WHITE PAPER

Deploying Quadruped Robots to the Automotive Manufacturing Industry

Boston Dynamics

Automotive manufacturing plants are complex, dynamic environments with thousands of assets that require constant monitoring to ensure that they operate safely and produce the optimal output. The cost of downtime in automotive plants is higher than most industries. Something as simple as a pump that is slowing down or a stopped conveyor can cause an entire line to go down and cost thousands of dollars per hour. Many facilities operate several work shifts so they can run continuously, 24 hours a day, seven days a week. These plants cannot afford a single asset to go offline. Catching issues such as leaks, wear and tear on equipment and inefficient processes before they result in critical failures is a game changer to plant operations. It allows technicians to plan the repair or replacement of assets on their schedule rather than in emergency mode.

The size and complexity of these plants makes it difficult to monitor the huge number of assets continuously. Automotive plants are high traffic environments with people and machinery in constant motion. Some equipment, including multiple active robotic work cells, can be hazardous to humans. Manually walking the site, taking measurements and inspecting assets, is a time consuming, arduous, and tedious task that can potentially put workers in dangerous situations. In addition, manual inspections often result in incomplete, inconsistent, and/or inaccurate data that does not support an efficient predictive maintenance program.

Quadruped robots walk a planned route through an entire facility, ascending stairs and avoiding obstacles while taking measurements and readings that technicians can then analyze to make maintenance and business decisions. These autonomous inspections give time back to the maintenance technicians so they can make better predictions, perform repairs, and ensure reliable operations. The abundant, accurate data that quadruped robots capture allows workers to catch issues ahead of time, make better predictions, and perform predictive maintenance, rather than being reactive and performing costly repairs after equipment has failed.

Current State of the Industry

Fixed sensors

IoT sensors placed on equipment to gather automated readings (such as the temperature of welding tips or motors or the pressure level in compressed air lines) are common in many manufacturing industries. However fixed sensors are not ideal in all situations because they:

- Have a limited field of view so they can't capture all of the data or images needed.
- Can be very expensive to scale. Manufacturing facilities have thousands of assets. It would take months or even years to place a fixed sensor on each asset. The number of sensors required is cost prohibitive and reading them would be too labor intensive. The result is that fixed sensors are often used only on high-priority, expensive assets and the opportunity to collect data on other assets is lost.
- Need to be moved when there are changes in equipment layout, which happens often at automotive plants as new models of vehicles are introduced and the plant is reconfigured.

Inconsistent/incomplete data

Many plants rely on workers to walk the plant, reading gauges and monitoring processes, but humans are not consistent in how they collect data or record information. For example, they don't all hold a camera in exactly the same way every time they take a picture, or they get distracted and forget to collect data at an appointed time or location. Not only are there inconsistencies in how different people perform a task, there are inconsistencies in how each person does a task from one time to the next. Inconsistent data makes it very difficult to do predictive maintenance effectively.

Low quality digital twins

A digital twin, a virtual model of a plant, can be critical to optimal plant operation because it allows workers to simulate line operation and catch problems before they occur. However, for a digital twin to be truly effective, it must have up-to-date information. Operations at automotive plants change quickly and frequently as new vehicle models are introduced, new parts are implemented, facilities are improved, and upgrades are made. Plus there's the normal degradation in asset performance as the equipment ages. To ensure that the digital twin is using current information, workers have to collect real-time data frequently, and immediately feed it into the digital twin system. This can be tedious and time consuming. With labor shortages and higher priority work in the queue, maintaining frequent, consistent readings of an entire plant is difficult and often impossible, so the digital twin is often out of date and/or incomplete.

Limitations of AMRs/AGVs

Autonomous mobile robots (AMRs) and autonomous guided vehicles (AGVs) are useful for moving products on an assembly line, transporting goods throughout the plant, and delivering loads, however, these machines stay in main aisle ways and can only travel on flat ground so they can't access all areas of a plant. Also, if their path is blocked they have limited re-routing capability. If an obstacle is in the way and they can't get around it, they stop and can't complete their mission.

