Projector System

Experiment Setup

There will be two groups of trials. In the experimental group, the robot will project arrows onto the ground in the direction of its travel, with different colored arrows for different speeds, as well as projecting a signal when it has identified the presence of a human. In the control group, the robot will utilize no projections

1. Human stands in marked location near one wall of the hallway and is told not to move. A video camera is placed across the hall to film the human's reactions during the trials.

2. Robot is placed on starting mark furthest from human.

3. Robot executes the pre-planned path corresponding to the furthest mark at a slow speed.

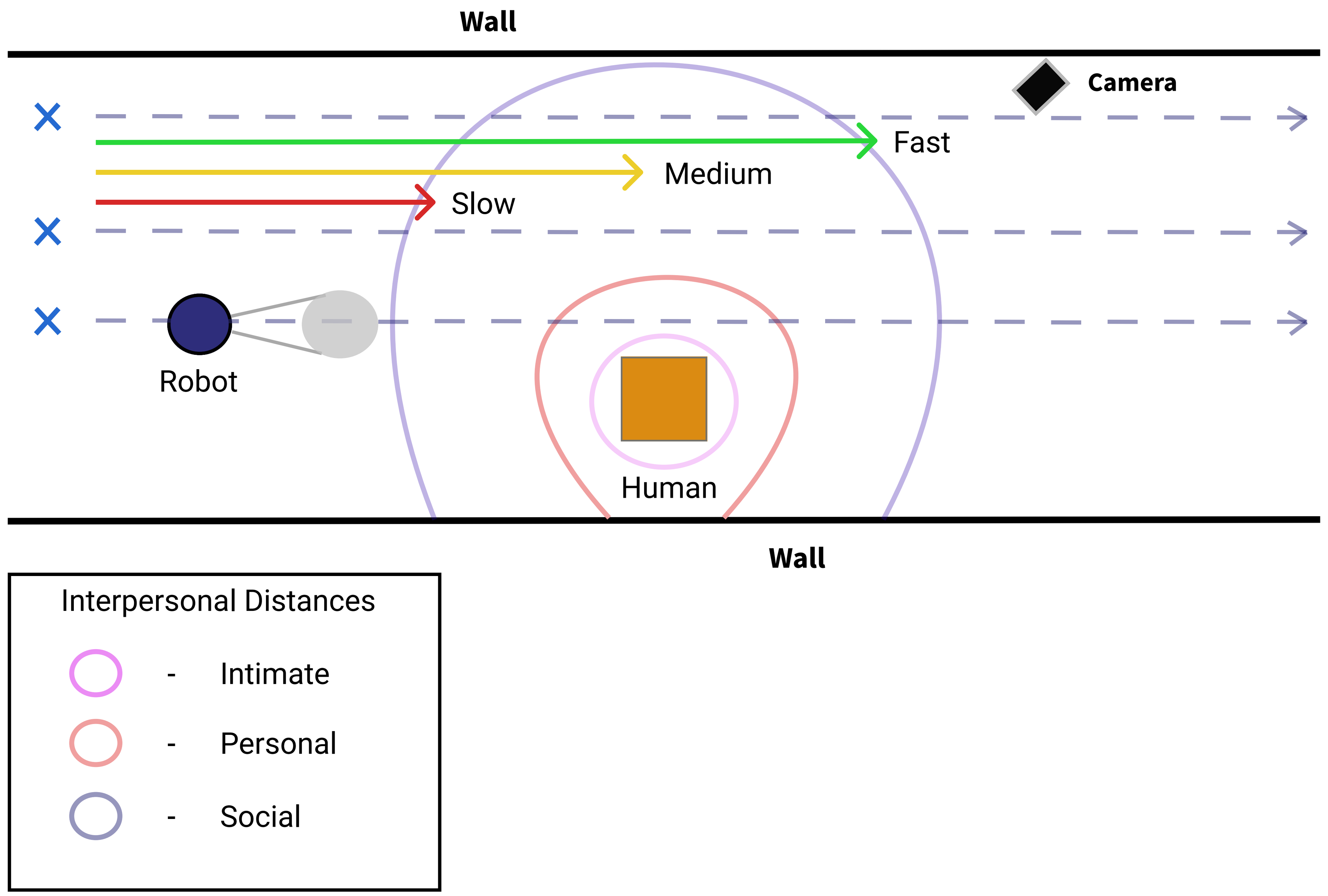
4. After the trial, human rates their level of comfort/safety/security on a scale of 1 to 5, with 1 being "completely comfortable" and 5 being "extremely uncomfortable"

5. Robot is reset at the same starting point, then re-runs the same path with medium and fast speeds, and human rates each trial after its completion

6. Robot is moved progressively closer to human and runs each path three times, one for each speed level - for three starting locations, this is a total of nine trials

7. After finishing all the trials, the human subject completes a survey about their level of perceived security, comfort, and safety and what the human subject thought the robot's projectors were conveying. Footage of the experiment will be reviewed for evaluation of behavioral metrics.

Experiment Diagram



Experiment Background

Interactions between humans are defined by communication through many levels of physical channels, ranging from verbal communication to eye movements. Many psychologists believe that nonverbal communication, like hand and eye movements, account for over 60% of the communication between two humans [1]. This poses a challenge to the goal of developing robots that interact smoothly with humans, as many of these movements are subtle and challenging to quantify for actionable responses. Even if robots are able to interpret all nonverbal cues, many robots do not have the physical capability to return these signals in the same fashion. Such bi-directional communication would require the robot to have effectors that mimic human body features like eyes, lips, and hands to effectively re-create human responses.

This research aims to circumvent the complexies of social navigation by proposing another method of human-robotic communication. Using a projector affixed to the robot's frame, the robot will project arrows along the ground that indicate the direction of the robot's movement and the speed it is travelling at. This method will clearly communicate the robot's navigational intent to the human, and it does not require any processing of the complexities of human social interaction or complicated effectors to mimic human social responses.

To measure the human subjects' levels of perceived safety, the experiment will use a combination of questionnaires and behavioral metrics to evaluate the human subjects' responses to the robot's movements.
The questionnaires will be created with input from recognized questionnaires used in human-robotic interaction experiments (Godspeed, BEHAVE-II, NARS). The experiments will be recorded for later observation of the human subjects' behavior during the experiment [2].

Citations:
1. Hogan K, Stubbs R (2003) Can't get through: eight barriers to communication. Pelican Publishing. Grenta

2. Lasota P, Fong T, Shah J (2014) A Survey of Methods for Safe Human-Robot Interaction. Foundations and Trends in Robotics. 5(4):261-349.