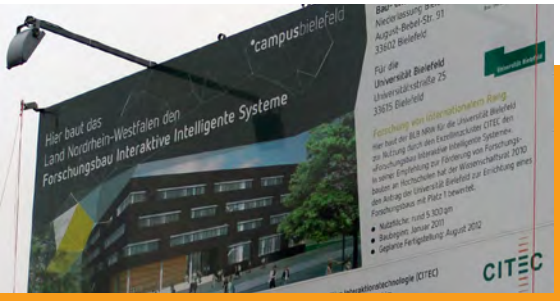
CITEC Newsletter
1/2011

Universität Bielefeld

CITEC
Cognitive Interaction Technology
Center of Excellence
Bielefeld University



Dear Readers,

While IBM's Watson's success in natural language answering has been an impressive demonstration of the state of the art in machine understanding, the differences between man and machine remain huge and many challenges about how to better shape the abilities of machines to the use and expectations of people remain open.
When talking to a robot we do not only care about how well it can answer our questions, but we may very well also care about whether the robot appears to us as an "it", or as a "he" or a "she", and whether it can guide its visual attention in a way that is compatible with humans. This newsletter reports about recent CITEC research on these issues, highlighting some of the facets that we may need to understand in order to make future agents not only prudent, but also pleasant, while keeping issues such as how to measure the IQ of machines or to enable semantic computing high on our agenda.

Sincerely yours,
Helge Ritter, CITEC Coordinator

CITEC NEWS

▶ **Dr. Axel Schneider was awarded the VDI 2011 Ehrenring** for his successful work on neurobionically controlled elastic joint drives with muscle-like behavior. The Ehrenring of the Association of German Engineers (VDI) is a prize for engineers up to the age of 40 years for exceptionally excellent technological and scientific work.

▶ **Minister of State for Innovation, Science, and Research of North-Rhine Westphalia, Svenja Schulze, visited CITEC** on January 24th for the symbolic turning of the first sod for the new CITEC research building. In her address, Minister Schulze remarked: „Here in Bielefeld, you are creating the framing conditions for future-oriented research. I am confident that this is money well invested".

▶ **„Bi:tasteMINT" awarded in nation-wide competition** by employers' association "Gesamtmetall". The „Bi:tasteMINT" program is designed to motivate female high-school graduates to start studies in one of the MINT subjects: mathematics, informatics, natural sciences, or technology.

▶ **Cognitive Interaction Technology for the Medical Profession** exhibited at the MEDICA Trade Fair from November 17th to the 20th in Düsseldorf. A first of its kind system platform presented visitors with a demonstration of how virtual reality (VR) can be used for diagnosis, treatment, and neuropsychological rehabilitation in the fields of neurology and psychiatry.

▶ **New mentoring program /move/ment** starts this spring in cooperation between CITEC and Bielefeld University as a platform specifically addressing female PhD researchers.

▶ **CITEC grants a second round of student scholarships** to six students who are studying successfully in the Bachelor and Master degree programs at the faculties involved in CITEC. This second round of scholarships continues CITEC's successful model for promoting excellent students.

http://www.cit-ec.de/news

Two new EU-FP7 funded research projects to start at CITEC in February.

The project **„EMICAB – Embodied Motion Intelligence for Cognitive Autonomous roBots"** is being coordinated by Prof. Dr. Volker Dürr, Head of the Biological Cybernetics group at CITEC. EMICAB will connect biomechanical, neuroethological, and neurogenetic findings on the planning and control of complex sequences of motion and use software to model these in the form of artificial neural networks. It will also construct a bionic, hexapod robot with elastic drives and a whole range of body sensors. The second project, **„JAMES – Joint Action for Multimodal Embodied Social Systems"** will develop a „bartender robot" who can engage in multimodal communication with several dialogue partners. The project is being coordinated by the University of Edinburgh and will make use of the „Ghost In the Machine" method, developed by Prof. Jan De Ruiter at Bielefeld University in order to enable the robot to be pragmatic and use socially appropriate communication.

