



Challenge 2: Cognitive Systems and Robotics

Challenge 2 focuses on artificial cognitive systems and robots that operate in dynamic, nondeterministic, real-life environments. Such systems must be capable of responding in a timely and sensible manner and with a suitable degree of autonomy to gaps in their knowledge, and to situations not anticipated at design time. Actions under this Challenge support research on engineering robotic systems and on endowing artificial systems with cognitive capabilities. Both research strands are intricately intertwined: many functionalities and desirable properties of robotic systems rely on cognitive capabilities. Conversely, robotic systems are suitable platforms for motivating, guiding and validating more basic cognitive systems work.

Hard scientific and technological research issues still need to be tackled in order to make robots fit for rendering high-quality services, or for flexible manufacturing scenarios. Sound theories are requisite to underpinning the development of robotic systems and providing pertinent design paradigms, also informed by studies of natural cognitive systems (as in the neuro- and behavioural sciences).

Research under Challenge 2 will fuel progress for instance from robots that are largely preprogrammed, to robots that are programmable through teaching and learning; from robots that are largely tele-operated, to robots that autonomously plan complex tasks; from robots with rigid components and structures, to those with dexterity and manipulation skills going beyond human level; from robots that operate in tightly controlled environments, to robots that can properly interact and cooperate with people in real-world environments.

Future robots will also come in various shapes and sizes (including miniature) and will increasingly incorporate intelligent materials, as well as advanced sensor, actuator and effector, (distributed, brain-inspired) memory and control technologies, and where needed, they will exhibit physical compliance.

Cognitive systems research extends beyond robotics. Hence, this Challenge will also address issues related to monitoring, assessing, and controlling heterogeneous multi-component and multi-degree-of-freedom systems, where this hinges on implementing cognitive capabilities. At an elementary level, such capabilities include establishing and recognising patterns in sensor-generated data. This is a prerequisite to higher-level operations such as scene interpretation, reasoning, planning, intelligent control, and complex goal-oriented behaviour. Learning, in appropriate modes, is essential at all levels.

It is equally important to be able to measure and compare progress towards the ambitious goals set under this Challenge. Developing suitable benchmarks, conducting benchmarking exercises and supporting scenario-based competitions are therefore firmly placed on the agenda.

Although Challenge 2 does not target any specific application area, research will be motivated, guided and validated by realistic, demanding and scalable real-world scenarios, where appropriate backed by industrial stakeholders. Gearing up cross-fertilisation between relevant industry and research communities is a key issue in this respect and industrial participation is therefore greatly encouraged.



Work under Challenge 2 will improve competitiveness in existing and future markets (e.g., manufacturing, professional and domestic services), and provide innovative solutions in areas that include (but are not limited to) assistance and co-working, production, logistics and transport, construction, maintenance and repair, search and rescue, exploration and inspection, systems monitoring and control, consumer robotics, education and entertainment.

Objective 2.1: Cognitive Systems and Robotics

Target outcomes:

- a) Robotic systems operating in real-world environments: Expanding and improving the functionalities of robotic systems and further developing relevant features, such as autonomy, safety, robustness, efficiency, and ease of use. As appropriate, work will include exploring ways of integrating, in robotic systems, new materials and advanced sensor, actuator, effector and leading edge memory and control technologies.
- b) Cognition and control in complex systems: Enabling technologies based on the acquisition and application of cognitive capabilities (e.g., establishing patterns in sensor data, classification, conceptualisation, reasoning, planning) for enhancing the performance and manageability of complex multi-component and multi-degree-of-freedom artificial systems, also building on synergies between cognitive systems and systems control engineering.
- c) Gearing up and accelerating cross-fertilisation between academic and industrial robotics research to strengthen synergies between their respective research agendas through joint industrially-relevant scenarios, shared research infrastructures; joint small- to medium-scale experimentation with industrial platforms and implementation of comparative performance evaluation methodologies and tools.
- d) Fostering communication and co-operation between robotics and cognitive systems research communities through: identification of common interests and areas of co-operation; knowledge sharing between EU, national, and international initiatives; supporting open-source hardware and software developments; updating R&D roadmaps taking account of work under relevant past and ongoing European programmes; addressing issues such as market potential, user acceptance, standardisation, continuing education, ethics, and socioeconomic impacts; outreach to relevant professional and general audiences.
- e) Speeding up progress towards smarter robots through targeted competitions based on suitably evolving reference scenarios focused on capabilities at issue under this Objective, and involving relevant stakeholders. This includes soliciting private sponsorships, organizing and managing pertinent events as well as accompanying dissemination measures and public relations activities.