Blueprint for the design of social-aware, gender-sensitive artificial companions

Brigitte Krenn, Sabine Payr, Stephanie Schreitter,

Gregor Sieber, Robert Trappl, Paolo Petta

<firstname.lastname>@ofai.at
Österreichisches Forschungsinstitut für Artificial Intelligence
Freyung 6, 1010 Vienna, Austria

Executive Summary

Presently, a whole generation of companion technologies is in a state of pre-commercial development. For the first time, companion applications are becoming affordable, functional and robust enough to appeal to large and varied groups of buyers. In order to develop its full market potential, however, companion technology needs to demonstrate that it introduces added value to users' everyday lives. Mostly, the benefit of companion technologies is expected to lie in the fields of assistance and entertainment, with the lines between the two frequently blurred. Thus, companion technology holds much promise not only from a technological perspective, but also from the end user´s point of view. Even if the underlying technologies work well, users' expectations will be disappointed when interacting with the system, they do not feel like fully-fledged partners in communication. Especially with embodied characters, users naturally tend to assume that interactions will be natural and effortless, resulting in frustrations if these expectations are not met.

The C4U project has studied users' expectations with regard to companion technologies, as well as test persons' interactions with applications. Its findings and observations have been documented in scientific papers and project deliverables. The project results contribute to differentiating the users' perspectives in the development of companion technologies in order to gain broad user acceptance. From the beginning, however, the project has not only aimed to observe, but also to recommend. Thus, this blueprint has been created in order to transform the findings into a specification for gender-sensitive and -appropriate system architectures for companion technologies. With the blueprint, experience which has been gained during the C4U project on its own as well as in cooperation with other national and international projects can be channelled into concrete instructions for a system and interaction design which is more natural and more usable -- and thus more successful. To our knowledge, the result is the first blueprint for the design of socially aware, gender-sensitive artificial companions.

1. Research Question: "What role does the companion's appearance play in (gender-sensitive) interaction and user experience/acceptance?"

1.1. State-of-the-Art

Types of Embodiment

"These results seem to suggest that robots are generally preferred above agents and agents are preferred above text interfaces. But the novelty effect may be an important factor in these studies and it is not clear how soon it would wear off. Kidd (2008) points out that the appearance of a robot seems to be a factor for a minority of people only, both in the case of initial attraction and in longer-term engagements. More important for people is what the robot has to offer and whether it is useful."

Guidelines:

- **Prefer robots over agents and agents over non-embodied interfaces. However, take into account the novelty effect when designing your robot/agent.**
- **Overall, functionality is more important than appearance."** SERA deliverable S3.1, p. 7

Appearance of Robots

"Guidelines

- **No absolute preference can be given to the appearance of robots in terms of humanoid vs. mechanoid. Make the choice dependent at least on preferences in the user group, as personality and other user characteristics play a role.**
- **Take into account habituation processes in piloting appearance."** SERA deliverable S3.1, p. 8

Appearance matched to task

"Guidelines

- **Consider whether appearance and role/task should be matched. (Note that the studies mentioned did not involve actual interactions with robots or agents, so novelty effects and habituation may influence the importance of this guideline over time)**
- **Pay attention to making the robot/agent attractive."** SERA deliverable S3.1, p. 9

Uncanny valley

"**Guideline**

- **To test different robot/agents designs with respect to uncanny valley effects, consider at least the following factors: (1) the variables related to the location of the different designs along the scale ranging from unequivocal artefact**

> **appearance to human resemblance and (2) the effect is dependent on the type of user."** SERA deliverable S3.1, p. 10

Summing up: "From this short overview one can draw a few conclusions. First, studies that compared anthropomorphic interfaces with simple text-based interfaces found that users had a preference for the former kinds. Second, there are several variables that should influence the design or choice of robot appearance: in addition the task at hand, personal preferences are also of importance. In general, one can conclude that carefully set-up empirical (pilot) studies can inform the definition of the appearance of an agent or robot so that it is matched with the task and the user group. Habituation processes may still make up for less than optimal choices. Kidd (2008) provides an important point: functionality is more important than appearance. **"**SERA deliverable S3.1, p. 10

For pictures of current robot companions see Figure 1 at the end of this document.

1.2. Appearances in C4U

In C4U, experiments with all three types of embodiment were conducted: robots in the Nabaztag experiments, a virtual bartender-agent with and without emotional facial expressions and disembodied interfaces as tourist guides in the Josefsplatz-experiment. See deliverables E3_2.1 and E3_2.2, for the Bartender Experiments; E3_2.3, for the disembodied tour guides and E3_2.4. for the Nabaztag.

