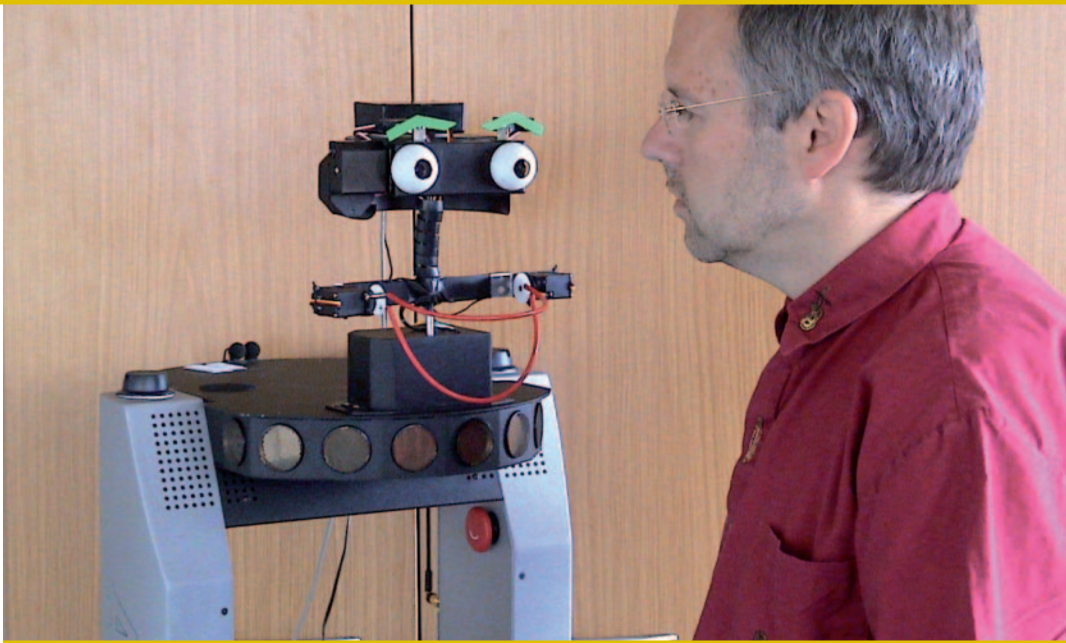
NEST Pathfinder

WHAT IT MEANS TO COMMUNICATE

NESTCOM



Recent NEST projects have produced a great deal of new knowledge on verbal and visual communication in humans. NESTCOM will analyse and integrate these results, with an emphasis on the underlying neural organisation of the brain that supports multimodal communication. A particular focus is the role played by mirror neurons. A better understanding of neural multimodal communications may help provide better neurocognitive models, improve speech and visual recognition in machines (which are still far behind human performance), and lead to more intelligent embodied robots.

What does it mean to communicate? Many NEST projects have explored verbal and visual communication in humans as well as motor actions. They have explored a wide range of topics, including learning by imitation, the neural origins of languages, and the connections between verbal and non-verbal communication. Now, NESTCOM is setting out to analyse these results to contribute to the understanding of the characteristics of human communication, focusing specifically on their relationship to computational neural networks and the role of mirror neurons in multimodal communications.

Mirror neurons are important as they are the smallest entities for multimodal integration in the brain. They fire when a primate performs an action that brings a reward or sees another primate taking that action. These neurons can effectively be activated from different modalities – motor, visual or auditory. Moreover, they fire independently whether it is a primate's own visual, auditory or motor area that is active or that of another primate.

These neurons were first identified in the monkey brain in specific cortical areas, the pre-motor areas. The key area is known as Broca's in humans and plays an important role in human speech, offering the possibility that the development of speech in children may involve some understanding of the reward system in another mind. It also suggests that mirror neurons are central to action imitation and communication development.

So, comprehension of the actions of mirror neurons is very important for understanding more of what makes communication work and how language can actually be based both on vision and on actions.

Improving recognition technology

An holistic analysis of the results of relevant NEST projects may also contribute to improving speech-recognition technology as machines still lag behind that of human performance. For example, the technology is substantially limited in applications such as

> "A unified collection of results from relevant NEST projects focused on neural multimodal communication."

verbal instructions in the relatively constrained environment of a car, where only a restricted number of words can be recognised currently. In an unconstrained noisy environment, such as a railway station, human speech recognition is still much better than machine recognition. There is little reliable technology available that is capable of identifying a cry for help in an open and noisy environment.

On the visual side, some reasonable recognition machinery that uses statistical methods already exists. Nevertheless, it is a difficult problem even now for machines to analyse three-dimensional structures in vision; the human eye and the human visual system still perform much better in difficult situations under various light conditions than machine vision.

Mirror neurons are also involved in the third modality, motor actions. A child quickly learns how to grasp things, even if it takes a year or two. This is a very complicated process with a machine, since, with all the degrees of freedom that humans have, it is extremely difficult to carry out coordinated grasping controlled by the brain as well.

The hope is that by improving understanding of the role of mirror neurons and the underlying concepts of the relevant cortical neural networks, it will be possible to better understand the integration of speech, visual identification and action at a neural level to improve the learning performance of intelligent robots in the long-term.

Knowledge through information integration

The NESTCOM consortium comprises a group of neurophysiologists (the first to identify mirror neurons in the monkey brain) and a team offering language communications and neuropsychology expertise. The project is coordinated by a team from the University of Sunderland whose neural network knowledge and involvement in the development of hybrid intelligent systems will make it possible to explore neural theories on real robots.

The project's overall objective will be to obtain a unified collection of results from relevant NEST projects focused on neural multimodal communication, covering both verbal and visual aspects. An important part of NESTCOM activities will be to disseminate this information to other research groups and interested members of the public.

The results will be publicised widely with the intention of producing an interdisciplinary scientific roadmap that will contribute to a better understanding of the neural, computational and social aspects of communication.

The work produced through NESTCOM will benefit future investigations in higher neuro-cognitive faculties and how they relate to human communications. Analysing and integrating relevant NEST results should also lead to a better understanding of speech, vision and motor actions in the long-term and, ultimately, better embodied robots.

AT A GLANCE

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What it Means to Communicate

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