Field observation: interactions between pedestrians and a delivery robot

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Abstract— Human-robot encounters in public spaces represent diverse and complex social situations and will raise new demands for theoretical foundations and methods used in HRI. In an exploratory field study with covert observation in an urban public space using a mock-up of a delivery-robot in a wizard-oz-approach, we hope to gain insights into spontaneous human-robot encounters. We outline and discuss an approach and setup for field observation and present exemplary cases from a pilot study.

I. Introduction

As robots become increasingly capable of navigating unstructured environments and are deployed in public spaces, the circumstances of human-robot encounters will change dramatically: In a public space like a sidewalk, many people affected will not be users, deliberately seeking an interaction with the robot, but will just "happen to be there". In previous work, we have proposed to refer to these people as *InCoPs* (incidentally copresent persons) [1]. Also, many encounters will not be limited to one human and one robot, but may include groups of people. Consequently, research in human-robot interaction (HRI) needs to extend its scope to address these more diverse and complex social environments. This concerns both the methods (e.g., the majority of HRI studies is still conducted in a laboratory environment [3]) as well as the theories used (e.g., most HRI research is limited to dyadic interaction between one human and one robot [5], [4]).

In recent years, some exploratory field studies have provided first insights into HRI in public spaces. Observed reactions of pedestrians ranged from indifference to explorative, obstructive and aggressive behavior. In an public urban place [6] and a shopping mall [7] [2], mobile social robots have been observed to be stopped, explored and even abused verbally and physically. The obstruction and abuse was often committed by groups of unsupervised children and in a continuously escalating progression from obstructive to aggressive behavior. In contrast to these instances of robot abuse, pedestrians have also been shown to be willing to help a guide robot [8]. Beyond these elaborate interactions, many human-robot encounters in urban environments like sidewalks will consist of causal passing situations, avoiding collision. These have been almost exclusively studied in laboratory environments (e.g. [9], [10]), which further underlines the need for studies of spontaneous encounters between naive humans and mobile robots "in the wild".

In the following, we will present an exemplary field study design to investigate spontaneous, natural encounters of humans and delivery robots in an urban environment. Based on our experience and two case analyses from a pilot study conducted in July 2020 in Aachen (Germany), we discuss the potential of gaining new scientific insights well as critical methodological challenges to address.
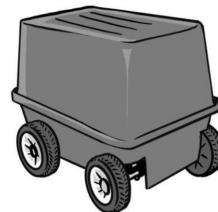
II. Methods and Results of a Field Observation

Fig. 1. Drawing of the robot mock-up used in the testing.

Natural interaction behaviour can be observed by conducting studies "in the field" [11]. By using a mock-up robotic system in a wizard-of-oz design, researchers can provoke and observe real and natural interactions between humans and robots. In our research project, we intend to observe and systematically categorise natural human behaviour in encounters between a delivery robot and pedestrians. The following study setup is used:

- **Robot**: low-cost self-built remote-controlled mock-up operated by a wizard hidden from the pedestrians
- **Recording setup**: up to three remote controlled pan/tilt/zoom cameras set up on tripods at about 180cm and a wireless microphone attached to the robot to capture utterances of pedestrians
- **Human observer**: placed openly, but inconspicuously nearby, listing behaviours and documenting events or utterances not captured on audio and video recording

In a pilot testing, three different locations were tested concerning their appropriateness for testing (camera setup, wizard and observer position, etc.). Each location was explored in 2-3 hours of observation and video and audio recording. In the following section, one location and two interaction scenarios (cases) at this location will be described.

A. Pilot Study: Case Analyses

This 3-hour pilot study was conducted in a car-free inner city pedestrian zone on a morning of a normal weekday. Pedestrians were mainly families with smaller children and

people of older age. The cameras were placed on the sides and were rarely detected by pedestrians. The wizard operating the robot (see Fig. 1) was hidden behind a small wall. The observer sat on a bench near the interaction scenario.

Data analyses of the video and audio recordings was done by identifying each interaction scenario individually (case) and qualitatively describing verbal and non-verbal behaviour during the interaction.

Fig. 2. Drawing of interaction case 1: family with two children.

1) Case 1: family with two children: A man and a woman with two young children (about 1,5 and 4 years old) approach on the sidewalk where the robot is driving (see Fig. 2). The older boy runs towards the robot and the robot stops. He looks at the robot from different angles at about 50 cm distance, touches the top of the robot once and addresses his parents: "Come, dad, I found something weird here!". The rest of the family approaches and when the younger child tries to touch the robot as well, the man picks up the child ("Don't touch that, sweetie"). As the family continues to walk, the boy says "The car is following me!". The parents have noticed the setup early and the woman points the boy to the wizard hiding behind a wall. After 90 seconds, the group leaves.

2) Case 2: couple of older age: A man and a woman walk towards the robot that drives ahead of them in the same direction of travel but at a slightly slower pace. The couple walks arm in arm towards it and the woman shakes her head, saying while walking past it: "This must be forbidden, such non-sense. People will trip over it. Beautiful!" The last word is spoken with irony. The couple does not stop or walk more slowly. They pass the robot with a slight turn to not bump into it and walk away without turning around. The man does not react to the woman's statement nor to the robot.

B. Planned Studies

The above mentioned pilot study served to test the study equipment and setup. Further studies will follow a two-step iterative process in researching human behaviour in spontaneous encounters with delivery robots:

- *exploratory field study:* Verbal and non-verbal behaviour of pedestrians will be gathered and analysed without predefined expectations, identifying and clustering common behaviours in encounters.
- *confirmatory field study:* This second study will serve to validate the identified behaviour categories and produce quantitative results on the frequency of behaviours.

