A Pilot Study on Human Reactions to Robot Dogs: Stress and Perceived Safety in Indoor Settings

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Introduction

Motivation:

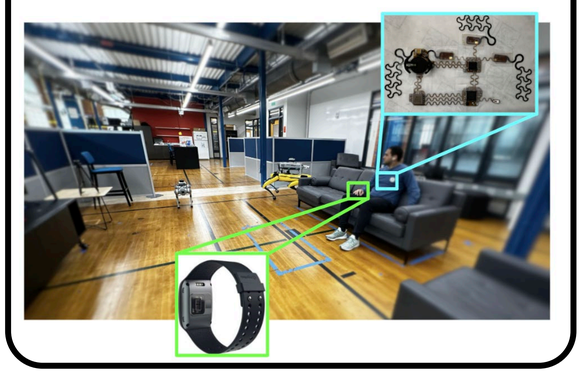
- As mobile robots **proliferate in communities**, designers must consider the impacts these systems have on the users, onlookers and places they encounter
- It becomes increasingly necessary to study situations where **humans and robots coexist in common spaces,** even if they are not directly interacting

Hypothesis:

Non-invasive physiological sensors allow for **tracking perceived safety during human-robot encounters** by decoding acute stress levels from known biomarkers in electrocardiography (ECG) and electrodermal activity (EDA) data.

Significance:

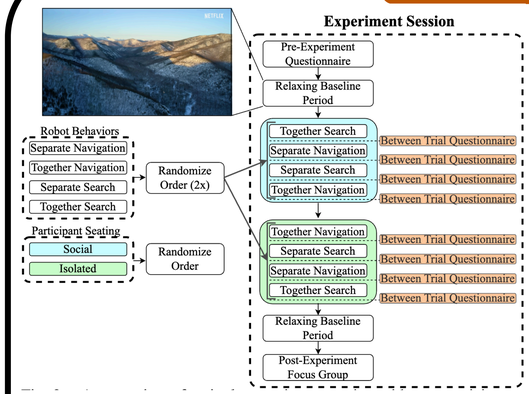
1. To the best of our knowledge, this is the first attempt to analyze the human physiological response to mobile quadrupeds. Achieved by the deployment of a two quadruped robots in a realistic apartment setting **(See Figure Below)**
2. We define and characterize human-robot *encounters* as a subset of human-robot interactions that involve the humans and robots in question simply coexist in a shared space with awareness of one another but are not necessarily actively interacting with one another.

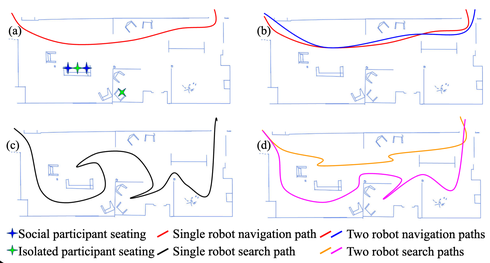


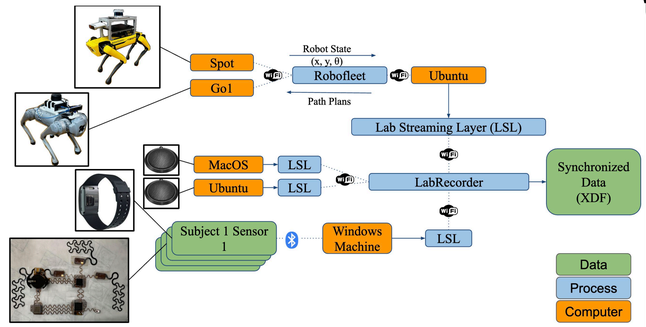
Research Questions

- What mobile robot dog behaviors and characteristics most strongly influence human stress response?
- Do participants feel more comfortable when seated together vs. when isolated?
- Do participants have a stress response when robots are present compared to baseline sessions?

