Dear Readers,

Discovering novel design principles to bring the interaction capabilities of technical systems closer to the sophistication seen in biological organisms continues to be a major research focus of CITEC. A striking example highlighted in this issue is the fascinating and highly unexpected design of the light processing mechanism in the eye of an elephant nose fish species that is highly adapted to living in very murky waters. Uncovered through a collaboration of CITEC researchers with a consortium of biologists and physicists it provides also a fine example of an achievement that was only possible through work across discipline borders. Bridging disciplines for new insights about cognitive interaction also characterizes the work of the newly established CITEC research group “Neuromorphic Behaving Systems” introduced in this issue and dedicated to identifying the principles of neural computation and their implementation in fully parallel and low-power neuromorphic VLSI circuits.

The latest decision of the German Research Foundation to grant CITEC another five year funding period in the highly competitive German Excellence Initiative program is a strong acknowledgement of the work of these researchers and their colleagues from more than 30 other CITEC research groups. It provides strong encouragement for continuing CITEC’s research path towards elucidating principles that enable cognitive interaction and their realization in technical systems.

Sincerely yours,

Helge Ritter,
CITEC Coordinator

CITEC NEWS

Team of Bielefeld reaches 3rd place in Robocup Worldcup 2012 @home League. It is a great success for the mainly student run Team and the best ranking Bielefeld robotics ever achieved in the global Robocup competition. RoboCup 2012 was held in Mexico City from Monday 18th through Sunday 24th June 2012 and addressed challenges in robotics in a playful way. Robocup is divided into Leagues in which Robots compete in specialized scenarios. From Soccer to household tasks. The RoboCup@Home league focuses on real-world applications and human-machine interaction with autonomous robots. Aside from the result there was much excitement about some highlights in ToBIs performance. For the first time the robot managed to grasp a can of coke in an official RoboCup Worldcup task. Also the robot autonomously opened a door and was able to drive onto its charging station.

Workshop on robot anthropology The workshop was held at CITEC on August 2nd/3rd and was another joint effort by CITEC and its cooperation partners at Osaka University. Aside from researchers from Bielefeld and Osaka, several colleagues from the Universities of Karlsruhe (TH) and Oldenburg attended the workshop to approach this rather novel field of study combining emergent technologies and questions of human sciences.

Funding approved for large-scale research equipment. Based on this positive DFG funding decision, the laboratories in CITECs new research building will be vested with cutting edge equipment to allow for the ambitious research questions to be tackled. The „Compliant Bimanual Manipulation Lab“ will be provided with state-of-the-art robotic hands and arms to implement and test concepts of manual intelligence. The „Cognitive Service Robotics Apartment“ will combine three central components of future intelligent systems: a mobile service robot platform, ambient intelligence for intelligent rooms and virtual agents on screens distributed throughout the apartment. A “Logic Analysis System” will help evaluate the highly complex microelectronic circuits and systems developed at CITEC. The „Reconfigurable Computing Cluster“ will be central to the development of future on-chip multi-processors for the realization of resource efficient cognitive systems and finally an „Immersive Virtual Experiment Environment“ will provide a controlled and dynamic environment for interaction experiments.

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

„Menschen, Tiere und Max“ by Ipke Wachsmuth

The new Book by CITEC researcher Prof. Ipke Wachsmuth takes the reader on a journey through the diversity and complexity of communication skills. Throughout the book the virtual Agent MAX, developed by Wachsmuths Artificial Intelligence Group, serves as a practical example to discuss various aspects of communication and address questions about the possibilities of artificial intelligence.

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Can't see the wood for the trees? Better try red.

In most vertebrates visual capabilities face a trade-off between visual acuity and sensitivity. Humans cope with this by using two types of light-detecting cells, the rods and cones. Densely packed cones enable us to perceive our daily environment with high acuity, while in dim light conditions we resort to the light-sensitive rods, allowing coarse, but highly sensitive, night-vision.

Working in collaboration with a consortium of biologists and physicists, we were interested to see how the elephantnose fish Gnathonemus petersii, a model system for animal cognition and orientation based on active electrolocation, fares under low light conditions. Gnathonemus lives in murky waters in West Africa (Fig. 1) where it forages at night and was long believed to solely depend on its electric sense.

