Sonair

Case study:

Cleanfix & Sonair

3D perception for robust cleaning in complex environments

How Cleanfix is advancing the new generation of the RA660 Navi XL cleaning robot with 3D ultrasonic sensing from Sonair

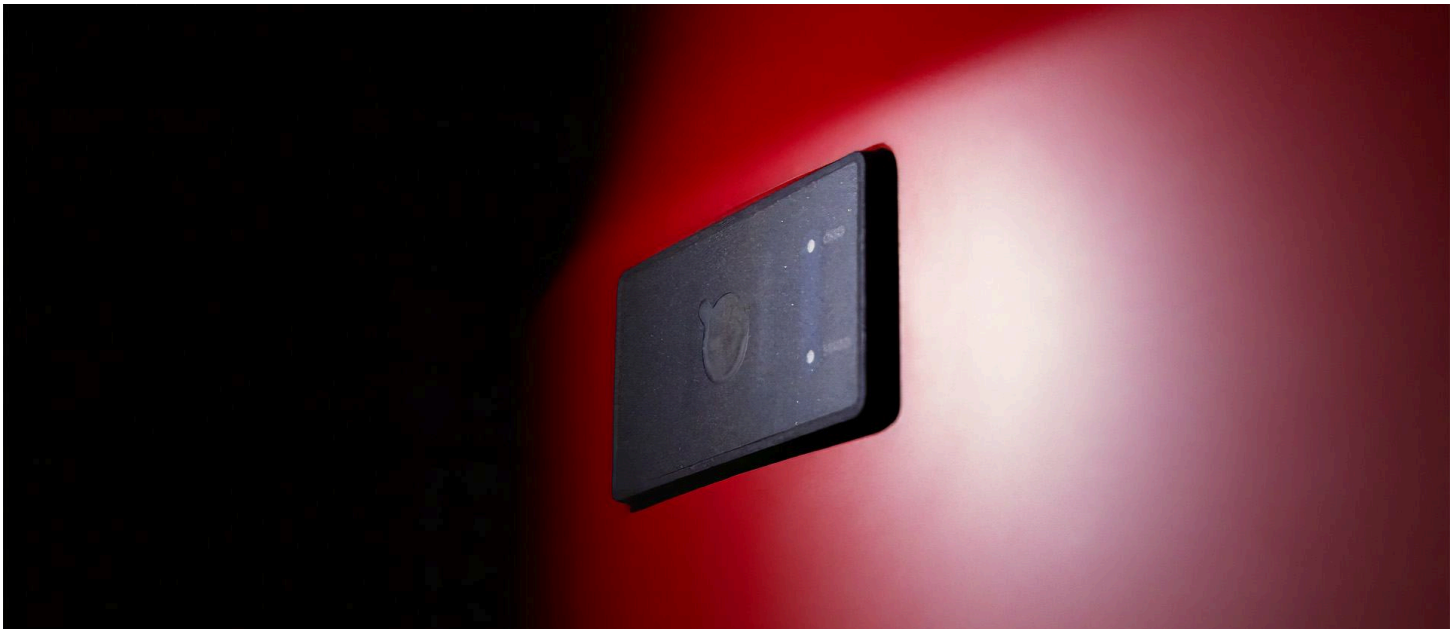
Rising costs, labor shortages, increasingly tight cleaning windows, and higher hygiene requirements are putting pressure on facility management, particularly in commercial and industrial cleaning. As a result, many companies now deploy autonomous cleaning robots in commercial and industrial environments. These robots often work unattended, at night, and side by side with people.

In the real world, dust, moisture, and low-profile obstacles are constant challenges for autonomous cleaning. With its next-generation cleaning robot, the RA660 Navi XL, Cleanfix has moved away from clunky, complex multi-sensor configurations in favor of purpose-built 3D sensing.

A key component is the 3D ultrasonic sensor ADAR from Sonair, which operates reliably where camera- and laser-based sensing systems (LiDAR) reach physical limits.

This is Cleanfix

Cleanfix Reinigungssysteme AG has been developing and distributing professional cleaning machines for decades. Founded in Switzerland in 1976, the company is widely regarded as a pioneer in autonomous cleaning. Cleanfix introduced the world's first professional cleaning robot in 2008. Its RA660 Navi platform, launched in 2015 and continuously developed since, serves as the foundation for the second-generation RA660 Navi XL, designed for dynamic operating environments.



Cleaning robots: Enabling autonomy in dynamic, real-world environments

Unlike traditional industrial applications with clearly defined workspaces, autonomous cleaning robots operate in open, dynamic environments. Gyms, schools, logistics centers, and production facilities are characterized by pedestrian traffic, temporary obstacles, and constantly changing situations. People move through aisles and forklifts cross intersections, while objects such as equipment, pallets, bags, and tools may turn up in unexpected places.

“The operating environments are highly dynamic and constantly changing. That’s exactly what autonomous cleaning robots must be prepared for,” explains Roger Kaiser, Head of Robotics at Cleanfix.

