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Intuitive Interfaces in Human-Robot Interaction

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Abstract. This study explores the intuitiveness of four user interfaces (UI) for controlling a mobile robot (BOE Bot): Electromyography, Oculus Rift, joystick, and speech recognition. Intuitiveness was assessed through two means: participants success in navigating the robot through a maze after self-directed training, and scores on usability questionnaires.

Keywords: human-robot interaction, interfaces, performance

1 Introduction

There has been few controlled empirical experiment about intuitive interfaces: for example Huttenrauch et al [3] involved only 6 users in the design of robots and did not involve a real robot. Khan [4] investigated the preferred methods of communication to intelligent service robots (ISB) and found speech to be the most preferred method of communication (82%), followed by touch screen (63%), gesticulating (51%), and written command (45%).

Previous research observed improved attitudes and reduced negative affects after use of well-suited HRI [7]. The nature, style and attitude towards robots will be highly individualised to each operator [2], therefore the HRI used will play a significant role in user experience. This paper investigates four user-interfaces (UIs) and their effect on the user: Electromyography (EMG: electrical activity of muscle tension), Oculus Rift (virtual reality), joystick, and speech recognition.

2 Methodology

29 volunteers from the University of Sheffield (69% male) with average age 28.34 (10.94) took part using all four UI in this study. Participants' attitude was measured with the Negative Attitudes Toward Robots (NARS) subscale 1 and the Robot Anxiety Scale (RAS) subscale 2 [6] The intuitiveness of each interface was measured with the System Useability Scale (SUS) [1] and the subscale on interface quality from the Post-Study System Usability Questionnaire (PSSUQ) [5].

Participants had to navigate robot over a maze consisting straight lines, identified point fo stopping, turning right and left, and going over a bridge. The

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instructions for participants indicated guidelines on how each UI was operated (go forwards/backwards, turn left/right, speed up/down, spin left/right, and stop).

3 Results, Discussion and Conclusions

Participants' NARS and RAS scores did not significantly reduce after the HRI ($Z < -0.69$, $p > .49$) and there was no effect of age or gender.

Several one way within participants ANOVA's showed a significant effect of controlling method on user experience of interface quality ($F(3, 26) = 35.84$, $p < .001$), system usability and learnability ($F(3, 26) = 67.33$, $p < .001$), the number of errors made ($F(3, 24) = 17.34$, $p < .001$), and time taken to complete the maze (t) ($F(3, 24) = 24$, $p < .001$).

Bonferroni corrected post hoc tests revealed that joystick performed significantly better than any other interfaces across all variables, followed by oculus rift. Joystick was rated as the most intuitive UI, and this might be a result of peoples familiarity with the interface and the simplicity of the technology.

Table 1. Mean and standard deviations of time taken to complete the maze (t) and number of errors with each interface (E) as well as average scores for Post-Study System Usability Questionnaire (PSSUQ) and System Useability Scale (SUS)

UI	PSSUQ	SUS	Errors (E)	Time (t), s
EMG	3.24 ± 1.52	48.10 ± 17.94	12.88 ± 9.65	600 ± 363.79
Speech	3.82 ± 1.68	46.47 ± 21.15	14.68 ± 12.79	537.82 ± 372.93
Oculus Rift	2.85 ± 1.09	58.45 ± 18.09	5.64 ± 3.73	275.25 ± 193.59
Joystick	1.61 ± 0.52	88.45 ± 7.86	2.03 ± 1.68	83.41 ± 23.59

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