Hence the complex design of the retina came as a real surprise (Fig. 2). Contrary to maximizing light-sensitivity through exposed rods, the retinal arrangement seems to doom Gnathonemus to fare badly in both sensitivity and resolution: The less sensitive cones are clustered into large cups that shield the sensitive rods located underneath them from the light. The convergence of the photoreceptors on a few ganglion cells per cup results in a low spatial resolution. Objects need to be separated by 3° to be resolved, corresponding to 6-times the size of the full moon.

At a glance (Fig. 2C), the retina looks like an insect eye made up of amazingly ordered hexagonal structures containing four layers of densely packed crystals of guanine. These crystals are arranged within epithelial cells, of which six join together to form a single cup (Fig. 3 A-B).

Based on the detailed analysis of these crystalline layers a simulation of how light travels through and interacts with these cups was performed (Fig. 3 C). The surprising result indicates that red light is selectively guided onto the cones by the mirror-like walls of the cups, intensifying the brightness of red light roughly 10-fold. In line with this, only a single cone-type was found which is optimally stimulated by red light. Taking the physics of light transmission into account, this “hot-spot” of red-light sensitivity makes sense as red light penetrates murky waters best while most of the blue and green light doesn’t even make it a few centimeters down from the water surface. So this retina is equipped with hundreds of parabolic mirrors that focus any red light attainable onto the cones.

This suggested that this fish may actively enhance the photon catch of the less sensitive cones while concurrently shielding the sensitive rods to enable the simultaneous use of both information channels. To test this hypothesis, neuronal recordings from the ganglion cell terminal in the brain were made. In accordance with the hypothesized mechanism by which the gain of rod- and cone-photoreceptors should be adjusted such that both are functional in parallel, responses to rod- and cone specific wavelengths stimuli extended over the same intensity range.

In summary, this novel and technically interesting design combines a coarse spatial resolution with wavelength specific illumination of photoreceptors, making the most of Gnathonemus’ visual sense. Contrary to humans, where the saying that one can’t see the wood for the trees sometimes literally can come true, attention in this fish remains focused on important stimuli by filtering out fine-grained details.

Fig 3: A. Raster-electron microscopy of the cups. B. Artists view of the cup being formed by six epithelial cells. C. These cells are lined with guanine crystals resulting in a wavelength-selective amplification of light at the location of the cones as is shown in this simulation. (Pictures: A. Reichenbach, J-Guck and M. Kreysing)


JProf. Dr. Jacob Engelmann is head of the Active Sensing Group at CITEC.
CITEC Summer School 2012

The CITEC Summer School 2012 “Verbal and non-verbal interaction: From experiments to implementation” took place from the 27th to 31st of August at CITEC.

Researchers from a broad range of disciplines were invited to contemplate and overcome the boundaries of their disciplines. 44 Participants from 15 countries attended the CITEC Summer school to explore the intriguing field of interaction from different disciplinary angles.

The summer school included lectures by high profile guest speakers. Katja Liebal took a “Closer Look at Our Primate Cousins” whereas Hiroshi Ishiguro disclosed his view on “Humans, Androids and Media”. Kerstin Dautenhahn displayed the benefits of “Robot-Assisted Therapy for Children with Autism”. Martha Alibali focused on “Gestures in Interaction” the “Windows to peoples mind”. Herbert Clark addressed “Spontaneous Depictions in Everyday Discourse” and Ivan Toni gave his view on: “Mind-Oriented Movements” and the concept of instrumental and communicative actions. In addition the daily schedule included different theme based practical workshops in the afternoons. Participants were able to choose from the streams: “Development of joint action”, “Gesture in communication”, “Multi-modal data recording and analysis”, “Verbal and non-verbal interaction in social neuroscience" and “Distributed cognition and coordination in interaction”. Discussion Groups and a social activities program completed the schedule.

