Robots claiming space: gauging public reaction using computer vision techniques

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Robots claiming space: Gauging public reaction using computer vision techniques

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1 Introduction

Robots are increasingly being used outside of controlled environments (*e.g.*, factory floors or research labs) and in more complex, social shared-spaces, such as exhibitions events, care-homes, or in schools. In these environments, people may need to learn robots' behaviours to accommodate them; across the long-term, people may habituate towards robots' behaviours and even presence (*e.g.*, children lose interest in a robot during long-term interaction [3]). The long-term dynamics of public's interest in, and habituation towards, robots in shared-spaces is not yet well established.

We introduce a long-term study of robots in a social shared-space and Sheffield Robotics' investigation into the dynamics of the public's interest and habituation towards the robots. This abstract describes our establishing of the interdisciplinary project combining 1) social robotics research to gauge public interest in robots in everyday shared-spaces and 2) computer vision based analysis of site security camera footage to give (unobtrusive) people count and directional flow measurement.

The study has two key aims: 1) Explore factors affecting habituation towards robots in long-term interactions, particularly people's use of the shared-space around the robot 2) Develop effective and reliable non-invasive measures of public interest towards robots.

2 Study Design and Environmental Description

The long-term study (lasting a full academic year) explores a population's initial interest, and then habituation, towards robots in a shared-space. We anticipate regular users of the space may regard the robots as just 'part of the furniture' or even a mild inconvenience over time. Within the long-term study, we manipulate the robots used, their behaviour/functionality, and the context of the shared-space to explore factors affecting people's use of the shared-space and habituation towards robots. Across the study, the introduction of robots is staggered based on their complexity in behaviour and morphology: simple robots and behaviours first (*i.e.*, Guardian; Pioneer LX); more attractive and cunning robots are used later (*i.e.*, FETCH; Pepper).

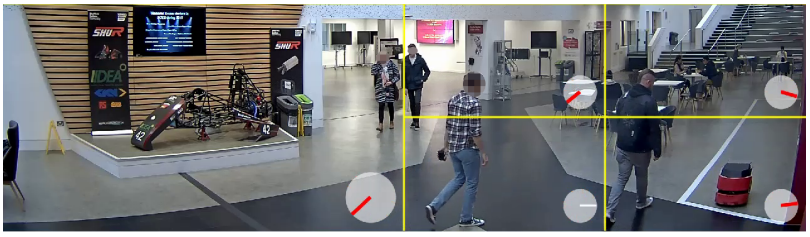

Fig. 1. Gauging public interests to robots in daily life using computer vision based flow analysis.

The research-site comprises a newly-opened atrium at Sheffield Hallam University: built for staff, students, and visitors on campus, it also serves a pass-through for commuters. This site is ideal for a long-term study, given the public-access and regular use. Fig. 1 shows the designated robot shared-space. Crowd and individual behaviour - and their use of space - is monitored via security camera footage.

3 Public Behavioral Pattern Analysis using Computer Vision

Video footage is captured using one overhead and three wall-mounted security cameras to analyse people's behavior towards robots, during working hours on weekdays. This set-up minimises intrusion into the environment (compared to staging with RGB-D cameras) to observe authentic behaviour. We have conducted primary analysis for busier times (1:00-2:00pm), using a popular aggregated channel feature (ACF) algorithm [2] to count people in the scene via upper-body detection for persons. This identifies how busy the environment is, from which, we can explore the impact of crowd density on robot interaction. Recordings are compared on a week on week basis, in hourly fashion.

Individuals' movement is calculated using optic flow analysis [1]; individual body parts' motions are aggregated to give motion for each detected individual. We divide the visual scene into quadtree-structure regions for fine-grain analysis of the robot's shared-space (Fig. 1). Finally, we average collective motions in each region for directional flow (*red* lines on white discs) to give coarse-grain cues of public attention to robots.

4 Summary

This abstract outlines our research interest, and study-layout in a long-term study of human robot interaction in shared-spaces. We identify suitable data-collection and analysis techniques for large volumes of crowd- and individual-level interactions with robots. Further development in this study, explores a robot's appearance and/or behaviour's influence on crowds and examines changes in interaction with robots in a shared-space.

References

1. Barron, J.L., Fleet, D.J., Beauchemin, S.S., Burkitt, T.A.: Performance of optical flow techniques pp. 236–242 (1992)
2. Dollár, P., Appel, R., Belongie, S., Perona, P.: Fast feature pyramids for object detection. IEEE Trans. on Image Processing 36(8), 1532–1545 (2014)
3. Kanda, T., Sato, R., Saiwaki, N., Ishiguro, H.: A two-month field trial in an elementary school for long-term human–robot interaction. IEEE Transactions on robotics 23(5), 962–971 (2007)