Industry Classification for Robotics & Automation (ROBO)

ROBO Global® Database

ROBO Global created and maintains a unique database of companies across the globe, of which a portion of their business and revenue is associated with robotics and automation. Our database has well over a decade of history and captures the entire value chain of end-user solutions, products, and key enabling technologies. At ROBO Global, our exclusive focus, combined with our access to a unique coverage team of disruptive technology industry experts and financial professionals, allows us to identify, research, and often meet with potential database members.

ROBO Global Industry Classification

In the absence of a benchmark industry classification system for identifying companies engaged in the global robotics, automation, and artificial intelligence industry, in 2013 we created the ROBO Global Industry Classification. Designed for the investment and research community, the industry classification currently identifies eleven subsectors of the robotics and automation theme that present a suitable level of product and technology maturity to carry high growth and return potential. Insights from our Strategic Advisory Board have confirmed that each of these eleven subsectors is positioned well to evolve and expand to support the growth of the global robotics and automation industry.

The ROBO Global Industry Classification is maintained by the ROBO Global Industry Classification Committee, which convenes at least once each quarter and engages in regular dialogue with the ROBO Global Strategic Advisory Board.

Please visit www.roboglobal.com/about-us/ for further information.



Membership Qualification

To qualify for membership in the ROBO Global Industry Classification, companies must pass each stage in the following multi-step screening process:

1. Companies must be included in the ROBO Global Database.

2. All non-publicly traded companies are excluded.

3. If a company's product, technology, services, or business model does not fit into one of the identified subsectors, then they are excluded. Each of the subsectors is discussed later in this document.

4. Companies are given a "ROBO Score," consisting of factors representing the levels of revenue the company receives from robotics and automation, levels of investment the firm makes in those technologies, and the market and technology leadership of the firm within the universe. Each stock's "ROBO Score" will range from 1 to 100 and will be reviewed regularly. Companies whose "ROBO Score" is greater than or equal to 50, and meet all other eligibility requirements, are eligible for inclusion in the ROBO Global Robotics & Automation Index Series.

5. Companies that do not pass the ROBO Global ESG Policy are excluded. For full details of our ESG Policy please contact info@roboglobal.com or visit www.roboglobal.com/esg-policy/.

Eligible companies seeking inclusion in the ROBO Global Industry Classification System or that seek to be classified in a different subsector should apply in writing to info@roboglobal.com.

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Subsector Descriptions

A description of each of the eleven robotics and automation subsectors within the current ROBO Global Industry Classification is provided below. Companies within these subsectors are identified as "Technology" companies or "Applications" companies:

- "Technology" refers to all companies that manufacture or provide services related to machinery, equipment, devices, or sensors that support a robot performing a task. It also includes companies that provide key enabling software and processing technologies used to advance the conversion to autonomous systems. Essentially, we are looking to identify the companies that enable robots to sense, process, and act.

- "Applications" refers to companies that incorporate multiple robotic and automation technologies into their product or manufacturing process to improve efficiency in traditional business lines, as well those that are developing entirely new business propositions within the theme.

Companies are further subclassified into the following eleven subsectors under either Technology or Applications.

TECHNOLOGY	APPLICATION
Actuation	3D Printing
Computing & Artificial Intelligence	Autonomous Systems
Integration	Business Process Automation
Sensing	Food & Agriculture
	Healthcare
	Logistics Automation
	Manufacturing & Industrial Automation

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Actuation (Technology)

Actuation is the means by which machines interact with the physical world. For human beings, this mainly refers to our limbs and, in particular, our hands. Machines, however, are not limited to manipulation. Almost anything that has an effect on the physical world can be made into an actuator. Actuation techniques include electric, hydraulic (compressed fluid), mechanical, and pneumatic (compressed air).

Computing & Artificial Intelligence (Technology)

Robotic and autonomous systems must make decisions at various levels, from determining the state of the environment they are operating in to optimally planning actions and controlling motion. This is analogous to the way our brain functions, and it is what allows the processing of information that leads to actuation. Accomplishing this in an autonomous robotics system requires raw computing and processing power, as well as increasingly advanced software. Computing can vary from embedded systems smaller than a fingernail to hyper-scale datacenters implementing sophisticated algorithms—including artificial intelligence (AI). Advancements in AI, especially machine learning, are key to the growth of autonomous systems. The main advantage of AI over human intelligence is its high scalability, resulting in significant cost savings. Other benefits include AI's consistency and rule-based programs, which eventually reduce errors. AI's longevity coupled with continuous improvement and new growth opportunities are the reasons why AI is drawing wide interest.

