NRI: FND: Spatial Patterns of Behavior in HRI Under Environmental Spatial Constraints

PI: **Marynel Vázquez**, Yale University. http://www.interactive-machines.com/projects/spatial

This project aims to advance autonomous reasoning about spatial patterns of behavior during human-robot conversations. It provides empirical knowledge and methods to incorporate spatial constraints into the way robots reason about spatial formations.

The Challenge

Prior work has shown that methods that reason about human spatial behavior, such as the arrangements shown in Fig. 1, are promising for automatic conversational group detection. However, these methods tend to be brittle because they build on simple mathematical models of spatial formations. These models do not consider that the configuration of the space where the interactions happen and the presence of other nearby people can affect human spatial patterns of behavior [1].

Scientific Impact

As robots enter consumer marketplaces, it is essential for them to be able to cope with the complexity of group interactions. Spatial reasoning is a foundational ability to facilitate group HRI in domains like service robotics, education and healthcare.

This project focuses on studying:

1) How do spatial constraints influence conversational group formations in HRI?
2) How can robots detect these formations under spatial constraints?
3) How can they autonomously generate appropriate spatial behavior to sustain conversations in constrained environments?

Broader Impacts

The methods and insights gained from this project are relevant to robotics applications in a wide range of critical, socially relevant domains. For all publications, we have open-sourced our code, lowering barriers of entry to this line of research.

Thus far, this project has provided training for 3 PhD students and 9 undergrads (including 4 female students and 1 student of color). Research findings have been incorporated in class lectures (e.g., AI, HCI) and used to engage middle school and high school students with our research via presentations at 4 outreach events.

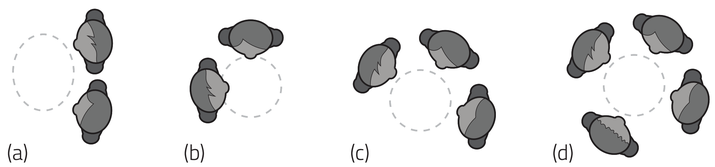

Fig. 1. Conversational spatial arrangements. Left to right: side-by-side (a), L formation (b), and circular formation (c,d).

Contributions

We proposed a **data-driven approach to detect conversational groups** [2]. The approach combined neural networks with graph clustering to identify interactions. We are now testing this approach in more complex settings and adapting it to generate appropriate spatial behavior for robots during conversations, subject to environmental spatial constraints.

We developed an approach to gather qualitative human feedback about conversational group formations in HRI via an online survey (Fig. 2). We used this approach to advance our **understanding of the effects of robot embodiment on human perception of conversational groups** in a realistic human environment [3]. Our results indicated that an important factor to consider in terms of how people perceive these groups is whether robot embodiment leads to discernible robot orientation.

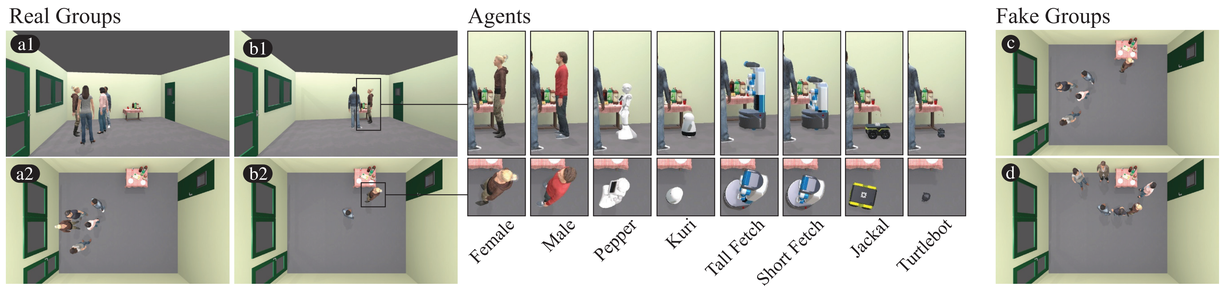

Fig. 2. Stimuli used in our study to investigate the effect of robot embodiment on conversational group perception. Participants provided their opinions of real and fake groups that were generated using data from real human conversations. Image a2 shows a top-down view of a1; b2 shows a top-down view of b1. The middle shows renderings of b1 and b2 for all the agents that were considered in the study.

Robotics@Yale
INTERACTIVE MACHINES GROUP

References

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