Spot's Role in Predictive Maintenance

Navigates autonomously

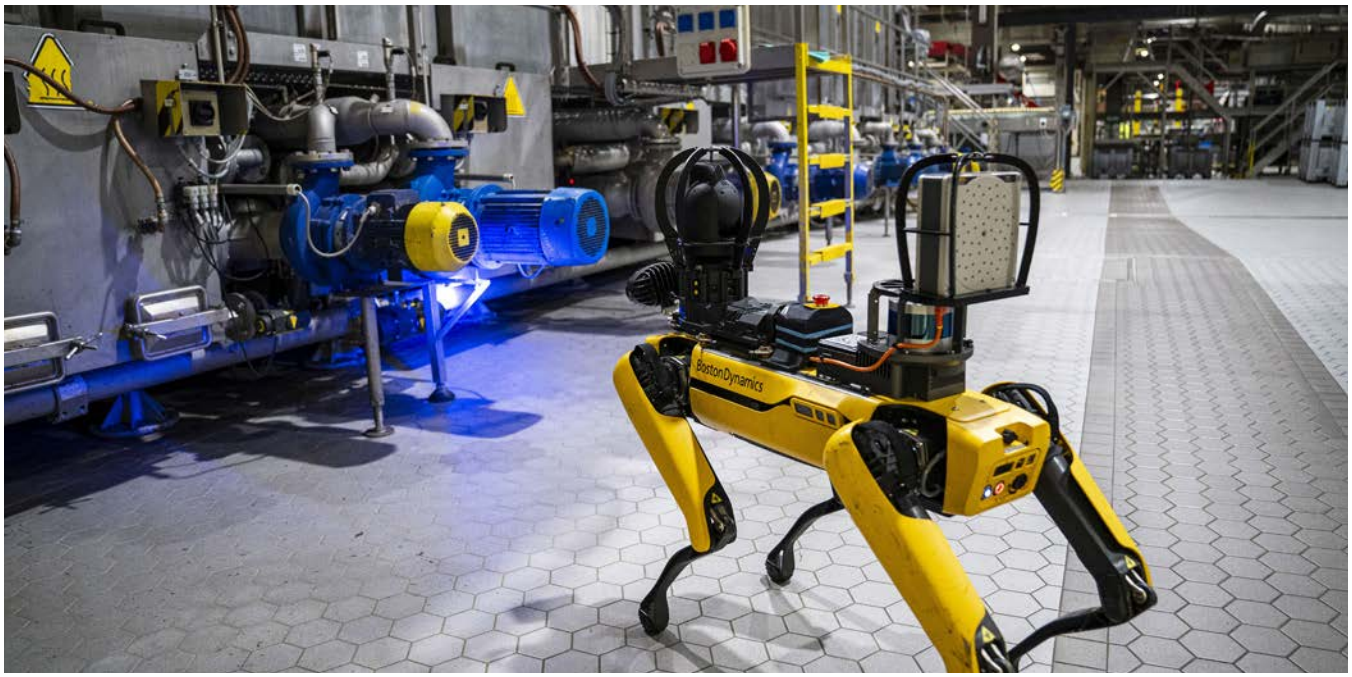
Spot's autonomous mobility is a key factor in its effectiveness in automotive manufacturing facilities. Its mobility and adaptability make it uniquely qualified for operating in these dynamic workplaces. With moving object detection, Spot will recognize a person or forklift crossing its path and it will stop and wait until it is safe to continue its mission. When Spot approaches a crosswalk, it checks for traffic and then safely crosses with its lights flashing to alert others of its presence.

Reroutes in dynamic environments

Spot's built-in advanced autonomy system allows it to reroute itself if a particular pathway is blocked. It can choose an alternate route from one of its recorded pathways and go on to successfully complete its mission of collecting and recording data. Spot only moves along its recorded pathways; it will never wander or explore a site. AGVs or AMRs, often used in manufacturing settings, do not have the awareness and re-planning capability that is built into Spot, so they cannot accommodate for changing environments.

Collects a large volume of reliable data

A large volume of reliable data is critical to a successful predictive maintenance program. Spot walks through a facility, taking measurements and making observations on the real-time condition of assets at regular intervals. Spot captures data consistently, with no variation in the way it is captured from mission to mission, resulting in a dependable and reliable data set. This enhanced data accuracy means workers can make predictive maintenance decisions with confidence resulting in improved plant efficiency and reduced downtime.



Collects data from assets in active work cells

While Spot does not generally go into active work cells (due to safety doors), it can inspect assets from outside the work cell, keeping technicians away from hazards like sparks from welders. Also, production can continue uninterrupted rather than stop when a technician opens the work cell door to complete the inspection.

