INDIGO: Interaction with Personality and Dialogue Enabled Robots

Stasinos Konstantopoulos[1] and **Ion Androutsopoulos**[2] and **Haris Baltzakis**[3] and **Vangelis Karkaletsis**[1] and **Colin Matheson**[4] and **Athanasios Tegos**[1] and **Panos Trahanias**[3]

Abstract.
The subject of this demonstration is human-robot interaction, focusing on robotic personality modelling and dialogue management. These are demonstrated in a museum guide use-case, operating in a simulated environment. The main technical innovations presented are the robotic personality model, the dialogue & action management system, and the robotic integration & simulation platform.

1 Introduction

This demonstration presents an innovative approach to human-robot interaction, focusing on robotic personality modelling and dialogue management.

The demonstration is built around a museum guide use-case, where a simulated robotic guide is operating in a virtual environment. During the demonstration visitors can interact with the simulated robot, while videos of a physical robot operating in a museum will also be shown. The same personality modelling, dialogue & action management, and natural-language components are used for both the simulated and physical robots.

2 Personality and Deliberation

The *personality model* of each robot derives the relevance factor of the various exhibits to a given dialogue state for a given robot. This is achieved by modelling personality as a fuzzy Description Logic program, and using fuzzy inference [5] to combine robotic interests with expressed or inferred user interests to calculate a combined factor for each exhibit. So, for example, a robot with an open personality will attend more to the user's requests than on its own interests to derive relevance factors, as opposed to pursuing its own interests; and a robot with a high level of conscientiousness will be more inclined to follow prescribed routes through the exhibition.

The raw robotic interests are modelled as numerical annotations over an OWL ontology, representing the robot's knowledge of the domain, in our case the exhibits of the guided tour. The domain ontology itself as well as the annotations are created using the ELEON authoring tool [1]. User interests are inferred either from explicit user requests or from PSERVER, a user modelling and personalization system [6].

Personality is externalized in *dialogue and action manager* (DAM) decisions about utterance plans as well as in *natural language generation engine* (NLG) realizations of these plans. DAM is built around the information-state update dialogue paradigm of the TRINDIKIT dialogue-engine toolkit[5] and takes into account the combined user-robot interest factor when inferring information state updates. DAM combines various interaction modalities and technologies, at the interpretation as well as the generation direction. While interpreting user actions, the system recognizes spoken utterances, simple gestures, and touch-screen input, combined into a multi-modal user action. Similarly, when planning robotic actions DAM coordinates a number of available output modalities, including, besides spoken language and depending on the configuration of the robotic platform, movement, facial expression, simple gestures, etc.

3 Natural-Language Interaction

The NATURALOWL NLG engine [3, 4], produces multi-sentence, coherent natural language descriptions of objects in multiple languages from a single semantic representation; the resulting descriptions are annotated with prosodic markup that drives the speech synthesisers.

The generated descriptions vary dynamically, in both content and language expressions, depending on robotic personality and interaction history. Robotic personality dynamically computes preference factors for the various items being described as well as for their properties. The preference factor of the item itself is used to decide the level of detail of the description being generated. The preference factors of the properties are used to order them, in order to choose which ones to include in a given description. Interaction history is used to compare to previously given information and to avoid repeating the same information in different contexts.

The natural-language interface is supported by robust *speech recognition* technology [2], capable of recognizing spoken phrases in noisy environments, and advanced *speech synthesis*, capable of producing spoken output of very high quality including near-human prosody. Speech recognition is improved by using the dialogue manager to dynamically restrict the vocabulary, according to the dialogue state.

[1] Institute of Informatics & Telecommunications, NCSR 'Demokritos', Athens, Greece.
Email: {konstant,vangelis, tegos}@iit.demokritos.gr
[2] Department of Informatics, Athens University of Economics and Business, Greece; and Digital Curation Unit, Research Centre 'Athena', Greece.
[3] Institute of Computer Science, Foundation for Research and Technology Hellas (FORTH), Heraklion, Greece.
Email: {xmpalt,trahania}@ics.forth.gr
[4] Human Communication Research Centre, Edinburgh University, U.K.
Email: Colin.Matheson@ed.ac.uk

