



Figure 1: Virtual characters showing prototypical non-verbal behavior.

context of the immediate situation, and the *communication situation*, with topics focusing on the conversation partners [13].

Parameters of the Network.

The first-time meeting scenario of our corpus [12] was annotated regarding the theories and classifications from the social sciences described above. To prepare the data for parameter learning, each annotated conversation is divided into datasets determined by a speech utterance. Each dataset may or may not be accompanied by a gesture and/or posture. For each dataset, the social background (such as gender and culture) is specified using the metadata of the annotations.

The SMILE-Framework² provides, amongst others, an implementation of the EM-algorithm [5], that requires a decision network and a list of datasets. With it, the structure of our network that was modeled based on theoretical knowledge, is filled with parameters learned from the multimodal corpus.

3. APPLICATION

The Bayesian network is integrated into a virtual environment holding culture-specific characters [4]. First-time meeting dialogues, similar to the ones recorded in the corpus, were scripted and tagged with the same categorizations of speech acts and topics as in our network. Animations are labeled according to the gesture and posture types. Each animation can be customized to match different levels of expressivity. The probabilities for culture-dependent non-verbal behaviors are generated by the network based on verbal behavior and cultural background, and then simulated with the characters.

Figure 1 shows a screenshot of a male German character in a prototypical German posture (FA - fold arms) in conversation with a female Japanese character performing an iconic gesture with a small spatial extent.

4. CONCLUSION AND FUTURE WORK

The hybrid approach described in this paper combines the advantages of the commonly used theory-driven and data-driven approaches, as it explains the causal relations of

²<http://genie.sis.pitt.edu/>

cultural background and resulting behavior, and augments them by findings from empirical data.

In the resulting network, on the one hand, the most probable culture-related level of expressiveness in non-verbal behavior is calculated, and on the other hand the most likely culture-specific non-verbal behavioral type (gesture and posture) is determined based on the verbal behavior (speech act and topic) that it should accompany.

For our future work we aim on evaluating the network and have a deeper look into further aspects such as gender-specific differences. In addition, studies will be conducted that test how virtual characters, performing the behavior calculated by our model, are perceived by human observers.

5. REFERENCES

- [1] R. Aylett, A. Paiva, N. Vannini, S. Enz, E. André, and L. Hall. But that was in another country: agents and intercultural empathy. In *Proc. of 8th Int. Conf. on Autonomous Agents and Multiagent Systems*, 2009.
- [2] P. Bull. *Posture and Gesture*. Pergamon Press, Oxford, 1987.
- [3] M. Core and J. Allen. Coding Dialogs with the DAMSL Annotation Scheme. In *Working Notes of AAAI Fall Symposium on Communicative Action in Humans and Machines*, pages 28–35, 1997.
- [4] I. Damian, B. Endrass, P. Huber, N. Bee, and E. André. Individualized Agent Interactions. In *Proc. of 4th Int. Conf. on Motion in Games*, 2011.
- [5] A. P. Dempster, N. M. Laird, and D. B. Rubin. Maximum likelihood from incomplete data via the em algorithm. *Journal of the Royal Statistical Society. Series B (Methodological)*, pages 1–38, 1977.
- [6] B. Endrass, E. André, M. Rehm, and Y. Nakano. Investigating culture-related aspects of behavior for virtual characters. *Autonomous Agents and Multi-Agent Systems*, 2013.
- [7] P. E. Gallaher. Individual Differences in Nonverbal Behavior: Dimensions of Style. *Journal of Personality and Social Psychology*, 63(1):133–145, 1992.
- [8] G. Hofstede, G.-J. Hofstede, and M. Minkov. *Cultures and Organisations. SOFTWARE OF THE MIND. Intercultural Cooperation and its Importance for Survival*. McGraw Hill, 2010.
- [9] G. J. Hofstede, P. B. Pedersen, and G. Hofstede. *Exploring Culture - Exercises, Stories and Synthetic Cultures*. Intercultural Press, 2002.
- [10] W.-J. Johnson, S. Marsella, and H. Vilhjálmsón. The DARWARS Tactical Language Training System. In *Interservice / Industry Training, Simulation, and Education Conference*, 2004.
- [11] D. McNeill. *Hand and Mind - What Gestures Reveal about Thought*. University of Chicago Press, 1992.
- [12] M. Rehm, E. André, Y. Nakano, T. Nishida, N. Bee, B. Endrass, H.-H. Huan, and M. Wissner. The CUBE-G approach - Coaching culture-specific nonverbal behavior by virtual agents. In *ISAGA 2007: Organizing and Learning through Gaming and Simulation*, 2007.
- [13] K. P. Schneider. *Small Talk: Analysing Phatic Discourse*. Hitzeroth, Marburg, 1988.
- [14] S. Ting-Toomey. *Communicating across cultures*. The Guilford Press, New York, 1999.