Do we apply gender-related stereotypes even to robots? Findings from an experiment with the Bielefeld Anthropomorphic head „FloBi“

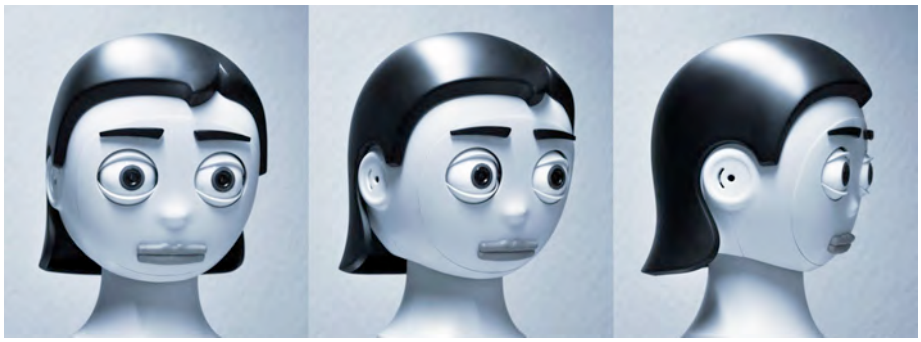


Fig. 1: Female robot type: Long hair.

When forming impressions of others around us, we often use quick rules of thumb: That is, we categorize other people according to their age, ethnicity or gender and we do so almost automatically. A primary source of social category information are human faces. For example, to determine a person's gender, we often rely on hairstyle as a salient facial cue. In 2007 Macrae and Martin demonstrated that isolated hair cues are capable of activating stereotypical knowledge structures about men and women [1]. CITEC researchers Friederike Eyssel and Frank Hegel are the first to investigate effects of visual gender cues on stereotyping in robots [2]. They did so in an experiment with FloBi, CITEC's new humanoid robot head. Due to its modular industrial design (Hegel, Eyssel & Wrede 2010), FloBi's appearance can be changed quickly. The experiment took advantage of this flexibility and used two different hair modules to create 'female' and 'male' versions of FloBi (see Figures 1 and 2). In the study, participants were asked to evaluate the 'gendered' robots with regard to gender-stereotypical traits (e.g., warm, trusting vs. dominant, determined). Additionally, participants evaluated the robots' suitability for typically female tasks (e.g., household maintenance, patient care) and typically male tasks (e.g., transporting goods, repairing technical equipment). Figure 3 shows the results:

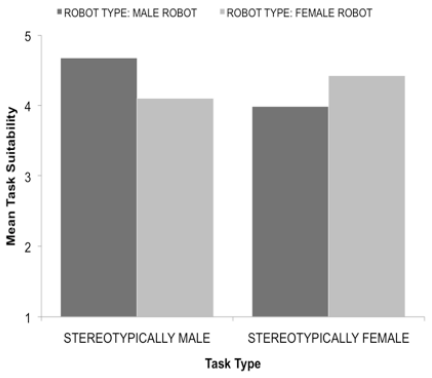


Fig. 3: Perceived suitability for gender-stereotypical tasks as a function of Robot Type.

By means of FloBi's modular design, the researchers were able to create distinct robot characters whose gendered appearance affected participants' expectations about the robots' personality and capabilities. The results show that gender stereotypes seem to be deeply ingrained, because participants applied them even to robots with male or female appearance. From these findings questions related to the ethics of robot design inevitably arise: Should gender-stereotypes be exploited in the design of robots to manipulate the user's mental models and increase efficiency of human-robot interaction? Or should designers construct counter-stereotypical machines (e.g., female service robots to help a mechanic, male CareBots) instead? Further empirical data from long-term interaction studies are needed to provide final answers. Generally, design choices should depend on the context in which the machine is used: If the ultimate goal is to reduce errors produced by machines, to minimize risks and dangers for the people using them (e.g., as rescue assistants), and to improve pleasantness of human-robot interaction, one might recommend the construction of stereotype-congruent robots. To illustrate this, the research at Bielefeld showed that the male robot was perceived as more agentic than the female robot. Thus, if one would decide to use this robot to assist in elderly care, the male robot could evoke fear in elderly users. Such hindering effects could be avoided by exploiting human mental models and expectations pertaining to the female robot, because data showed that students in the present sample evaluated the 'female' version of FloBi as more communal, but also as more suitable for elderly care than the male version. Ultimately, evaluation studies with prospective users have to provide insights into how FloBi is evaluated by actual senior citizens living in care facilities.