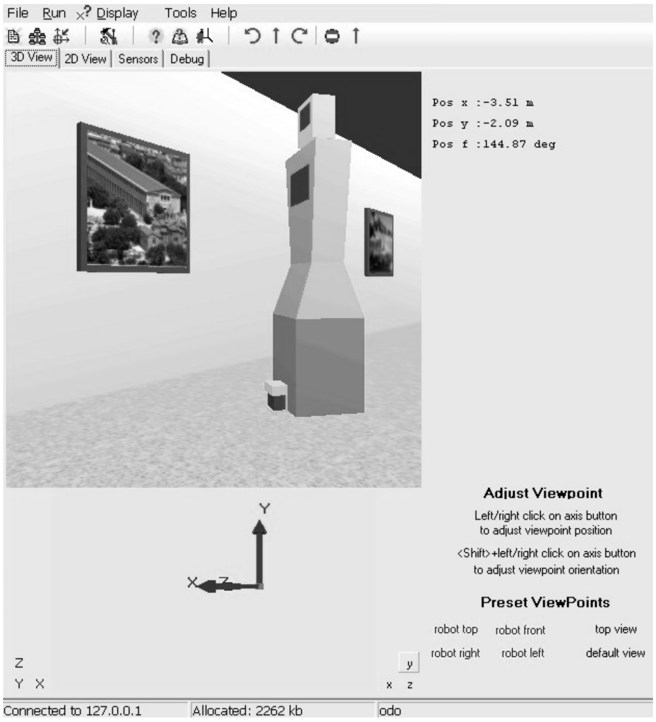

Figure 1. ORCA Simulation window showing 3D view of the environment and position parameters.

4 System Integration

The demonstration is based on the ORCA[6] communication server and robot simulation software. The ORCA *communication protocol* organizes communication as typed packets, with the various components declaring themselves as *producers* or *consumers* for each type of packet. Producers and consumers connect to a *communication server* through which they exchange *requests* and *data packets*. When the server receives a request for a packet type, the server forwards it to the producers of this type; when it receives a data packet, the server forwards it to the consumers of packets of this type.

The ORCA distribution also includes a simulated robotic platform, a virtual environment for the simulated robot to operate in, navigation software, and a simple menu-driven action manager. These tools provide a development environment where the various components can be independently developed and tested before being integrated in a physical robotic platform.

5 Conclusion

This demonstration presents several innovations in human-robot interaction, including adding a *robotic personality* component in the deliberative layer and basing the system on the ORCA integration & simulation platform.

ACKNOWLEDGEMENTS

The work described here is supported by the FP6-IST project INDIGO. INDIGO develops and advances human-robot interaction technology, enabling robots to perceive natural human behaviour, as well as making them act in ways that are more familiar to humans. To achieve its goals, INDIGO advances various technologies, which it integrates in a robotic platform. Please see `http://www.ics.forth.gr/indigo/` for more information.

[5] See `http://www.ling.gu.se/projekt/trindi/trindikit/`
[6] See `http://www.ics.forth.gr/~xmpalt/research/orca/`

References

[1] Dimitris Bilidas, Maria Theologou, and Vangelis Karkaletsis, 'Enriching OWL ontologies with linguistic and user-related annotations: the ELEON system', in *Proc. 19th IEEE International Conference on Tools with Artificial Intelligence (ICTAI-2007), Patras, Greece, October 29–31, 2007*, volume 2. IEEE Computer Society, (2007).

[2] Stéphane Dupont, Jean-Marc Boite, Christophe Ris, Olivier Deroo, V. Fontaine, and L. Zanoni, 'Context Independent and Context Dependent Hybrid HMM/ANN Systems for Training Independent Tasks', in *Proc. of EUROSPEECH 97*, Rhodes, Greece, pp. 1947–1950 (1997).

[3] Dimitris Galanis and Ion Androutsopoulos, 'Generating multilingual descriptions from linguistically annotated OWL ontologies: the NaturalOWL system', in *Proceedings of the 11th European Workshop on Natural Language Generation (ENLG 2007), Schloss Dagstuhl, Germany*, pp. 143–146 (2007).

[4] George Karakatsiotis, Dimitrios Galanis, and Ion Androutsopoulos, 'NaturalOWL: Generating texts from OWL ontologies in Protégé and in Second Life'. System demonstration, 18th European Conference on Artificial Intelligence, July 2008.

[5] Stasinos Konstantopoulos and Georgios Apostolikas, 'Fuzzy-DL reasoning over unknown fuzzy degrees', in Proc. International IFIP Workshop of Semantic Web and Web Semantics (IFIP-SWWS 07), 29–30 Nov. 2007, Vilamoura, Portugal. *Lecture Notes in Computer Science*, vol. 4806, pp. 1312–1318, Berlin/Heidelberg (2007). Springer.

[6] G. Paliouras, A. Mouzakidis, C. Ntoutsis, A. Alexopoulos, and C. Skourlas, 'PNS: Personalized Multi-Source News Delivery', in *Proc. of the 10th Intl. Conference on Knowledge-Based & Intelligent Information & Engineering Systems (KES 2006)*, Bournemouth, UK (2006).