

## Robotic Automation for Industrial Inspection

### Intel RealSense helps autonomous mobile robots map facilities, avoid obstacles, climb stairs, and navigate to dynamic docking stations

#### Spotlight on ANYbotics

ANYbotics autonomous legged robots solve inspection problems in challenging environments. Customers rely on ANYbotics robotic solutions for end-to-end solutions that include:

- Inspection and Monitoring: to check pre-defined inspection points and monitor infrastructure for anomalies
- Inspection Intelligence: AI-based analytics provide actionable inspection insights at unprecedented quality
- Modular Payload: ANYmal's capabilities can be customized with software and sensor payloads

#### At a Glance

- ANYbotics is a pioneer in the use of legged robots for industrial inspection. Its solutions include an autonomous robot platform, inspection intelligence capabilities, and an integrated data processing workflow.
- Each ANYmal robot has six Intel RealSense D435 modules that work together to create an elevation map that helps the robot navigate around a site and traverse difficult terrain, including climbing stairs.

# ANYbotics

#### Challenge

Industrial sites are complex environments. Monitoring the condition of equipment and infrastructure is mandatory. But industrial inspections are often tedious, error-prone tasks that expose humans to hazardous environments.

#### Solution

ANYmal D is a four-legged robot platform that conducts autonomous industrial inspection. Designed for harsh, challenging, and unmanned environments, this autonomous mobile robot (AMR) excels at routine condition monitoring of equipment and infrastructure.

#### Results

ANYbotics' robotic solutions provide advanced inspection reports by patrolling facilities and monitoring the condition of equipment and infrastructure.

#### Benefits

Precise visual acuity from Intel RealSense modules help ANYmal AMRs boost equipment uptime, enhance operational performance, and improve worker safety.

#### Introduction: The Importance of Inspection Intelligence

##### Eyeing the Future

Factories, power plants, chemical processing facilities, and other industrial sites routinely perform inspections to gauge the health of key equipment, as well as to trigger corrective actions. In some cases, maintenance personnel must inspect equipment multiple times per day, often in unpleasant or potentially hazardous settings. Internet of things (IoT) devices have helped automate some aspects of gathering and processing equipment data, while keeping humans out of dangerous environments.

Deploying autonomous mobile robotics for routine inspections also allows businesses to shift skilled workers into more productive roles. Humans can focus on more skilled tasks while robots perform inspections that boost uptime, enhance operational performance, and improve quality. ANYbotics is leading the way with ANYmal D, a ruggedized four-legged robot designed to operate independently in factories, power stations, chemical plants, railways, construction sites, mines, and other facilities. Its fleet of autonomous mobile robots optimize routine condition monitoring tasks by collecting and analyzing visual, thermographic, and acoustic data.

Intel® RealSense™ 3D depth perception capabilities are fundamental to these inspection systems. Each ANYmal D robot has six Intel RealSense D435 modules:

two on the front face, two on the rear face, and one on each side. The modules work together to create an elevation map that helps the robot navigate around a site and traverse difficult terrain, including climbing stairs.

“Intel RealSense cameras are a key component of our automated mobile robots,” says Daniel Lopez Madrid, Perception Team Lead at ANYbotics AG in Zurich, Switzerland. “They offer an excellent price/performance ratio that is unique in the industry.”



**Intel RealSense 3D depth perception modules help ANYmal robots recognize obstacles, avoid collisions, distinguish foreground from background objects, and measure and understand shapes.**

## Selecting Intel RealSense D435

Madrid and his team decided to standardize on Intel RealSense D435 for several important reasons:

- Intel RealSense has excellent on-board data processing capabilities
- Refined visual data processing algorithms are available right out of the box
- An open software development kit (SDK) allows ANYbotics to adapt Intel RealSense to various tasks, environments, and conditions
- Intel RealSense has a low price point, along with high-end capabilities
- A compact form factor makes it easy to integrate multiple Intel RealSense modules into each robot

“Our engineers and integration specialists like Intel RealSense because it includes a flexible platform to build on,” sums up Madrid. “The modular design facilitates easy integration. We put them in custom cases to achieve an IP67 rating, which is critical when robots operate in wet environments.”