[1] e.g. Burton et al. 1993; a full list of references can be found in [2].

[2] Eyssel. F. & Hegel, F. (in press). (S)he's got the look: Gender-stereotyping of social robots. Journal of Applied Social Psychology.

JProf. Dr. Friederike Eyssel is head of the research group Gender and Emotion. **Dr.-Ing. Frank Hegel** is interaction designer in the Applied Informatics group. Both are CITEC members.

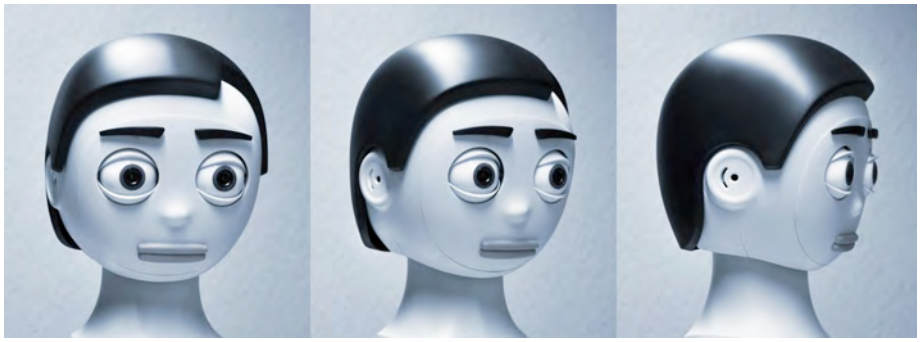


Fig. 2: Male robot type: Short hair.

▶ Books

Gesture in Embodied Communication and Human Computer Interaction
Kopp, Stefan; Wachsmuth, Ipke (Eds.)

This book constitutes the thoroughly refereed post-workshop proceedings of the 8th International Workshop on Gesture in Embodied Communication and Human-Computer Interaction, GW 2009, held in Bielefeld, Germany, February 2009.

ISBN: 978-3-642-12552-2
Publisher: Springer

Intelligence Tests for Robots?

On 7 & 8 February a group of leading international researchers met at CITEC to discuss the challenge of how to benchmark and evaluate interactive cognitive systems. The workshop aimed at developing new methods for assessing the quality of interactive cognitive systems. The central questions to the workshop were:

- How do existing robotics competitions influence the development of technological systems? And how should they be adapted or optimized to reflect the real challenges of the future?
- What preconditions have to be met in order to compare approaches and techniques on a systems level?
- Is it possible to measure the „cognitive abilities" of a system? And how can the outcome be related to decisions on systems design?

Following the common need for new and more objective benchmarks the workshop brought together an interdisciplinary group of internationally renowned researchers from Japan, the United States, Canada, Sweden, Italy, Spain, France, the Netherlands, Austria, and Germany.

▶ http://www.cit-ec.de/BCogS_2011

Research Group: Semantic Computing

The Semantic Computing Group at CITEC was founded in October 2009 with six members: Prof. Dr. Philipp Cimiano, Dr. Christina Unger, Dr. John McCrae, Oliver Beyer, Timo Reuter and Anja Vigouroux. Dr. Dennis Spohr and Judith Gaspers joined in 2010.

Professor Dr. Philipp Cimiano received his PhD from the University of Karlsruhe (now Karlsruhe Institute of Technology – KIT) in Applied Computer Science, where he also stayed as a post-doctoral researcher after his graduation. After holding positions as substitute professor at the Ruprecht-Karls-Universität in Heidelberg in Linguistic Computer Science and as Assistant Professor in Web Information Systems at Delft University of Technology, Cimiano accepted a position as full professor in Semantic Computing at Bielefeld University. Philipp Cimiano is editorial board member of journals such as the Semantic Web Journal (IOS Press), the Journal of Applied Ontology (IOS Press) as well as the International Journal of Semantic Computing (World Scientific).

