As robots learn to imitate

Can robots learn to communicate by studying and imitating humans' gestures? That's what MIRROR's researchers aimed to find out by studying how infants and monkeys learn complex acts such as grasping and transferring it to robots.

"Our main motivation for the project was to advance the understanding of how humans recognise and imitate gestures," says Professor Giulio Sandini, coordinator of the three-year IST-funded project, MIRROR. "We did that by building an artificial system that can learn to communicate by means of body gestures."

Researchers began by designing and conducting behavioural experiments with infants of different ages and with monkeys within the framework of the so-called 'mirror neurons'. These neurons, first discovered in the brains of monkeys, have the unique property of being activated not only when monkeys or human infants perform specific grasping actions, but also when they see the same grasping action performed by someone else – for example, the mirror image of his or her own body. Mirror neurons behave as a motor resonant system activated both during goal-directed actions and the observation of similar actions performed by others.

During the first year of the project, researchers worked at improving humanoid robotic platforms and conducted experiments using a 'cyber glove'. This set-up allowed researchers to collect visual and motor data that was used in investigating the relationship between vision and action in the recognition of hand gestures.

The second year's experiments with monkeys and infants investigated how visual and motor information can be used to learn to discriminate grasping actions. They then used

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that information to show how, by detecting visual clues to the function of an object, a robot can mimic simple object-directed actions.

In the final year they concentrated on integrating the developed work into a humanoid robot, which consisted of a binocular head, an arm, and a multi-fingered hand. Although the integration is not fully complete, they believe they have uncovered many elements of a biologically-compatible architecture that can be replicated in robots.

"We now have better knowledge of how and when the ability to grasp objects appropriately appears in human babies," says Professor Sandini. "From the robotics point of view, we demonstrated that it is easier to interpret actions performed by others if the system has built a representation of the action during learning. Learning precedes understanding. We implemented a complex behaviour on our robot based on this representation."

Although the project is finished, all the members of the consortium now participate in a follow-up FP6 IST project called RobotCub that has, among other aspects, the scientific goal of continuing the MIRROR's project work. RobotCub focuses on building a humanoid platform and studying the development of manipulation skills.

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