Research Group: Neuromorphic Behaving Systems

The Neuromorphic Behaving Systems (NBS) group was established at CITEC in August 2011 by Elisabetta Chicca and includes two graduate students (Harshawardhan Ramachandran and Syed Ahmed Aamir). Dr. Chicca holds a Master in Physics from the first University of Rome, “La Sapienza”. In 2006, she received a PhD in Natural Sciences and Neuroscience from the Swiss Federal Institute of Technology Zurich (ETHZ – Physics department) and the Neuroscience Center Zurich respectively. She was awarded a two year postdoctoral fellowship from the Swiss National Science Foundation (Marie Heim–Vögtlin Grant) to carry on her research at the Institute of Neuroinformatics (University of Zurich and ETH Zurich), where she continued working first as a Postdoc and then as Group Leader until 2011. In August 2011 she was appointed Assistant Professor (Juniorprofessorin) at CITEC and the Faculty of Technology at Bielefeld University. Dr. Chicca is associate editor for Frontiers in Neuromorphic Engineering and member of IEEE technical committees (BIOCAS and NSA).

Research interest

The aim of the Neuromorphic Behaving Systems (NBS) group is to identify the principles of neural computation and implement them in fully parallel and low–power neuromorphic VLSI circuits and systems for solving computational problems in real-time. The NBS group studies models of large networks of recurrently connected neurons and explores their computational capabilities using biologically inspired electronic systems. Ultimately the group is interested in developing compact low-power real-time systems which can be applied to the field of autonomous robotics.

Collaborations

- Institute of Neuroinformatics, University of Zurich and ETH Zurich, CH
- Institute for Neural Computation, University of California San Diego, USA
- Plymouth University Cognition Institute, University of Plymouth, UK
- Research group in insect olfaction, University of Konstanz, Germany
- Nonlinear Systems Laboratory, MIT, Cambridge, USA
- Theoretical Neuroscience/Neuroinformatics, Freie Universität Berlin, Germany
- RBCS/Cognitive Humanoids Lab, Italian Institute of Technology, Italy

http://www.nc.cit-ec.uni-bielefeld.de/
CITEC selected for 2nd funding period in
German Excellence Initiative

This June, the German Research Foundation (DFG) announced which
of the existing 37 Excellence Cluster initiatives would receive funding
for another 5 year period within the
German Excellence Initiative. The
competition included new proposals
from initiatives that thus far had
not been part of the Excellence
program. The decision was preceded
by reviews of all initiatives by panels
of international experts, whose
recommendations provided the basis
for the final outcome announced on
June 15.

It was 15:40 on the afternoon of that
day when the decision went out on
the newstickers, eagerly awaited by
researchers in universities throughout
all of Germany. For CITEC, this moment
brought the desired outcome: it
appeared on the list of 43 initiatives (12
of them joining the Excellence program
for the first time) selected for funding
for a duration of five years starting from Nov-1 this year.

Having so far focused on the elucidation of important functional
constituents of cognitive interaction, such as grasping, navigation, dialog
capabilities and active memories, CITEC will use its 2nd funding period for a
better understanding of the interplay of several such functionalities during
cognitive interaction. The goal is to
arrive at a thorough understanding of what is needed for technical systems to
deliver „deep assistance“ to humans in a variety of contexts, ranging from
ambient support in ordinary home scenarios to human–robot cooperation
in households or on the factory floor.

To realize such systems, CITEC researchers will strive for new
integration methodologies. A major and ambitious goal is to organize functional
growth and adaptivity as pervasive properties at a multitude of levels in
order to overcome the limitations of the classical „blueprinting“ approach
of systems engineering, which requires the specification of every detail in
advance. To this end, CITEC researchers will, for instance, focus on the study of
scaffolding mechanisms for directing growth and adaptivity. This will be
complemented by exploring new ways that enable systems to adjust to
resource limits with regard to material, energy, and information in order to
come closer to the efficiency that we see in many biological systems.

Another important focus line will be systems with a capability of „life-long
learning“.

To fuel these plans, CITEC will continue the fruitful cooperations with its
strategic partners and strengthen several of its highly successful
structures, including the Virtual Faculty, the Central Labs, and its
integrated Graduate School. This will be accompanied by the launching of a
balanced mix of highly interdisciplinary projects aiming for breakthroughs enabled
from the connection of expertise across discipline boundaries, complemented by smaller-scale „high-risk projects“, and a select few larger scale initatives aiming to achieve the high level of integration that is the hallmark of cognitive systems. Along
with this, we remain dedicated to maintaining CITEC’s reputation as an
exciting place to monitor, to visit and
to be, for researchers both young and old.