

Deploying robots and drones in process plants and facilities

Robots have long been used in discrete manufacturing and machine automation applications, and their use is now spreading to address process industry applications.

Process plants need leaner and more efficient operations to cope with aging assets and workforces. Key technologies for reaching these goals are robots and drones. They can be used to enhance safety while improving productivity and operational efficiency, especially in hazardous environments.

In general, robots and drones are better at performing routine tasks than humans, who typically prefer and excel at more creative uses of their talents. Routine tasks are boring for humans, and because of this natural characteristic, they sometimes skip routine safety procedures and ignore dangerous signs in the field. However, robots can be designed to execute these types of tasks without skipping steps.

Robots and drones can relieve humans from working in hazardous environments, and perform some tasks humans are unwilling to do. Their capabilities allow them to perform more mundane and dangerous jobs and free up workers for higher-value activities.

Robotics are not new to the process industries. For decades, they have been used in dangerous environments such as deep-water oil exploration, subsea inspection, and hazardous plant areas. Robots have been effective in these applications. They are highly specialized and expensive, but technology advances are addressing these and other issues.

Sensors, computing, connectivity

Advancements in sensing, computing, and connectivity technologies are leading the robotics revolution. Advanced sensing and microelectromechanical (MEM) technologies are making robots more functional, less expensive, smaller, and lighter. Smartphones helped in the development of advanced MEM technologies at low cost with a small form factor. This increased market adoption, and these technologies are being applied to improve robots and drones.

The internet provided communication and cloud computing infrastructure, coupled with high demand for connected devices. Autonomous vehicle research

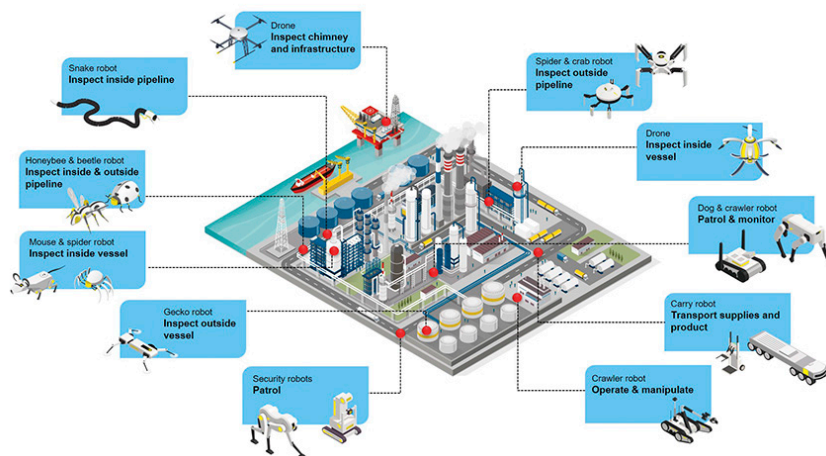


Figure 1: Many different types of drones and mobile robots are being used to perform various tasks in process plants. Images courtesy: Yokogawa

and development allowed for high-priced technology testbeds fueled by vehicles to lower costs. Artificial intelligence made analysis of large data sets possible, and machine learning can be used to make decisions and take corrective actions in real time.

The convergence of all these and other technologies has created space for innovation, with robotics one of the main beneficiaries.

Mobile robots, drones: How they help

In general, mobile robots and drones must perform two main functions. One is mobility, which requires a means of propulsion, along with multiple onboard sensors for guidance such as light detection and ranging, high-def cameras, infrared cameras, and others.

This allows robots to move forward, backward, sideways, and in curved paths while avoiding obstacles, climbing stairways, and performing other necessary movements. It also allows drones to avoid obstacles in flight without the need for constant human monitoring and control.

The second main function of robots and drones is related to the specific task and application. For

example, robots use gas sensors to detect leaks, high-definition cameras to read gauges, and infrared cameras to measure temperature. On rotating equipment, robots use microphones to detect abnormal noises and vibration sensors to detect excess movement. Drones use cameras to transmit video information to operators, and they carry payloads to remote areas.

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Robots to inspect assets

Asset inspection and maintenance has been the first target application for robotics in the process industries. The SPRINT Robotics Consortium is a user-owned and -managed organization, with its main objective collaboration on a new industry-driven initiative to promote the development, availability, and application of robotic technologies in technical inspection and maintenance of capital-intensive infrastructure. Early targeted application areas include the inspection of pipelines, storage tanks, and pressure vessels. Remote control robots are useful in these and other hazardous environments.

A variety of robot form factors such as crawlers, snakes, drones, etc., are available, with each having unique capabilities designed for specific applications (Figure 1).

Snake robots crawl in pipelines, carrying multiple cameras and LED lights, to perform visual inspection and ultrasonic measurement of pipe wall thickness. Snake arms inspect vessel interiors. Spider and honey-bee robots can inspect pipeline interiors and exteriors.

Drones perform upstream oil and gas industry inspection tasks such as locating leaks and detecting

the presence of hazardous gases, and they are also used to inspect confined spaces in large vessels. Bike robots are also used to inspect vessel interiors.

Crawler robots can move around plants and facilities to perform many of the same tasks as human operators making rounds. Dog and human form factor robots can perform simple repairs. These types of robots can be equipped with manipulating arms able to turn valves, paint structures, push buttons, and even replace electronic boards in cabinets.

To achieve the highest levels of effectiveness, it's necessary to deploy, maintain, integrate and coordinate the actions of these different robots.

Deployment and maintenance

Deploying robots in an industrial environment requires more than just purchasing and installing individual robots. Robots must be trained to perform specific tasks effectively, and they must be maintained and repaired. Each robot must be deployed based on its suitability for often hazardous environments, and best practices and regulations must be followed.

For example, since most mobile robots for industrial applications are battery-based, recharging or battery swap is required every few hours. This simple task can become very complex if the robot is working in a hazardous area, where careful planning is required to achieve maximum efficiency while maintaining safety.

Robot training is commonly required initially, whereby a general-purpose robot is programmed to perform a specific task, following either pre-designed routes or autonomously. Instead of generating lines of code to program robot operations, some manufacturers offer a training function. This allows users to deploy and guide a robot with a touch screen interface to create a robot trajectory, with robot programming automatically generated based on this user input.

Robot integration, coordination

A mobile robot management system can schedule and manage the wide variety types of robots and drones deployed in an industrial plant or facility, with integration made easier if robotics with open interfaces are purchased.

Another important aspect of robot and drone deployment in the process industries is integrating vast amounts of information. Most robots and drones carry multiple cameras, with many types of sensors, which produce information that must be stored, integrated, and made available. Operators prefer one graphical interface to show an overview of multiple robots and drones, but also require the flexibility to deep dive into each sensor or camera (Figure 2). **ce**

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Figure 2: Operators can safely monitor field conditions remotely using information provided by mobile robots and drones.