Research Interest

The aim of the group is to push understanding of how meaning (semantics) emerges and how it can be computed within intelligent and cognitive systems. The groups research revolves around two main topics of dialog: One goal is to endow intelligent systems with the knowledge that they require in order to behave successfully in a certain environment. This includes knowledge about language and its use in a certain context as well as the structure of the world (ontology) and the effect of actions on the world. The goal here is to develop techniques and models by which cognitive systems can acquire such knowledge autonomously or in interaction with humans. Another goal is concerned with the development of methods that ease the users access to the vast amount of structured and unstructured knowledge found on the Web. Here the focus is on access at the level of semantic content, abstracting from specific formats, layouts, surface form or even particular natural languages.

Current Research Activities

The group is in particular concerned with the development of methods and techniques for:

- Construction of and reasoning with representations of meaning of natural language●
- Cognitively-inspired machine learning and knowledge acquisition crossing multiple modalities
- Improving access to the growing amount of structured data on the Web
- Automatic generation of narrative structures to allow users to make sense of the vast amount of content available on the Web in an intuitive fashion
- Efficiently structuring large amounts of unstructured information
- Language learning and concept acquisition
- Knowledge acquisition and ontology learning from the Web, in particular their application in intelligent and cognitive systems
- Improving the way we access and disseminate scientific knowledge, focusing on the Web as a system that can be used to share scientific knowledge but also on digital libraries as centralized systems
- Information extraction that can be easily adapted to different domains and languages and allow to extract knowledge from unstructured resources

Collaborations

The group cooperates with a number of research groups and companies worldwide on the above mentioned topics:

- Knowledge Management Group, Karlsruhe Institute of Technology (KIT)
- Knowledge Media Institute (KMi), Open University
- Wirtschaftsinformatik und Maschinelles Lernen (ISMLL) Group, Universität Hildesheim
- Faculty of Science and Technology, Queensland University of Technology (QUT)
- Web Information Systems (WIS) Group, Delft University of Technology
- Digital Enterprise Research Institute (DERI), National University of Ireland, Galway
- Institute for Web Science and Technologies, Universität Koblenz
- Ontology Engineering Group, Universidad Politécnica de Madrid
- Language Technology Lab, Deutsches Forschungszentrum für Künstliche Intelligenz GmbH (DFKI), Saarbrücken
- SAP Research Center, Karlsruhe
- Ontoprise GmbH, Karlsruhe
- Fluid Operations AG, Walldorf
- BeInformed, The Netherlands
- XBRL Europe

"Where-to-look-next?": Experimental studies with humans and a computational model for robot vision

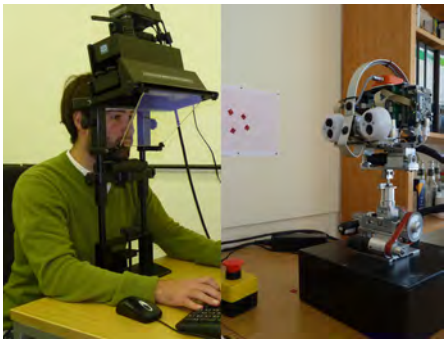


Fig. 1: Eye tracking "in action" (left) and the humanoid robot head "Zeitgeist" with fast shifting cameras (right)

Humans and autonomous robots sample visual information from their environment for efficient action control. Only part of the environmental information is taken up at one moment depending on where the eyes or cameras are directed in space. For human vision, fixations are regularly followed by fast eye movements, the saccades. These saccades – on average three per second – bring the high-resolution part of the eye, the fovea, to new locations in space. Importantly, eye movements are not directed to new locations in a random fashion but are instead shaped by the current task. How does the task direct the eyes to a new location? Research from the last 15 years has shown that covert visual attention determines "where-to-look-next". Attention refers to the ability to prioritize processing of visual information while the eye is fixating. Despite consensus on attention-based control of "where-to-look-next" much needs to be learnt about the underlying mechanisms.

