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# Robotics for InterAction Technology: Italy's key role in the next revolution

The national recovery and resilience plan overlooks a strategic research field where Italy has a competitive advantage.

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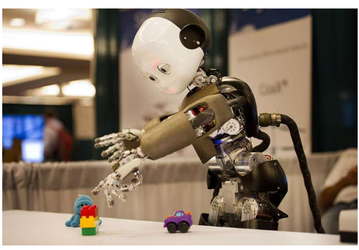

The iCub robot, made at the Istituto Italiano Di Tecnologia in Genova, Italy. Credit: David Paul Morris/Bloomberg via Getty Images.

In Italy's National Recovery and Resilience Plan (PNRR), neither robotics nor Artificial Intelligence (AI) are mentioned among the ten Key Enabling Technologies (KET) that should be the focus of new dedicated research centres. Given the universal recognition of the importance of these technologies, many were surprised.

A possible explanation is that these technologies are assumed to be instrumental to progress in other areas. It is indeed difficult today to think of advancing the digital industrial transition, sustainable mobility, environmental protection, agritech, and even protecting cultural heritage and biodiversity (to cite some of the examples of KET in the Plan), without the help of AI and robotics. Indeed, the text cites AI several times as a tool to reform the public administration (in recruitment, procurement, regulation, taxation and tourism reception), and drones are mentioned for environmental and climate monitoring.

Considering the role of robotics and AI as an implicit enabler, instead of a key enabling technology per se, has unfortunate consequences on research and innovation in the field. We risk missing the common elements among such different application areas, and the cross-fertilization that comes from multidisciplinary efforts.

We argue for the importance of investing not only in the 'vertical' applications, but also in the 'horizontal' fundamental research leading to the development of an overarching general theory and technology of AI and robotics. To do so, it is useful to start by clarifying terminology. The media often throw the terms AI and robotics together in a confusing way. Even in scientific circles, given that there is so much overlap of scope and methods, it is not always evident whether the differences of research problems grant sufficient specificity for two distinct disciplines, or either one is part of the other.

Several existing definitions of AI, or machine intelligence, converge toward the concept of implementing the essential features of human cognition on a computer. In the pioneers' programme, the goal of AI was *the ultimate understanding of intelligence, with obvious practical applications in the creation of intelligent devices or even robots*. Colloquially today, the term AI describes machines that mimic cognitive functions of the human mind, such as learning and problem solving, which fundamentally amount to processing information from data. In contrast, in the crisp and commonly accepted definition offered by Michael Brady in 1980, Robotics is the intelligent connection of perception to action. Robots exist to process interaction with the physical world – not only brains (intelligence) and sensors (perception) but bodies (action) as well.

The fact that AI focuses more on replicating cognitive abilities which reside in the central nervous system, such as image and language processing, while robotics focuses on physical abilities which involve other body parts, such as manipulation and locomotion, is all but the tip of the iceberg. The differences in the two types of intelligence involved have been well-known since at least the 1980s, and best exemplified by Moravec's paradox that "it is comparatively easy to make computers exhibit adult level performance on intelligence tests or playing checkers, and difficult or impossible to give them the skills of a one-year-old when it comes to perception and mobility".

More evidence of the gap between information and interaction processing comes from contrasting vision and hearing with touch. AI has made great progress in processing images and sounds, but tactile information remains a much bigger challenge. To humans, the sense of touch is fundamental importance. A child starts interacting with the world by touching all objects and intuitively learns how to grasp and manipulate them thanks to the intelligence embodied in its hands, in association with, but beyond, the visual memory of the objects.

Indeed, manipulation of the environment is a perfect example of the crucial challenges in front of us. On 20 July 2021 Wojciech Zaremba, a co-founder of the San Francisco-based OpenAI, announced that the company had disbanded its robotics team, which had recently made headlines for learning to sort a Rubik cube with a robot hand from scratch. Zarembra acknowledges the difficulty in acquiring enough real-world information for data-hungry supervised- and reinforcement- learning algorithms. To solve unstructured, highly interactive tasks in the real world, data cannot be taken for granted – the system must itself obtain them from the environment through interaction. This is the fundamental challenge robotics poses to the future of AI, one that makes the two disciplines inseparable.

The mission statement of the Italian Institute of Robotics and Intelligent Machines (I-RIM) proposes the neologism InterAction Technology (IAT) – where the 'A' is deliberately capitalised to emphasise the importance of the physical action. By addressing the problem of learning interaction, robotics and AI will produce a new generation of intelligent devices capable of collaborating with people and interacting with the environment, thus providing the missing link between the digital and physical world in which we live. In this sense, IAT represents the natural evolution of Information Technology (IT) towards a real symbiosis between human and machine.

IAT, as the technology that fleshes out Artificial Intelligence, will play a key role in the near future. It is already today the engine of competitiveness and flexibility of the manufacturing industry, where Italy has one of its most resilient excellences. Robotics for services is showing even more disruptive effects on sectors such as agriculture, health care, environmental monitoring, security, transport, infrastructure and public services. European robotics is at the forefront of the world, and Italian roboticists are among the first in Europe. The average quality of our publications is the best in the world in the Top 10% of the most cited, and second only to the USA in terms of impact and the average number of citations. Italian manufacturing is first in Europe for added value, and the intelligent machines manufacturing our goods are largely made in Italy.

If Italy wants to be in the leading group of the next technological revolution, it must invest in a field with in which it already has an advantage. This is the path indicated by Europe with Horizon Europe and the public-private partnerships (PPP) in AI, Data and Robotics, in which the national communities of robotics and Artificial Intelligence are centrally placed. In order for Italy to consolidate its scientific and industrial leadership, it is necessary to strengthen the unity of fundamental research and technological development across the different applications. We therefore hope that the government plans clear and energetic actions while implementing the PNRR, where robotics and intelligent machines could play a key role for the well-being of its citizens and for economic and industrial development.

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