These studies will advance earlier findings from anecdotal and observational research on natural interaction by applying a systematic and iterative research agenda. We aim to derive informed hypotheses about human behaviour in human-robot encounters that we can later test in laboratory studies.

III. DISCUSSION

Our pilot study illustrates the feasibility of field studies with a simple robot mock-up. From the behaviour observed and the comments we received when talking to pedestrians, we can infer that most people were easily convinced that our low-cost remote controlled vehicle can perceive and react to its surroundings and navigate autonomously. However, some pedestrians tend to immediately search for someone who belongs to the robot. The majority of pedestrians who approached us showed a lot of interest in the topic of delivery robots.

The children exhibited explorative behaviour and curiosity, which we have observed in several instances in our pilot study. The parents intervened immediately. This observation is in accordance with prior findings from field observations [7] [2], who found that the presence of adults reduced the risk of an interaction proceeding to longer obstruction and abuse. Case 1 also illustrated how a group dynamically interacts with a robot, responding to the robot itself as well as one another. The couple in case 2 did not stop to interact with the robot, which is the predominant behaviour we observed. The utterance of the woman shows that not all pedestrians welcome the presence of mobile robots on the sidewalks.

Future field studies will include short follow-up interviews with pedestrians to gain further insights into the pedestrians experience of the encounter. All of our studies have been approved by the ethics committee of the German Psychological Association and we follow a protocol for data security. In further studies, the following main factors for improvement will be applied:

- **Hiding the wizard**: we are currently searching for more appropriate locations in the city of Aachen.
- **Improving the robot mock-up**: we plan to use a more elaborated mock-up that resembles delivery robots more closely in its appearance, sound and movement. This mock-up is currently being built in our laboratory.
- **Pre-planning the trajectory**: the robot mock-up should deliver a realistic impression of a robot carrying a delivery, so that pedestrians are able to experience a realistic delivery situation.

In conclusion, this pilot study served to test the observational study equipment and setup. In further studies, we intend to gather a holistic and systematic understanding of human behaviour in spontaneous interactions with delivery robots through different methodological approaches in field observations.

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References

[1] Rosenthal-von der Pütten, Astrid; Sirkin, David; Abrams, Anna M. H.; Platte, Laura (2020): The Forgotten in HRI: Incidental Encounters with Robots in Public Spaces. In: HRI '20 Companion, March 23-26, 2020, Cambridge, United Kingdom.

[2] Yamada, Sachie and Kanda, Takayuki and Tomita, Kanako, An Escalating Model of Children's Robot Abuse in Proceedings of the 2020 ACM/IEEE International Conference on Human-Robot Interaction, 2020, pp. 191-199.

[3] Jung, Malte; Hinds, Pamela (2018): Robots in the Wild. In: J. Hum.-Robot Interact. 7 (1), S. 1-5. DOI: 10.1145/3208975.

[4] Abrams, A. M. H., Rosenthal-von der Pütten, A. M. (2020). I–C–E Framework: Concepts for Group Dynamics Research in Human-Robot Interaction. International Journal of Social Robotics, 1-17.

[5] Fraune, M. R., Sherrin, S., Šabanović, S., Smith, E. R. (2019, March). Is human-robot interaction more competitive between groups than between individuals?. In 2019 14th ACM/IEEE International Conference on Human-Robot Interaction (HRI) (pp. 104-113). IEEE.

[6] Salvini, P.; Ciaravella, G.; Yu, W.; Ferri, G.; Manzi, A.; Mazzolai, B. et al. (2010): How safe are service robots in urban environments? Bullying a robot. In: 19th International Symposium in Robot, 2010, S. 1-7.

[7] Brščić, Drazen; Kidokoro, Hiroyuki; Suehiro, Yoshitaka; Kanda, Takayuki (2015): Escaping from Children's Abuse of Social Robots. In: Julie A. Adams, William Smart, Bilge Mutlu und Leila Takayama (Hg.): HRI'15. Proceedings of the 2015 ACM/IEEE International Conference on Human-Robot Interaction : March 2-5, 2015, Portland, OR, USA. the Tenth Annual ACM/IEEE International Conference. Portland, Oregon, USA, 3/2/2015 - 3/5/2015. [New York]: ACM, Associaton for Computing Machinery, S. 59-66.

[8] Weiss, Astrid; Igelsböck, Judith; Tscheligi, Manfred; Bauer, Andrea; Kühnlenz, Kolja; Wollherr, Dirk; Buss, Martin (2010): Robots asking for directions - The willingness of passers-by to support robots. In: Pamela Hinds, Hiroshi Ishiguro, Takayuki Kanda und Peter Kahn (Hg.): Proceeding of the 5th ACM/IEEE international conference on Human-robot interaction - HRI '10. Proceeding of the 5th ACM/IEEE international conference. Osaka, Japan, 02.03.2010 - 05.03.2010. New York, New York, USA: ACM Press, S. 23-30.

[9] Hiroi, Yutaka; Ito, Akinori (2019): A Pedestrian Avoidance Method Considering Personal Space for a Guide Robot. In: Robotics 8 (4), S. 97. DOI: 10.3390/robotics8040097.

[10] Senft, Emmanuel; Satake, Satoru; Kanda, Takayuki (03092020): Would You Mind Me if I Pass by You? Socially-Appropriate Behaviour for an Omni-based Social Robot in Narrow Environment. In: Tony Belpaeme, James Young, Hatice Gunes und Laurel Riek (Hg.): Proceedings of the 2020 ACM/IEEE International Conference on Human-Robot Interaction. HRI '20: ACM/IEEE International Conference on Human-Robot Interaction. Cambridge United Kingdom, 23 03 2020 26 03 2020. New York, NY, USA: ACM, S. 539-547.

[11] Gravetter, F. J., Forzano, L. A. B. (2018). Research methods for the behavioral sciences. Cengage Learning.