Researchers at CITEC, CoR-Lab, and in the Neuro-cognitive Psychology group – the "Task-based Vision" project – are tackling these research issues by experimental methods studying humans and by computational models for robot vision. Experimentally, perceptual performance and oculomotor behavior of human subjects are measured in highly controlled psychophysical tasks and by means of eye tracking techniques (Fig. 1). A key idea that is pursued by this group refers to the interaction of attentional control with visual short-term memory (VSTM) for determining "where-to-look-next". In one series of experiments (1), subjects had to perform a memory-guided saccade. During the retention interval, a distractor D appeared briefly. If the D was presented within a 20° sector towards the saccade target then the traditionally thought of as purely "sensory-based" considered "global effect" occurs, i.e., the eye will land at an intermediate position between saccade target and D (Fig. 2). Overall, these experiments reveal that sensory processing and short-term memory are highly interdependent processes in determining "where-to-look-next". Further support for this idea comes from another series of experiments (2) the results of which show that VSTM consolidation interferes with the initiation of simple reflexive saccades. VSTM processes without any motor component seem to recruit the same limited resources as purely sensory-based saccade control. Grounded on these and many other findings, a new computational model for the efficient control of "where-to-look-next" has been developed by the Task-based Vision group (3). The model takes camera images as input. Based on inhomogeneous visual feature processing, an attentional priority map with proto-objects – a medium-level representation between pixel and object recognition – is computed (Fig. 3). The cameras of the humanoid robot head (Fig. 1) are then directed to the location with the currently highest priority. Interestingly, this computational model shows new emergent properties that will soon be tested experimentally with human subjects.

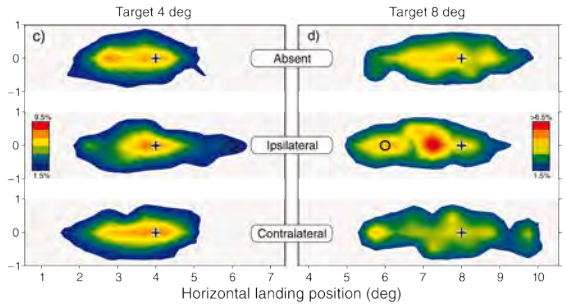


Fig. 2: Deviations in % of a memory-guided saccade in directions of a distractor (absent, ipsilateral, contraleral).

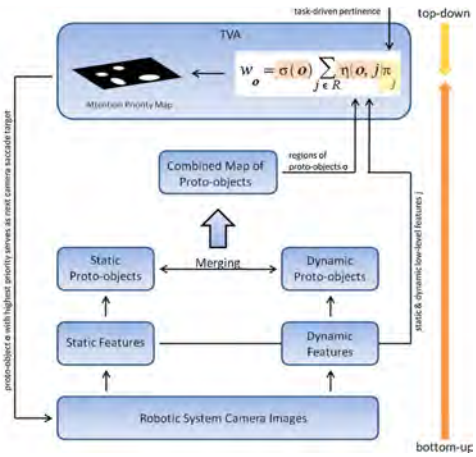


Fig. 3: Macro-Architecture of the computational attention model

[1] Herwig, A., Beisert, M., & Schneider, W. X. (2010). On the spatial interaction of visual working memory and attention: Evidence for a global effect from memory-guided saccades. Journal of Vision, 10(5):8, 1–10.

[2] Carbone, E. & Schneider, W. X. (2010). The control of stimulus-driven saccades is not subject to central, but visual attention limitations. Attention, Perception, & Psychophysics, 72, 2168-2175.

[3] Wischnewski, M., Belardinelli, A., Schneider, W.X. & Steil, J. J., (2010). Where to look next? Combining static and dynamic proto-objects in a TVA-based model of visual attention. Cognitive Computation, 2, 326-343.

Prof. Werner Schneider is head of the Neuro-Cognitive Psychology unit that includes among others **Dr. Anna Belardinelli, Dr. Elena Carbone** and **Marco Wischnewski** (all CITEC members), and **Dr. Arvid Herwig**. **Dr. Miriam Beisert** is a member of the Max Planck-Institute for Brain and Cognitive Sciences in Leipzig. **Prof. Jochen Steil** is a director of Research Institute for Cognition and Robotics (CoR-Lab), CITEC member and head of the research group Cognitive Robotics and Learning.

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