IFR International Federation of Robotics

Media Backgrounder

# Artificial Intelligence in Robotics

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# IFR Background Information for Journalists on Artificial Intelligence in Robotics

## 1. What is artificial intelligence?

There is no agreed definition of artificial intelligence (AI) – or human intelligence. John McCarthy, who coined the term artificial intelligence in 1956, complained, “As soon as it works, no one calls it AI anymore”. The general characteristics of computer programmes and methods currently termed AI include technologies that create and use a predictive model to determine correlations within large datasets and, are able, as a result, to make suggestions and execute transactions. Examples include: Recommendation engines; spam filters; price engines; algorithmic trading systems; scheduling systems; medical systems that process either images or records to generate diagnoses. The output of an artificial intelligence algorithm can be used as the input to another programme or physical machine which executes a task, such as a robot.

## 2. How is artificial intelligence applied in robots? What are the benefits?

Artificial intelligence in robots gives companies new opportunities to increase productivity, make work safer, and save people valuable time. Substantial research is being devoted to using AI to expand robot functionality. Commercially available applications include the use of AI to:

- Enable robots to sense and respond to their environment: This vastly increases the range of functions robots can perform.
- Optimise robot and process performance, saving companies money.
- Enable robots to function as mobile, interactive information systems in numerous settings from public spaces to hospitals to retail outlets, saving individuals time.

### Examples

#### Sense-and-respond:

**Identifying, picking, and passing objects:** Traditionally, robots have been able to pick up objects in a pre-programmed trajectory in which the object must be known and in the expected place. Robots equipped with sensors can now be programmed using artificial intelligence to identify specific objects regardless of their spatial location. 3D vision software allows the robot to detect objects that are hidden by other objects. Through machine learning, one of the technologies classed as AI, the robot can teach itself in a very short time how to pick up an object it has not encountered before, applying the appropriate level of force. The machine learning algorithm continues to improve as it picks. Picking technology is advancing rapidly but it is currently very difficult for robots to pick objects that are not rigid – for example, goods in plastic wrapping or floppy materials, or have irregular and variable shapes – such as fruit and vegetables – with an accuracy and speed that is commercially viable.

**Inspection:** Artificial intelligence enables robots to inspect a wide variety of objects to detect faults – from fruit and vegetables to underwater pipelines.

**Mobility:** AI technologies are enabling advanced mobility in robots. Whilst robots have been mobile for over 60 years (the first Automated Guided Vehicle was introduced in 1953), AI enables robot mobility in unpredictable environments. Mobile robots have traditionally been programmed to execute a specific set of manoeuvres in a linear fashion, guided by signals (magnetic, laser, lidar) from devices installed for this purpose in their environment. They have not traditionally been programmed to deal with unexpected events – for example, if they encounter an obstacle, they can stop to avoid collision, but they will not be able to find an alternative route to their goal. In contrast, an AI-enabled mobile robot gets from A to B by building a real-time map (or updating a pre-programmed map in real-time) of its environment and of its location within that environment, planning a path to the programmed goal, sensing obstacles and re-planning a path in-situ. Mobile robots using AI are in commercial use in a number of industries and applications such as:

- Fetching and carrying goods in factories, warehouses, hospitals.
- Performing inventory management (mobile robots using RFID scanners or vision technologies).
- Cleaning – from offices to large pieces of equipment such as ship hulls
- Exploration of environments dangerous for humans – e.g deep-sea, space, contaminated environments.

## Process Optimisation

AI is used to optimise robot accuracy and reliability. Most large industrial robot manufacturers offer customers services using AI to analyse data from robots in real time to predict whether and when a robot is likely to require maintenance, enabling manufacturers to avoid costly machine downtime. Robot performance can also be optimised through analysis of data from sensors - tracking, for example, its movement and power consumption. The robot programme can be adjusted automatically based on the output of the AI algorithm.

Predictive maintenance and process optimisation do not require AI. However, AI technologies improve the speed and accuracy of both activities, resulting in cost savings. In large-scale manufacturing automation projects robots are typically connected to other machinery – including other robots – and AI is used to optimise the whole process, analysing data from all machines.

