Emotive Non-Anthropomorphic Robots Perceived as More Calming, Friendly, and Attentive for Victim Management

Cindy L. Bethel, Ph.D.
Department of Computer Science
Yale University
New Haven, CT
cindy.bethel@yale.edu

Robin R. Murphy, Ph.D.
Center for Robot-Assisted Search and Rescue
Texas A & M University
College Station, TX
murphy@cse.tamu.edu

Abstract

This paper describes results from a large-scale, complex human study using non-facial and non-verbal affect for victim management in robot-assisted Urban Search and Rescue Applications. Statistically significant results are presented that indicate participants felt emotive robots were more calming, friendlier, and attentive.

Introduction

This study evaluated the impact of using non-facial and non-verbal affective expressions for victim management in robot-assisted Urban Search and Rescue applications (US&R). On average it takes between 4-10 hours to extricate victims of disasters once they are located and during that time robots remain with victims to monitor their condition and the surrounding environment (Murphy, Riddle, and Rasmussen 2004). A major concern in victim management is a condition known as shock. It is essential that victims remain calm to aid in the prevention of shock (Jones and Kline 2009). This study used two non-anthropomorphic US&R robots (Inuktun Extreme-VGTV and iRobot Packbot Scout- see Fig. 1) that were programmed to operate in an emotive mode using non-facial and non-verbal affective expressions or in a standard mode. Non-facial and non-verbal affective expressions were implemented because the field robots currently in use in US&R applications are necessarily appearance-constrained and non-anthropomorphic and may be required to socially interact with humans(Bethel and Murphy 2008). The non-verbal methods of affective expression and communication used for this study (movements, postures, and orientation) can be implemented through software and require no physical modification of the robots (for design recommendations based on proximity refer to (Bethel and Murphy 2008)).

The robots operated in the standard mode were programmed to rapidly approach participants, had quick and erratic movements, raised to full height, and turned away from participants to observe the surrounding environment. These robot behaviors were based on observations of robot operators in emergency response training exercises (Murphy, Riddle, and Rasmussen 2004). These behaviors made the robots appear aggressive and increased arousal levels of participants. In the emotive mode, the robots approached participants slowly exhibiting interest, movements were slow and controlled, the robots remained lower to the ground, and maintained orientation toward participants to show attentiveness.

Figure 1: The Robots: iRobot Packbot Scout (left) and Inuktun Extreme-VGTV (right).

Experimental Design

The study was conducted in a high-fidelity, confined space, simulated disaster site (see Fig. 2) in a laboratory setting with all experiments conducted in the dark using infrared cameras. The study utilized multiple self-assessments, psychophysiology measures (EKG, skin conductance level, and respiration), structured follow-up interview, and video-observations from four different camera angles (overhead, upper torso, robot, and participant views). The study included 128 participants, 79 females and 49 males, ages 18 - 62. This was a mixed-model design with robot (Inuktun and Packbot) the within-subjects factor; operating mode (standard or emotive) and robot order (Inuktun first or Packbot first) were the between-subject factors. Participants were randomly assigned to interact with both robots in either the standard mode or the emotive mode with order counterbalanced.

Results

Doubly multivariate analyses of variance were conducted for the self-assessments. The effects of the factors of interest (robot, operating mode, and robot order) were evaluated using the Self-Assessment Manikin (SAM) (Bradley and Lang 1994) and a Robot Survey (Mutlu et al. 2006). The results from the arousal (calm vs. excited) dimension of the SAM

Figure 2: Confined simulated disaster site.

assessment indicated a statistically significant main effect (α = .05) of operating mode on arousal F(1,123) = 12.05, p = .001 (See Fig. 3). Participants exposed to robots in the emotive mode reported feeling calmer.

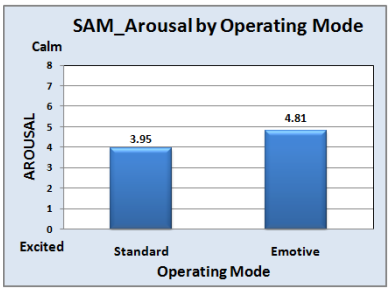

Figure 3: Graph of the main effect of arousal from the SAM assessment.

Results from the Robot Survey indicated a statistically significant main effect (α = .05) for operating mode on friendliness (unfriendly vs. friendly) F(1,124) = 5.631, p = .019. The values for robot friendliness reported by participants exposed to robots in the emotive mode were higher (M = 4.95) compared to the standard mode (M = 4.47). Higher values indicate the robot was perceived as more friendly. Participants exposed to robots operated in the emotive mode reported feeling that the robots were friendlier.

The Robot Survey results indicated a main effect of operating mode on the question *"How much did the robot look at you?"* (α = .05) based on percentages F(1,124) = 6.491, p = .012. The perceived percentage of time the robots looked at the participants was higher (M = 63.48) with robots operated in the emotive mode compared with robots in the standard mode (M = 54.84). Participants exposed to robots in the emotive mode reported that the robots spent more time looking at them indicating a higher level of attentiveness.

Conclusions

This study revealed three statistically significant main effects: arousal by operating mode, friendliness by operating mode, and attentiveness by operating mode. There were no other factors that impacted each of these results. The results indicate that participants were calmer when exposed to robots operated in the emotive mode. They reported feeling that the emotive robots were friendlier and spent more time oriented toward them. This research demonstrates that the use of non-facial and non-verbal affect (movements, postures, and orientation) for victim management in US&R applications impacts how victims respond to the US&R robots. Victims will be calmer, and likely feel more comfortable with robots they perceive as being friendly and attentive, which will lower arousal levels and could lower the risk for shock onset. The responses obtained in this study were apparent in a lab setting and it is expected that the responses would be more noticeable in a disaster environment.

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