

## 4. ROBOTS AND ROBOTICS TECHNOLOGIES

Definitions as to what constitutes a robot vary greatly, even among users and suppliers of robotics systems. However, a general consensus has been developed as to the essential features that distinguish robotics from other classes of technology. Robots must exhibit the following capabilities: sensing, intelligence, and motion, as described in Table 2, below.

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*Robots sense, think, and act in the physical world, often autonomously.*

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**Table 2: Features of Robots and Robotics Technology**

Ability	Definition
Sensing	Robots employ sensing technology to acquire information about their environment.
Intelligence	Robots process information captured through sensor technology and produce outputs for decision making, coordination, and control.
Motion	Robots automatically follow instructions that are pre-programmed or generated in real-time based on sensor input to perform a deliberate, controlled, and often repeated, mechatronic action, including point-to-point mobility.

*(Source: ABI Research)*

### 4.1. AUTONOMY

Many would add “autonomy,” the capacity of robotics systems to move or perform tasks responding to both environmental and internal stimuli without external control, to the classic “sense-think-act” definition of robotics. It is the combined ability to sense, think, and act with some degree of autonomy that differentiates robotics from other classes of technology and machinery.

Increasing levels of autonomy is an overarching trend within all segments of the robotics sector—consumer, industrial, commercial, civil, and defense. Greater autonomy in robotics systems can reduce application costs and increase system capabilities. In addition, the same technologies that support autonomous operation in robotics systems can be incorporated into products and services not necessarily deemed “robotic” by the general public, such as self-driving cars.

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*Rising levels of autonomy in robotics systems is a capabilities multiplier, and can reduce costs as well.*

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As technology improves and autonomous robots build on their successes to become commonplace, the number and scope of independent, self-directed systems and applications will increase substantially. As such, autonomy is a transformational capability, and therefore a massive opportunity.

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*Autonomy is a transformational capability.*

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## 4.2. AUTONOMOUS, INTELLIGENT SYSTEMS

The definition of the term “robotic” has evolved over time to reflect the change from fixed, programmable actuated devices to mobile systems that adjust their actions based on multimodal sensor feedback, becoming progressively more autonomous over time. These same autonomous systems have also benefited from advances in on-device hardware and software, as well as access to cloud-based, distributed computing resources, becoming much more intelligent with each passing day.

Robots also have a physicality that humans find greatly appealing and many other technologies lack. For this reason, robots have historically been employed by researchers and businesses to demonstrate advances in machine learning and AI, and as a result, they have become equated in the process. The entertainment industry, along with the media and business communities, has done the same. As a result, robots and robotics technologies are increasingly understood as the physical instantiation of AI. This is an accurate characterization for many robotics systems and will become more so over time.

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*Robots and robotics technology are increasingly, and accurately, viewed as the physical instantiation of AI.*

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