Integration (Technology)

Robotics and automated systems are made up of many components (sensors, actuators, and computational units), which can be distributed over large spaces. Integration consists of architecting a system to determine how components work together to achieve a defined objective in a robust, high-performance, and cost-efficient way.

Sensing (Technology)

In order for a system to exhibit autonomy and determine its own internal state, it must be able to sense its environment. This is referred to as exteroception and proprioception. For robotic systems, this level of sensing is important for the same reasons that exteroceptive senses (sight, sound, etc.) and proprioceptive senses (the ability to know where our limbs are and what they are doing without directly observing them) are important for human beings—they enable us to perceive the world around us. Robotic systems, however, are not limited to the standard senses. In robotics, a sensor can be developed to detect almost anything that can be measured.

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3D Printing (Application)

Traditionally, things are built either by assembling separate parts together or by removing material from a larger work-piece. 3D printing (also called “additive manufacturing”) adds yet another way of building by depositing different types of materials where they are needed. One of the primary benefits of 3D printing is the potential for customization that is not economically feasible with traditional techniques.

Autonomous Systems (Application)

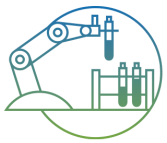
Autonomous systems are designed to responsively operate in a dynamic environment with minimal human intervention. This is typically achieved by using sensors to perceive environmental conditions, modeling appropriate responses to changing conditions using planning and control system modulation, and then controlling actuators to interact with the environment. Autonomous systems may use adaptive reasoning, machine learning, statistical methods, and other forms of artificial intelligence to refine their own responsive behavior and their models of external conditions. Examples include indoor and outdoor transportation systems, including surface and air vehicles such as autonomous mobile robots, drones, cars, trucks, and trains, as well as autonomous mobile robots for material handling and robotic cleaning machines.

Business Process Automation (Application)

The technology-enabled automation of complex business processes drives greater simplicity, productivity, quality, transparency, sustainability, and ultimately greater competitive advantages for companies embracing a digital transformation. Ranging from data analytics and business intelligence to robotics process automation, examples also include voice assistants, chatbots, visualization and simulation software, and AR/VR. But automation isn’t just for IT processes. It can be applied to HR, finance, marketing, and R&D functions, streamlining workflows and automating hundreds of processes.

Food & Agriculture (Application)

Feeding and sustaining the world continues to be one of our most important economic activities. A new generation of autonomous systems and data analytics tools are bringing the benefits of traditional automation, such as precision and the elimination of rote labor, to this domain. For example, precision agriculture offers the potential to greatly reduce costs and minimize our environmental footprint by applying water and fertilizer on an as-needed basis. Meanwhile, the food processing industry continues to automate aggressively to meet the increasing demand for greater volume, lower costs, and more stringent safety requirements.



Healthcare (Application)

As healthcare costs continue to rise globally, robotics, automation, and AI are poised to provide a countering force to this trend. Using robotics and autonomous systems in areas including rehabilitation, diagnostics, exoskeletons, and care for the elderly promises to drastically reduce costs and improve the quality of life for many people. In addition, as in all other application areas, robotics and automation can enable new capabilities that transcend cost-cutting, such as the use of robots for many types of precision medicine, including surgeries on the tiniest elements of the heart and lung, and neurological treatments.

Logistics Automation (Application)

The logistics and warehouse automation industry is at an inflection point as the boon in e-commerce continues to dramatically raise the bar for supply chain efficiency. From autonomous mobile robots and advanced storage systems to track & trace technologies, logistics automation enables increasingly speedy, safe, and error-free distribution, a shorter time-to-market, and ultimately lower costs to businesses and consumers.

Manufacturing & Industrial Automation (Application)

Factory automation is an increasingly critical success factor in manufacturing as businesses pursue higher productivity and lower costs in the face of global competition. Automation also means workplace safety and frees up workers from tedious manual labor to focus on strategic, high-level tasks that require human expertise. While the automotive industry was the first to deploy robotics and automation, many other industries are still in the early stages of adoption, offering significant growth potential.