The virtual bartender is more functional than the Nabaztag robot, as it is also capable of verbally expressing affective (positive, negative and neutral) behavior as well as emotional facial expressions. The goal of the user study implementing disembodied tour-guides was to investigate whether different synthetic language varieties evoke different personas in users and any kind of embodiment would have influenced their evaluation.

In the EmoChatting experiment (for details see document E3.2.1), users communicated with an autonomous dialog system and a Wizard-of-Oz System, both come equipped with two versions: with and without emotional facial expression. If the dialog system has emotional facial expressions is visible to the user, if it is an autonomous dialog system or a WoZ system is not visible in its appearance. In this experiment, differences in the reactions of male and female dialog-partners towards the system were investigated. After each of the four sessions, users evaluated whether they found the communication realistic, they enjoyed it and felt an emotional connection. Also dialog acts were analysed as well as Linguistic Inquery and Word Count (LIWC) categories. The results suggest that female and male users do not significantly differ in their reactions towards emotional facial expressions.

1.3. Guidelines and Recommendations for Appearance based on C4U Experiments

- **Emotional facial expressions are not relevant when designing gender-sensitive companions.**

2. Research Question: "How and to what extent influence a companion's communicative skills (gender-sensitive) interaction and user experience/acceptance?"

2.1. State-of-the-Art

Conversational behaviours

"Guideline

- **If one equips robots and agents with conversational skills, one needs to take into account the many levels on which conversation works and consider how to contribute to verifying, establishing and maintaining required preconditions and context, accounting for procedures such as of engagement, feedback, and information structuring."** SERA deliverable S3.1, p. 11

Use of natural cues

"Guidelines

- **As humans will interpret the (nonverbal and other) behaviours of a robot/agent similarly to the behaviours of humans, the behaviours should be carefully designed and work in similar ways as in the human case (e.g., provide non-functional clues) to avoid misinterpretation and to benefit from the inferences made.**
- **On the other hand, robots and agents are accepted to be different from humans and can have non-human-like interfaces that can be exploited in the interaction to take care of important communicative functionalities."** SERA deliverable S3.1, p. 10

Affective and social behaviours

"Guidelines

- **A (companion) robot/agent should express elements of its internal state (affective or otherwise). To find out which internal states are important and how they are expressed in a given situation, one can turn to studies of human-human expressions in similar situations, as expressivity is task/role/situation dependent.**
- **Principled generative models can provide important contributions by ensuring coherence while sustaining variability in long-term interactions."** SERA deliverable S3.1, p. 12

Situational Awareness

"Guidelines

- **Robots/agents should be designed so as to take into account the context of use (context-awareness, situation-awareness, user awareness, affect-sensitiveness).**
- **If adequate, robust interpretation capabilities (for e.g. identification of the interacting peer, recognition of affective tone) are not available, then the actions**

> **of the robot/agent should be carefully designed to either match generic situations or carefully restricted contexts of use where the context can be validated."** SERA deliverable S3.1, p. 13

Summing up: "The premise that robots and agents should be human-like seems to be the dominant opinion of the field. However, as Kobayashi et al. (2008)'s successful example shows, this should not be mistaken for an immutable principle. When human-likeness is the goal, analysing human-human interactions in the selected domain and trying to copy the relevant behaviours on the system is a good way to proceed (see Bickmore's example for instance), but care must be taken to identify the full scope of the related required capabilities and to assess the viability of their technical realisation." SERA deliverable S3.1, p. 13

2.2. Conversational Behavior in C4U

In C4U, the Nabaztag and the virtual Bartender are both conversational agents.

Enabled by the LIWC category analysis, the virtual Bartender is capable of reacting on certain verbal cues. The perception layer of the autonomous dialog system is able to detect affective categories such as positive and negative emotions, anger, anxiety and sadness as well as expressions from other categories, such as leisure, work, swear words and health.

In the Nabaztag experiment, the rabbit was designed to take the initiative to start interactions to collect as much data as possible and due to its function as an assistive robot to remind the users of task and activities. A conversational analysis was conducted, revealing for example that the treatment of some topics has a nested structure and a topic change is not possible during communicating about these topics and this effect leaded to frustration of some participants, while other had no problem dealing with it. Recapitulated, the results of the conversational analysis show that there exist different user stiles, e.g. minimalism, conflict, compliance, and playfulness. Therefore, it is not sufficient to design one "persona" for a companion, but several "personas" that are adaptive to a variance of user stiles.

2.3. Guidelines and Recommendations for Appearance based on C4U Experiments

- **Design different "personas" that are adaptive to different user stiles**

3. Research Question: "What role do a companion's social skills play in (gender-sensitive) interaction and user experience/acceptance?"

3.1. State-of-the-Art

Relational Communication Skills
The following list is mainly derived from Bickmore et al (2009, 2003). Quotes are from SERA deliverable D3.1, compare p. 14.