Small, flat, or partially occluded obstacles near the ground are particularly challenging. Examples can include waste, sports equipment, tools, forklift forks, pallet edges, and overhanging loads in warehouse aisles. Conventional 2D sensors often fail to detect these objects reliably, resulting in collisions, stops, or inefficient detours.

Since autonomous cleaning is designed for continuous, repeated operation across large areas, even short interruptions have a direct impact on efficiency and operating costs.

ADAR: Spatial 3D perception replacing 14 linear ultrasonic sensors

With ADAR, Cleanfix has achieved a major technical first by providing the RA660 Navi XL with true 3D spatial awareness through ultrasonic sensing. Earlier generations relied on up to 14 linear ultrasonic sensors, each covering only a limited area. ADAR consolidates these functions into a single sensor, generating a three-dimensional point cloud with a field of view of up to 180 × 180 degrees.

ADAR uses a MEMS (micro-electromechanical systems) ultrasonic array with electronic beamforming to emit pulses in multiple directions. Reflected signals are processed to generate a 3D model of the environment. This enables the new Cleanfix robot to detect small, ground-level, or partially occluded obstacles both at range and directly in front of the platform, including objects protruding into the driving path or located near people.

This is ADAR

Acoustic detection and ranging

The world's first safe 3D ultrasonic sensor

3D: From a flat 2D view to full 3D, capturing all spatial data

Four meter range: With full, vertical 180 x 180 degree views

28 zones: Pre-configure 128 safety zones and constantly monitor one stop zone and two warning zones

The resulting perception data is fed into the robot's control system, where it influences navigation and motion behavior in real time. This supports smooth, predictable operation in dynamic and shared environments.

One advantage of this technology lies in the physical properties of ultrasound: unlike LiDAR, it is largely insensitive to dust, moisture, darkness, and transparent or highly reflective surfaces. In this way, ADAR complements the existing navigation architecture with light-independent obstacle detection.

"For us, it was crucial that perception remains stable even under difficult conditions. Only then can autonomous cleaning be reliably scaled in everyday operation," Kaiser explains.

Stable system behavior through robust perception

A key development goal of the updated robot model was achieving stable and predictable system behavior in daily operation. In practice, the limits of existing perception concepts become apparent: camera- or LiDAR-based sensing systems can misinterpret particles or reflections as obstacles in dusty or humid environments.

ADAR's robust perception reduces false obstacle detections caused by environmental effects. This results in fewer unplanned stops and a smoother motion profile, especially in open areas or environments where people are also working.

"Our customers don't evaluate algorithms—they evaluate results: minimal interruptions, predictable deployments, and a robot system that works reliably for hours," Kaiser says.

High data protection, high economic efficiency

The RA660 Navi XL operates without cameras. It neither captures nor stores image data, relying exclusively on sensor data for navigation and obstacle detection. This simplifies deployment in sensitive environments where people, confidential processes, or protected information are present, such as schools, gyms, public facilities, industrial sites, and administrative buildings. Data protection is achieved not through safeguards, but through the deliberate omission of image-based sensing.

Another advantage is reduced maintenance effort: ADAR does not require optical lenses or covers that need regular cleaning. This reduces downtime and service interventions, an important factor for operators managing multiple machines. In daily operation, this means fewer manual interventions and higher system availability, both of which are critical in night time operations. In fleet operation, this directly lowers the total cost of ownership and supports the scalability of autonomous cleaning solutions.

Integration into a robust overall system

Cleanfix deliberately follows a lean sensor architecture. Its 180 × 180-degree field of view and 3D perception allow ADAR to replace multiple dedicated sensors, reducing sensor count and system complexity compared with camera-based architectures.

Fewer components mean less cabling, fewer potential failure points, and higher overall reliability, both in daily operation and in series production.

Powering functional safety in dynamic environments

The robot platform has also been updated with a new chassis, improved service access, IP66-rated electronics, and a revised drive system designed for greater durability and easier maintenance.

The RA660 Navi XL is designed in accordance with IEC 63327 for autonomous cleaning machines. Improved environmental perception through ADAR supports predictable system behavior and makes a substantial contribution to the functional safety of the robot. This is complemented by an integrated safety warning light (BlueSpot), status LEDs, acoustic signals for active communication with the surroundings, and a revised operating concept with a new user interface. In parallel, ADAR is currently undergoing the process of PLd / SIL2 safety certification.

Conclusion: Robust technology for the complexities of everyday cleaning

With the new generation of the RA660 Navi XL, Cleanfix leverages modern sensor technology to further align autonomous robotics with the realities of everyday cleaning operations. The integration of ADAR 3D ultrasonic sensing represents a key building block for robust, light-independent environmental perception and stable, predictable system behavior, even under changing conditions.

“In this way, the new robot not only contributes to efficiency and economic performance in autonomous cleaning, but also supports safe and reliable operation,” concludes Roger Kaiser.

And the journey continues: Cleanfix will use the experience gained with the new cleaning robot to further develop future machines and product generations, ensuring that perception, safety, and real-world usability are designed together from the outset.

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