Study Design



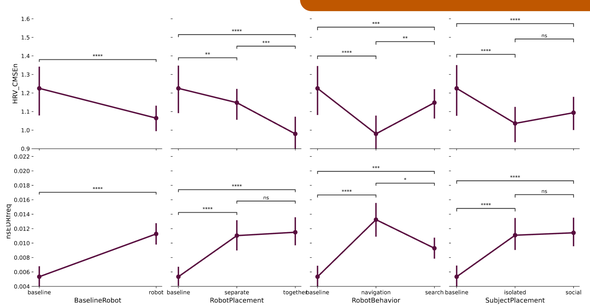




We conduct a study with 24 total participants over 13 total sessions. This study is approved by the University of Texas Institutional Review Board (**IRB #00004099**).

- Study sessions are outlined in the **upper left figure**
- **Control Variables**: (1) single v. multi-robot, (2) navigation v. search behavior, and (3) social v. isolated seating (see **lower left figure**)
- **Data is collected** from a smart watch, an ECG E-tattoo and the robots in real time during experiments (see **upper right figure**)

Results



All subject differences for the principal features HRV_{CMSEn} and nsEDRfreq in each possible experimental condition. ns: 0.05 < p; *: 0.01 < p <= 0.05; **: 0.001 < p <= 0.01; ***: 0.0001 < p <= 0.001; ****: p <= 0.0001.

Overall data with all subjects' data combined, the Mann-Whitney-Wilcoxon two-sided test for interval data (See Above Fig). On average, we found that subjects were:

1. more nervous whenever the robots were in the shared environment compared to when they were not;
2. more nervous when the robots were travelling together rather than alone;
3. more nervous when the robots were navigating compared to searching;
4. and whether subjects were sitting alone or together did not induce significant changes in the principal stress-related features examined

RESULTS OF THE REPEATED MEASURES ANOVA TEST FOR NUMBER OF PHASIC EDA RESPONSES DURING EACH ENCOUNTER CONDITION

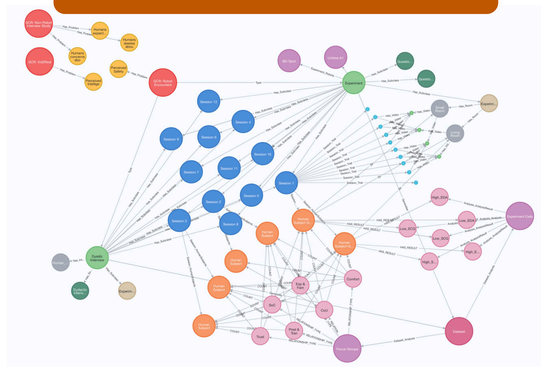
	F value	p-value
BaselineRobot	13.477	0.000365***
SubjectPlacement	0.463	0.498
RobotBehavior	5.986	0.0159*
RobotPlacement	2.215	0.139

***p-value < 0.001; *p-value < 0.05.

Code	Number of interviewees	Relative frequency of interviewees (%)	Number of references	Relative frequency of references (%)
Context of Use	24	100%	104	25%
Experience & Familiarity	22	91.67%	64	15%
Comfort	23	95.83%	85	20%
Sense of Control	18	75%	33	8%
Trust	21	87.50%	46	11%
Predictability & Transparency	23	95.83%	91	22%

Results from the content analysis performed on the focus group data. Codes are found as factors influencing perceived safety from ref. [2].

Dataset Publication



The data is being curated into a **graph that represents the relationships between data**, processes involved in data generation and results. This process is ongoing for publication into the Texas Data Repository.

Scan the QR Code on the right for a video demonstration of the database and a novel GPT trained to output commands to interface with the graph database from natural language queries.

Acknowledgments

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References

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[2] - Neziha Akalin, Andrey Kiselev, Annica Kristoffersson, and Amy Loutfi. A taxonomy of factors influencing perceived safety in human–robot interaction. International Journal of Social Robotics, 15(12):1993–2004, 2023.