- Increasing breadth and depth of topics (mostly during social dialogue)
- Increasing amount of small talk
- Increasing amount of information the agent knows about the user (telling the agentthings is a type of "investment" made in the relationship)
- Increasing use of empathy, agreement with the user, and humour
- References to past interactions and mutual knowledge should increase over time
- References to future interactions, inclusive pronouns, expressing happiness to see the user, nonverbal immediacy behaviours, and the use of greeting routines, forms of address"

- Meta-relational communication: "being very clear up front about the roles and expectations of each of the parties in the relationship, and checking in from time to time to see how everything is going and making adjustments as needed"
- Appropriate use of politeness and facework
- Appropriate use of empathy: this "can go a long way towards making them feel understood and alleviating negative emotional states such as frustration" (p.198, with reference to (Klein et al, 2002))

- Express empathy: "You did not achieve your goal, perhaps you were busy."
- Cheering and Complementing: "Well done!"
- Support self-efficacy and optimism: "You did not achieve your goal. Don't worry. It will go step by step." (cf. Blanson-Henkemans et al. 2009)

Interpersonal variables

„Guideline

- **Use the appropriate conversational strategies to establish the right settings for important relational variables."** SERA deliverable S3.1, p. 15

Personalisation and Adaptation / Memory and Learning

"Guideline

- **Work on memory systems – in particular forgetting – in long-term interactions is fairly new ground for the research community. Incorporating the adequate strategies for user modelling is an important requirement for continuous engagement and attachment."** SERA deliverable S3.1, p. 15

Summing up: "For companion, health advising, therapist and other such agents and robots, the interpersonal variables between system and user have to be "right"; just as they have to be in real-life human-human interaction. This requires special interactive skills. **"**SERA deliverable S3.1, p. 15

3.2. Social Skills in C4U

Both the Nabaztag robot and the bartender-agent are equipped with social skills. The assistive robot Nabaztag focuses on encouraging the users by expressing empathy, cheering and optimism.

The bartender agent on the other hand is equipped with three versions of an affective system. These different affective profiles give the impression, that the bartender is in a neutral, good, or bad "mood". While the positive affective system is cooperative, empathic, supporting, positively enhancing and focusing on similarities with a user, the negative system is conflicting, confronting, focusing on differences with a user and the neutral system is professional, focused on the job and not responding to expressions of affect. (See Skowron 2011).

Data collected within the CyberEmo project was analysed for differences in the reactions of female and male dialog-partners towards the three affective profiles. The results revealed that female users reacted with significantly more rejective dialog acts and no answers than male participants on the negative system. Therefore, affective aspects as well as the selection of an affective system are relevant when designing gender-sensitive systems.

In a language-attitude-study, the influence of synthetic language-variety and voice quality on the attribution of personas to three synthetic voices (male standard Austrian German, female colloquial Viennese and male dialectal Viennese) was investigated (see deliverable E_3.2.3).

In each language variety, there was either a female or a male voice available, therefore we were not able to compare the evaluation of a female and a male voice of the same language variety. However, the post-hoc analysis showed that the persona attributed to the female voice was rated as especially low for 'aggressive' and 'open minded'. The male standard Austrian voice was evaluated as very 'pleasant', 'serious' and 'intelligent' and the male voice representing Viennese dialect as very 'natural' and 'relaxed' with a high 'sense of humor'. These results show that depending on the social context, different synthetic language varieties are more or less appropriate.

3.3. Guidelines and Recommendations for Social Skills based on C4U experiments

- **The selection of an affective system is relevant when designing affective gender-sensitive systems (female dialog partners react significantly more rejective towards a conflicting and confronting system that focuses on differences with a user than male dialog partners)**
- **Select synthetic language varieties depending on the social context.**

