significant difference was the peak hand velocity: hand movement was slower for handover.

Gaze fixations during approach

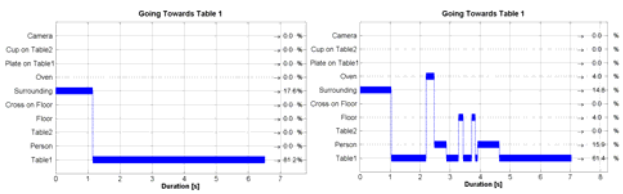
Intention recognition is the basis of effective interaction. Here we investigated whether gaze direction can be used as predictor for goal-directed behavior in an approach scenario.

Using the EyeSeeCam video-oculography [3], the gaze of several subjects was recorded while approaching one of three targets (Table 1, another person, Table 2). For further analysis, only large saccades were considered.

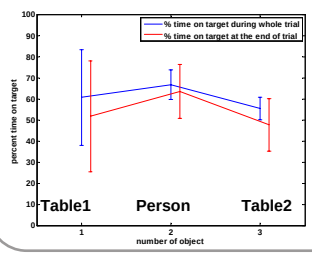


Results

Large inter-individual differences of gaze behavior when approaching the same target (see examples below)



Fixation of the goal object during the last 55% of the approach leads to a possible intention recognition based on gaze direction approximately 3s in advance



Objects most looked at:

1. Goal Object
2. Floor
3. Surroundings
4. Oven

→No significant difference in fixation duration for type of object or location

Conclusions

In both approach experiments, we identified variables which can be used to predict the intention of the approaching person. During approach-and-handover, the movement of the acting hand started more than 1 s in advance. During a goal-directed approach, humans look at the goal about 3 s in advance. We assume that humans can recognize these indications and use them for predicting future actions, which facilitates interaction between humans. The present results can be transferred to robotic systems and used to improve human robot interaction by making the robot's intention easily recognizable.

[1] P. Basili, M.Huber, T. Brandt, S. Hirche, S. Glasauer, "Investigating Human-Human Approach and Hand-Over", in The book of „Human Centered Robot Systems. Cognition, Interaction, Technology", pp. 151-160, Heidelberg, Germany: Springer Verlag, 2009.
[2] E. A. Sisbot, A. Clodic, R. Alami, M. Ransan, "Supervision and Motion Planning for a Mobile Manipulator interacting with Humans", ACM/IEEE International Conference on Human-Robot Interaction, pp. 327-334, 2008.
[3] E. Schneider et al., " EyeSeeCam: An eye movement-driven head camera for the examination of natural visual exploration", Ann. NY Acad. Sci, vol. 1431, pp. 461-467, 2008.