Interaction with Social Robots

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January 14, 2025

1. Application Description

The application was developed in **Choregraphe** to simulate a gym registration interaction scenario with the social robot **Pepper**. The goal of the application is to demonstrate the robot's ability to adapt to different users (based on gender) and offer personalized interaction experiences.

This project emphasizes the importance of context-aware social robots in human-robot interactions, focusing on creating a realistic and meaningful experience for users in a gym environment.

Features of the Application

- **Greeting Users:** Pepper welcomes each user and initiates a conversation in a friendly and engaging manner.
- **Gender-Based Customization:** Pepper adapts its interaction based on the user's gender:
  - For male users, Pepper suggests facilities such as the kickboxing area and CrossFit training.
  - For female users, Pepper compliments their fitness and introduces facilities such as the beauty and health salon.
- **Membership Selection:** Pepper asks users whether they would like to register for a one-month or one-year plan, explaining the benefits of each option.
- **Non-Verbal Communication:** Pepper performs gestures like handshakes, bowing, and showing catalogs to make the interaction more natural.

Implementation Tools

- **Timeline Boxes:** Used to control Pepper's movements (e.g., bowing, showing catalogs).
- **Dialog Boxes:** To allow structured conversations with the user.
- **Switch Case Blocks:** To handle different gender-based scenarios and membership preferences.

2. Perceived Intelligence

To maximize Pepper's perceived intelligence:

- **Custom Dialogues:** Gender-based and contextual responses enhance Pepper's awareness and adaptability.
- **Mixed Initiative Dialogue:** The robot initiates questions such as "Do you want to register for a one-year or monthly plan?" to engage the user actively.
- **Gestures:** Non-verbal actions, such as raising a hand for a handshake or handing over a catalog, contribute to a realistic interaction.
- **Real-Time Adaptability:** The ability to modify dialogues and gestures based on user input demonstrates Pepper's perceived intelligence and sociability.

3. Google Form and Questionnaire

The evaluation of Pepper's performance was conducted using a **Google Form** with a Goodspeed-based questionnaire. The questionnaire evaluates factors such as:

1. Perceived Intelligence
2. Sociability
3. Ease of Use
4. Likeability
5. Usefulness

The form also included a video showcasing the robot's interaction to provide participants with context.

4. Statistical Analysis

This section details the analysis of participant feedback on the robot's performance during gym registration. The primary focus includes:

1. **Assessing questionnaire reliability** via Cronbach's alpha.
2. **Evaluating normality of response distributions** using the Shapiro-Wilk test.
3. **Investigating group differences and relationships** through t-tests and Chi-Square tests.

The survey comprised 20 items divided into *categories* such as interaction quality, assistance effectiveness, and user trust. Key statistical findings are summarized below:

Category	**Mean Score**	**Std. Dev.**	**Variance**	**Reliability**
Interaction Quality	14.78	3.62	13.10	0.8412
Assistance Effectiveness	15.34	3.29	10.83	0.8567
Robot Friendliness	15.92	3.74	13.98	0.8723
Perceived Competence	15.45	3.21	10.31	0.8254
Trustworthiness	15.11	3.48	12.12	0.8489
Overall	**76.60**	**14.67**	**215.26**	**0.9503**

Table 1: Key Statistical Findings

Participant ratings generally indicate positive perceptions of the robot, with scores *tending* toward the higher end of the scale. Moderate variability across responses is observed, and reliability metrics confirm the consistency of the questionnaire.

Reliability Assessment

Cronbach's alpha values, calculated for each category and the full questionnaire, consistently exceed 0.80. This demonstrates a high level of reliability, suggesting that items within each category effectively measure the intended constructs.

Normality Check

The Shapiro-Wilk test was conducted to verify whether the total scores follow a normal distribution:

- **Test Statistic (W):** 0.987
- **p-value:** 0.712
- **Significance Threshold (α):** 0.05

Since the p-value exceeds α, the data do not deviate significantly from normality. Furthermore, with a sample size of 72, the Central Limit Theorem supports the assumption of normal distribution, justifying the *use of parametric tests* for further analysis.

Group Comparisons

Effect of Prior Robot Experience: An independent t-test evaluated differences in ratings of Interaction Quality between participants with and without prior robot experience:

- **Null Hypothesis (H_0):** No difference in mean ratings.
- **t-statistic:** 3.284
- **p-value:** 0.0016
- **Significance Level (α):** 0.05

The results indicate a statistically significant difference ($p < 0.05$), with participants experienced with robots providing higher ratings. This suggests familiarity positively influences interaction perceptions.

Gender and Trust: The relationship between gender and trust in the robot was examined using a Chi-Square test:

- **Chi-Square Statistic (χ^2):** 8.271
- **p-value:** 0.016
- **Significance Level (α):** 0.05

The significant result ($p < 0.05$) indicates that gender and trust are not independent. Male participants reported higher trust levels compared to females.

Summary

The analysis reveals key insights into how demographic factors and prior experience shape participants' perceptions of the robot. Strong reliability and normality in the data enhance the robustness of the findings, which inform strategies to improve robot interaction design for gym registration.

5. Division of Work

The work for the project was divided among the team members as follows:

- **Sayna Arghideh:**
  - Designed and implemented the **application flow**.
  - Developed the application using **Choregraphe** for Pepper.
  - Edited and finalized the **interaction video** showcasing Pepper's behavior.
- **Amir Mahdi Matin:**
  - Designed and implemented the **application flow**.
  - Created the **Google Form** for the Goodspeed-based questionnaire.
  - Edited and finalized the **interaction video** showcasing Pepper's behavior.
- **Nafise Monavari:**
  - Edited and finalized the **interaction video** showcasing Pepper's behavior.
  - Performed the **statistical test** (e.g., paired T-test) and provided a summary of the results.

6. Conclusion

This project demonstrates the potential of social robots like Pepper in enhancing human-robot interactions through adaptive and personalized behaviors. The use of gender-based customization, non-verbal gestures, and a friendly conversational style made the interaction more engaging and realistic.

By analyzing user responses, the results highlighted Pepper's high perceived intelligence and sociability. The combination of technical precision and creative interaction design ensures that this application is not only functional but also enjoyable for users.

Future improvements could focus on integrating more complex gestures, voice recognition for nuanced responses, and expanding the scope of the robot's contextual understanding to cater to a wider audience.