## Precise Visual Acuity for Precise Inspection Tasks

A complete robotic inspection solution must have the perceptual capabilities and intelligence to detect irregularities with equipment or infrastructure—as well as to traverse a known environment that may include unknown conditions. Each Intel RealSense camera has two sensors to calculate depth, allowing ANYmal to navigate landscapes, avoid obstacles and recognize objects, people and scenes.”



In addition to collision avoidance, the Intel RealSense cameras help ANYmal robots locate and connect to docking stations, even in dynamic environments in which the stations are constantly being moved to new areas.

While other sensors such as LiDAR cameras may have a longer range and higher accuracy, Madrid says they are heavier, more expensive, more difficult to integrate, and require computing to take place in an onboard PC. “Intel RealSense reduces costs and minimizes complexity compared to these alternative approaches, which require a GPU for processing,” he says. “Thanks to the built-in infrared dot projector, we can operate in the dark as well as in situations with very uniform surfaces where other stereo cameras fail.”

## Using the Intel RealSense SDK

Developing an AMR platform requires sophisticated hardware and software, including tools for computer vision and simulation. Madrid and other members of the ANYbotics engineering team favor the Intel RealSense modules because they work out of the box and have a very flat learning curve. The team uses standard hardware in conjunction with Robot Operating System (ROS), a specialized software framework built on an open source foundation.

ANYbotics engineers use Intel® RealSense™ Vision Processor D4 to handle workloads from the stereo cameras. When paired with an Intel RealSense™ Depth Module, this vision processor outputs depth and HD infrared data via the USB port. ANYmal uses this data to create a virtual representation of the robot’s surroundings so it can effectively traverse the industrial environment.

These capabilities give customers an autonomous system with advanced condition monitoring capabilities for routine inspection tasks. A pan-tilt inspection unit features high-end

## Technical Components of Solution

- ANYbotics ANYmal optimizes routine condition monitoring tasks through its ability to collect and report visual, thermographic, and acoustic analysis. Its AI-based algorithms provide consistent, reliable, and up-to-date information on the health of equipment and infrastructure.
- Intel® RealSense™ technology is a suite of depth and tracking solutions designed to give machines and devices the ability to “see” and understand their surroundings.
- The Intel® RealSense™ Vision Processor D4 is a high performance ASIC designed to handle workloads from stereo cameras. When paired with an Intel RealSense™ Depth Module, it is able to output depth and HD infrared data over USB.

**“Intel RealSense hits the sweet spot in terms of size, cost, performance, and flexibility.”**

**- Daniel Lopez Madrid, Perception Team Lead, ANYbotics AG**

### Learn More

- ANYbotics:

<https://www.anybotics.com>

- Intel® RealSense™ Technology:

<https://www.intelrealsense.com>



**ANYmal's pan-tilt inspection unit features high-end sensors for accurate and reliable visual, thermal, and acoustic measurements.**

sensors for accurate and reliable visual, thermal, and acoustic measurements, as well as inspection intelligence software covering some of the most relevant industrial inspection tasks.

“The Intel RealSense SDK and ROS drivers make it very easy for us to integrate these modules with the rest of the technology stack,” Madrid explains. “We can create detailed configurations and optimize the robot's behavior under multiple situations, such as with an infrared projector, with multiple frame rates, and other variables.”

### Preparing ANYmal for work

Energy plants, processing facilities, and construction sites often have steep stairs, narrow hallways, and tight spaces unsuited for traditional wheel-and-track based robots. ANYbotics' nimble, ruggedized, walking robots represent a unique alternative to reliably

navigate these facilities. Built for harsh environments, ANYmal is water-proof and dust-proof, making it ideal for use in indoor and outdoor environments, in all weather conditions.

For example, at BASF's Ludwigshafen plant, ANYmal robots perform routine inspection tasks such as reading gauges, taking acoustic measurements of pumps and compressors, and checking the environment for hotspots using the integrated thermal camera. This streamlines operations for one of the world's largest global chemical manufacturers.

“Intel has been great to work with and has very responsive customer support,” Madrid concludes. “Whenever we encounter issues, the Intel RealSense team has been there to solve them, quickly and efficiently. It is easy to get up and running with the Intel RealSense modules.”