## Mobile Information Robots

Mobile robots are being used as information booths to assist customers in environments such as hotels, hospitals, airports and shops. They can answer questions, lead customers to requested products or locations and can video-link the customer to a human service agent.

## 3. How will the use of AI in robots affect workers and jobs?

Intelligent robots can make work safer and more satisfying. Robots are assuming an increasing range of jobs that are dangerous for humans, such as cleaning toxic or infected environments.

AI expands the potential for robots to share tasks or processes with workers, taking on those parts of the task or process that are unergonomic and repetitive, such as lifting, fetching and carrying. These applications do not depend on AI, but AI technologies enable the robot to work effectively in unpredictable or rapidly-changing environments.

*See the IFR's positioning papers on '[The Impact of Robots on Productivity, Employment and Jobs]' and 'Robots and the Workplace of the Future' (LINK) for more information on how robots affect workers and jobs.*

## 4. What is the focus of research and development in AI for robots?

The main areas of focus of AI research in robots are:

- Expanding picking capabilities to deal with objects that are not rigid or are not in static locations.
- Expanding robot mobility to work effectively in non-standard environments (such as rough terrain).
- Enabling control of robots through verbal commands and gestures.
- Making robots easier to programme: Robots can already be programmed by physical demonstration (the robot is guided through the required motion path and force /torque measurements are translated into code). Research is ongoing in applying AI to enable robots to learn by watching video demonstrations, and by independent trial and error. Reducing robot programming time and costs will increase robot adoption by small-to-medium sized companies, making them more productive. Connected robots will also be able to learn together, running effectively as parallel computers.

It is important to note that it will be some time before these technologies are commercially viable, let alone ubiquitous - it typically takes several years or even decades for new technologies to be adopted at scale[1].

[1] The McKinsey Global Institute finds it can take between eight and 28 years for technologies to be adopted at scale, from the point at which they become commercially available (*A Future That Works: Automation, Employment, and Productivity*, McKinsey Global Institute, January 2017).

## 5. Are existing regulatory systems and safety standards sufficient to cover the risks of AI in robots?

The IFR believes that existing safety standards are sufficient to cover current developments in the use of AI in robots[2] in commercial applications.  Currently, no additional regulation is required.

## 6. Is the idea of super-intelligent robots that humans are not able to control a myth? Will robots outsmart us?

Fears of super-intelligent robots relate to General Artificial Intelligence (GAI). There is no agreed definition of GAI, but broadly speaking, it the ability of a software programme to apply concepts acquired in one specific context to multiple other contexts. In humans, part of being able to apply learning from one context to another involves tacit knowledge[3]. Machines do not ‘learn’ like humans – they adjust parameters based on goals and limits set by programmers with no understanding of what they are doing and why.

GAI is not possible today, nor is it clear when, if ever, it might be. However, it is up to humans to determine the parameters, or degree of autonomy, under which AI operates as well as the level of unpredictability we are prepared to accept. AI programmes do what they are programmed to do[4]. The commercial relevance of GAI in robots is unclear. The commercial viability of a robot is based on its ability to carry out tasks with high precision and reliability, in compliance with strict safety and regulatory standards.

[2] The ISO standards governing robot safety include ISO 10218-1 and ISO 10218-2:2011 Safety requirements for industrial robots, Parts 1 and 2;  ISO 13482:2014 Safety requirements for personal care robots and ISO/TS 15066:2016 Safety requirements for collaborative robots.  In Europe, safety is regulated through the EU Machine Directive. In the US, the safe application of robots is regulated by OSHA Guidelines for Robotic Safety.

[3] Even young children know, for example, that a giraffe cannot climb a ladder – something an AI algorithm could only derive based on access to explicit information.

[4] This is not to say that AI algorithms always do what the programmer intended. But algorithms cannot define or repurpose their end goal. Concern has been raised about self-learning algorithms that discover correlations between data without being tasked with finding something specific or trained on existing examples. This can make it difficult for programmers to understand why the algorithm has reached a particular conclusion. The IFR supports a strong emphasis on ongoing research into algorithms that are able to explain their computations to programmers and users.