Social Head Gaze and Proxemics Scaling for an Affective Robot Used in Victim Management

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I. Introduction

This paper evaluates the use of social head gaze and proxemic scaling in an affective robot for victim management using two large scale simulated Urban Search and Rescue (US&R) scenario studies.On average between four and ten hours pass from the time a victim is discovered to the time of extrication of the victims [2], [5]. During this time an urban search and rescue robot remains with the victim to monitor their condition and the environment. Throughout this critical period, it is important that the robot interacts with the victims in a socially appropriate way in order to reduce stress levels, keep the victims calm, at ease, positive, and engaged until assistance arrives while preventing a condition known as shock [4].

In order to evaluate two critical social factors, head gaze and proxemics, two studies were preformed in a high fidelity urban search and rescue scenario. The two studies reported in this paper used Survivor Buddy, a four degrees of freedom affective multimedia head mounted on an Inuktun Extreme-VGTV robot (refer to Figure 1). The system is capable of travelling through small spaces when the Survivor Buddy head is in the folded position, but expands into a fully affective system once a victim is encountered. In the first study Survivor Buddy used social head gaze behaviors as described in [7] with the robot base remaining stationary, while in the second study these head gaze behaviors were modified using scaling functions based on distance as the robot moved towards the participants.

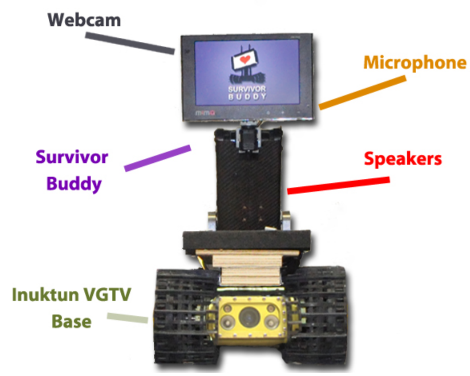

Fig. 1. Survivor Buddy

II. Study 1: Social Head Gaze

The first study examined the role of social head gaze for victim management. The study featured a 1X3 (manual gaze, autonomous gaze, no gaze) design. The study used 93 participants following 80% power, a medium effect size of 0.25 and an $\alpha = 0.05$. The participants consisted of 53 males and 40 females with an age range of 18-67 ($M = 32.38, SD = 14.84$). We hypothesized that participants would prefer a robot with social gaze behaviors than a robot which did not have any gaze behaviors at all. The participants were placed in a simulated confined space (refer Figure 2) in a dark room at beginning of the study. Then a video of a disaster situation was played after which the robot held a 15 minute dialog with the participants who played the role of a trapped victim. The robot followed guidelines for a 911 dispatcher and focused on assessing the participants physical health and gaining information as to location and nature of the event. Depending on the condition the robot generated gaze that was manually synchronized with speech a-priori or autonomously generated in real time using the behavioral robotics framework described in [7] or did not generate gaze at all. The participants then completed a 143 question post interaction assessment, after [1], [6], [3], in order to access participants' affective state and perceptions of the robot. A univariate ANOVA on conducted on the self assessments indicated that both the gaze conditions (autonomous and manual) were rated positively ($p < .05$) for measures of comfort, likability, robot caring, robot empathy, human-like behavior, and understanding of robot behavior when compared to the no gaze condition. Additionally, only the autonomous condition showed statistically significant improvements ($p < .05$) over the no gaze condition for robot integrity, robot loyalty, at ease, engagement and positive feelings.