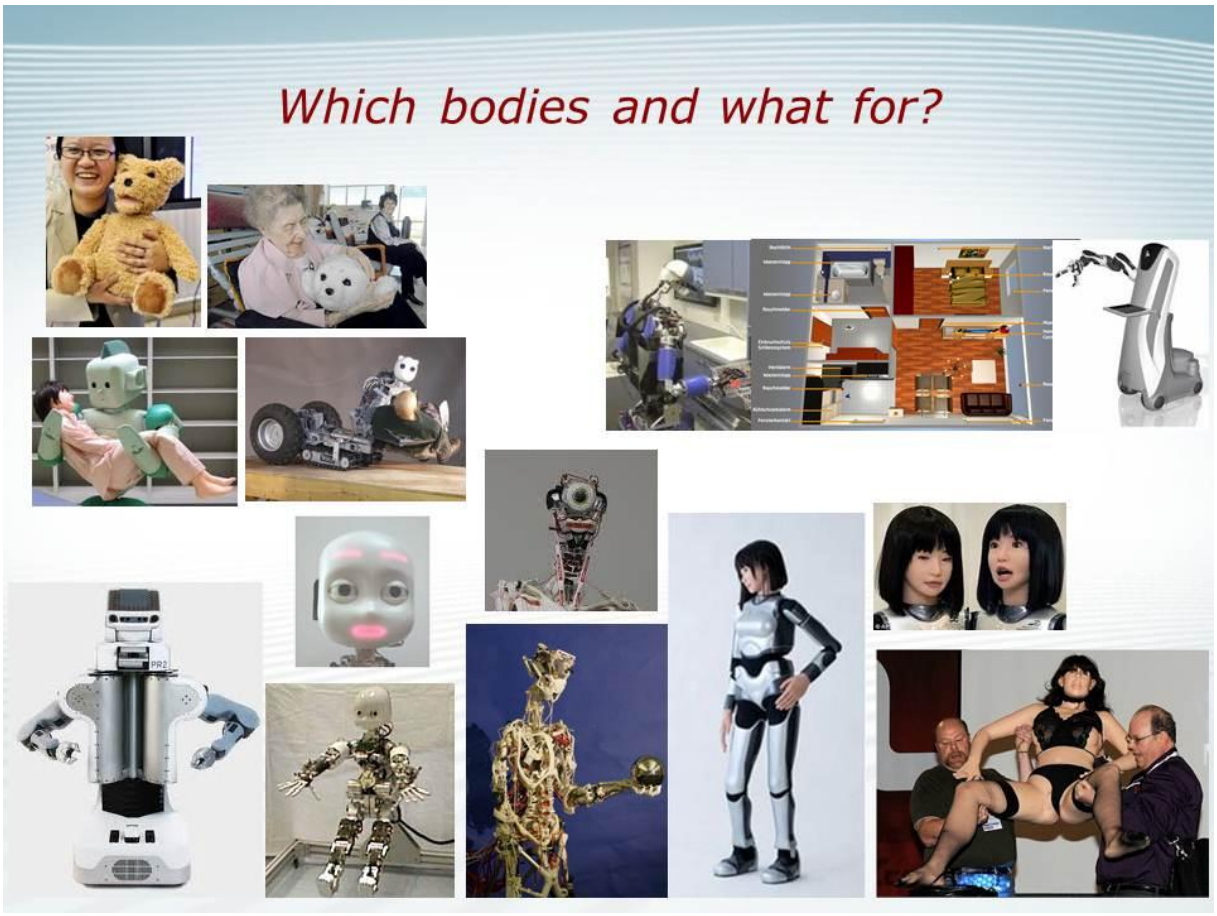

Figure 1: A selection of current robot companions.

Acknowledgments

The project team would like to thank Alexandra Klein for all the valuable contributions she has made and assistance she has given to the project over the past two years.

References

T. W. Bickmore (2003) Relational Agents: Effecting Change through Human-Computer Relationships,
Ph.D. Thesis, Massachusetts Institute of Technology.

T. W. Bickmore, D. Schulman, and L. Yin (2009) Engagement vs. Deceit: Virtual Humans with Human
Autobiographies, in (Ruttkay et al. 2009), pp. 6-19.

O. A. Blanson Henkemans, P. J. M. van der Boog, J. Lindenberg, C. A. P. G. van der Mast, M. A. Neerincx, and B. J. H. M. Zwetsloot-Schonk (2009) An online lifestyle diary with a

persuasive computer assistant providing feedback on self-management, *Technology and Health Care*, 17(3):253-267.

C. D. Kidd (2008) Designing for Long-Term Human-Robot Interaction and Application to Weight Loss, PhD Thesis, Massachusetts Institute of Technology, School of Architecture and Planning, Program in Media Art and Sciences.

K. Kobayashi, K. Funakoshi, S. Yamada, M. Nakano, Y. Kitamura, and H. Tsujino (2008) Smoothing human-robot speech interaction with blinking-light expressions, in *Proceedings of the 17th IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN 2008)*, IEEE Press, Washington, D.C., pp. 47-52.

J. Klein, Y. Moon, and R. Picard (2002) This Computer Responds to User Frustration: Theory, Design, Results, and Implications. *Interacting with Computers*, 14:119-140.

SERA Deliverable 3.1 S. Ben-Allouch et al. (2010) Design Guidelines. Deliverable 3.1 FP7-231868 SERA Social Engagement with Robots and Agents.

M. Skowron, S. Rank, M. Theunis, J. Sienkiewicz " The good, the bad and the neutral: affective profile in dialog system-user communication" Proceedings of the fourth bi-annual Affective Computing and Intelligent Interaction Conference – ACII 2011, Lecture Notes in Computer Science, pp. 337-346, Springer, Heidelberg (2011).