Researchers develop software modules of cortical architectures to enable intentional behaviors in humanoid robots

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By the end of a research project funded by the European Commission an interdisciplinary team of researchers has developed/designed software modules of cortical architectures to enable intentional behaviors in humanoid robots. Such models, inspired by the functioning of the cerebral cortex, provide the necessary flexibility to develop “perceptual engines” for cognitive robotics. The project EYESHOTS “Heterogeneous representations of the 3D space across visual fragments” was aimed to replicate the structural mechanisms of spatial cognition in an artificial system, which are responsible for orientation and interaction in space. At the heart of the EYESHOTS system is an innovative software substrate inspired to the functioning of the human brain. By analogy with what occurs in the cerebral cortex, the networks developed in the EYESHOTS project code a multiplicity of fragmented and heterogeneous information. By mixing visual, proprioceptive and motor features they specialize and learn behavioral schemes for controlling eye movements and the eye-arm coordination. The visual information extracted from the stereo video stream is differently exploited for controlling binocular fixation and object recognition. Then, it is combined with oculomotor information and those relative to the position of the arm by learning how to look, how to build a representation of the environment, and how to coordinate reaching movements to both the fixated object and those outside of the field of view on the basis of a sensorimotor memory. In everyday life, the experience of the 3D space around us is mediated through the movements of the eyes, head and arms, which allow us to observe, reach, and grasp objects in the environment. From this perspective, the motor system of a humanoid robot should be an integral part of its perceptual machinery. “Traditionally, however” – observes Silvio P. Sabatini, Associate Professor of Bioengineering at the University of Genoa and coordinator of the research project – “in robot vision systems perception-action loops close at system level by gathering new sensorial data caused by the

motor act and driving new actions triggered by their perceptual interpretation. In this way, we disregard the computational benefits/advantages of the movement (e.g., of the eyes) on the processing itself of the visual signal." "In the brain" – continues Sabatini – "perception-action loops close earlier and at inner and finer scales, and this is crucial to enact interaction in the peripersonal space, that is in the space that we can simultaneously explore by the gaze and reach simply by stretching out our arms". The intelligence of an artificial system just relies on this kind of sensorimotor integration that allows an intentional interaction with the space around us. Research in neurophysiology continuously provides evidence that the brain uses representations, which are both perception and action oriented by measuring how visual receptive fields change according to motor actions, such as the position of the eyes and limbs.

All the processing modules used in EYESHOTS are based on distributed representation in which sensorial and motor aspects coexist explicitly or implicitly. "This can be considered an interesting methodological result of the EYESHOTS project," explains Prof. Sabatini. "Through the distributed coding it is indeed possible to avoid a sequentialization of sensorial and motor processes, that is certainly desirable for the development of cognitive abilities at a pre-interpretative (sub-symbolic) level, that is when a system must learn binocular eye coordination, handling the inaccuracies of the motor system, and calibrate the active measurements of the space around it." Why are these results relevant? The brain does not make sounds: no bubbling, no moaning, and no beating. Often, such an organ is considered a silent, distant, and preserved world. What we perceive, and our actions are the results of its functioning only, and the unique way in which it makes it all possible in an only apparent seamless way is invisible. "We believe" – concludes the researcher – "that building bio-inspired systems, not only in their mechanics, but also in the processing schemes would open new perspectives on robotic research and on the study of diagnosis and rehabilitation techniques for pathological, degenerative and developmental disorders of visuomotor integration." The project has been coordinated by the University of Genoa (Italy), and it has had the participation of the Westfälische Wilhems University (Germany), the University of Bologna (Italy), the University Jaume I of Castellon (Spain), and the Catholic University of Louvain (Belgium). Source: European Union

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