III. Study 2: Proxemics Scaling

The second study explored the role of proxemic scaling of robot actuation during victim management tasks. The study, a 1x3 (no scaling, linear scaling, logarithmic scaling) between-subjects design, investigated the difference between three

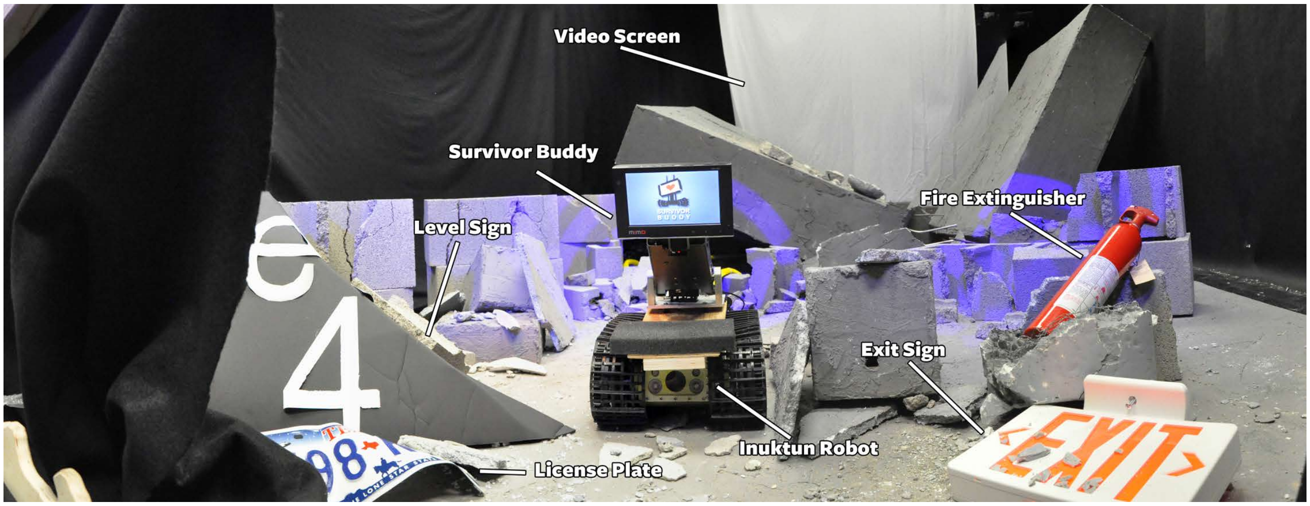

Fig. 2. The simulated disaster area from the participants point of view.

proxemic scaling conditions. The control condition featured a robot performing victim management tasks using a medium level of actuation magnitude for traversing the environment, moving its affective head, and controlling its headlight brightness. In the other two conditions, the robot performed the same tasks, but varied its actuation magnitude based upon proximity and a proxemic scaling function. In one case, the robot used a linear function to scale its movements (closer to victim meant smaller movements) and in the other case the robot used a logarithmic-based function to scale its movements (closer to victim meant smaller movements). The scenario used was similar to the study in Section II, with the exception that the robot was mobile and traversed through all four proxemic zones (from 3.66 to 0.1 m) as it held a conversation with the participant. Once the robot was very close to the participant, it asked the participant to place their hand on its base, with the premise of taking vital signs.

The study yielded significant differences in ratings of the robot between conditions. Through subjective evaluations (N=72), areas of: comfort ($p < .001$), natural movement ($p < .001$), safety ($p < .02$), self-control ($p < .02$), intelligence ($p < .01$), likability ($p < .01$), and submissiveness ($p < .001$) were all found to be significantly higher in the logarithmic scaling condition in comparison to at least one other condition. The attribute of personal space consideration was found to be significantly better with either type of scaling in comparison to the control condition.

IV. Conclusion

Both the studies expand our understanding of social behaviors for victim management. The results from the first indicate that mechanisms for autonomous gaze perform as well as manual gaze for victim management, and that overall a robot exhibiting social head gaze behaviors is preferred over *no gaze* at all. The results of the second study indicate that a logarithmic scaling function provides the most performance gains for proxemic considerations in victim management. Furthermore, the results show that while linear scaling provides benefits for some attributes, logarithmic scaling creates the projection of a more socially competent robot. Together these studies demonstrate the use of social head haze and proxemic scaling in US&R applications and highlight the importance of social competence of robots for victim management.

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