Augments the workforce

Operators have a very busy work schedule and they don't have the time to walk around gathering data. Expensive sensors that could provide helpful insights into asset condition and performance sit unused, leading to missed opportunities for predictive maintenance. Workers also often do not have time to record the data so there is no history on the condition of various assets making it difficult or impossible to use data modeling to look for trends in equipment performance and to plan maintenance. Spot makes the operators' work easier by doing the data collection work, freeing up time for workers to focus on tasks that are more valuable than walking around and inspecting equipment. Spot can gather data with those often unused, expensive sensors, providing a richer data set. The data Spot collects is recorded and stored as a digital record that can be used for trend analysis, exposing issues earlier, allowing for better predictive maintenance decisions, leading to less downtime and reduced maintenance costs.

Detects issues early

Compressed air leaks waste electricity and result in unnecessary expenses. The Compressed Air and Gas Institute estimates that a single quarter inch leak can cost $2,500 to $8,000 per year. Many facilities have an average leak rate of 30%, resulting in a loss of nearly $3.2 billion annually. Previously, the entire manufacturing line had to be shut down so leaks in pneumatic systems could be heard, identified, and fixed. Equipped with an acoustic sensor, Spot can detect these leaks while the plant is in operation, which is faster, easier, and cheaper than shutting the plant down. Spot's acoustic imager payload (the Fluke SV600) can also find other sounds such as a screeching noise made by failing bearings on roller systems in the lower elements of conveyors. Workers can then order parts and make repairs before the equipment fails and stops production. The savings is significant as the cost of repairing an asset is typically around 10% of the cost of replacing it.

Spot and Digital Twin Applications

Deploying Spot with a laser scanning payload enables you to perform regular, repetitive reality captures of your facility so you always have up-to-date information about the environment. Along with inspection payloads, this allows you to capture and centralize data on all aspects of your operations in a single digital twin, providing seamless reporting on current status, changes, and anomalies from site scans and maintenance inspections.

A robust, up-to-date digital twin:

- Visualizes equipment performance, so technicians can catch issues before they become critical failures, and plan predictive maintenance
- Provides accurate measurements for all utilities and floor space, so machinery upgrade projects can be evaluated and planned properly
- Allows industrial engineers to optimize processes
- Gives inventory management insight into where parts/bins are congregating
- Helps uncover hard-to-find faults during construction or remodeling, reducing rework and providing accurate as-built models

For a digital twin to be truly useful, it must be based on current data, but capturing and maintaining that data can put a strain on staff. Spot can be a key player in creating and updating digital twins while relieving staff of the burden of data collection. It can walk an entire facility at regular intervals, taking measurements, reading gauges, and recording data. Spot can ascend and descend stairs, including open grate stairs, to mezzanine or basement levels. It can navigate in tight spaces and enter hard-to-reach areas to capture information at angles that may be awkward for humans. With its IR camera, Spot can perform thermal inspections and detect “hot spots.” Using an acoustic imager, Spot can detect sounds indicating air and gas leaks so even the smallest leak can be detected before it becomes a problem. Spot can perform visual inspections, collecting images of critical assets, looking for cracks, wear, or other signs of damage over time.

The data that Spot collects, along with information such as supplier-provided 3D files of parts that include all of their properties (manufacturing tolerance, thermal expansion, etc.), creates a more accurate, up-to-date digital representation of the facility than could be created with data collected solely by humans. This single source of truth for data allows technicians to focus on specific areas that Spot inspected and submit a maintenance request from within the digital twin.

Fleet Management

For deployments of Spot at industrial facilities, Orbit is a portal for fleet management and analysis. It provides a real-time view of robot operations on a map of the facility. Operators can plan routes, schedule missions, monitor progress, and operate robots remotely. If part of the plant is being retrofitted, operators can set up no-go zones in Orbit so Spot will avoid the area during routine missions. The Orbit dashboard displays real-time alerts when inspection results fall outside ideal thresholds and tracks trends in equipment health over time. It can also send email notifications to operators so they are always up-to-date. Orbit connects to existing business systems so data Spot collects can be shared and preventative maintenance actions (such as generating a work order) can be automated.

Orbit™

Implementation and Scalability

Spot is easy to use and intuitive to learn, making it quick to deploy for both manual operations and autonomous missions. Spot is a “teach and repeat” system.

- Define the route that Spot will travel and the locations for it to read gauges, take measurements, or capture images
- Set the thresholds for measurements to receive an alert when an anomaly is detected
- Create a mission schedule
- Start collecting data

Spot will autonomously execute the missions and collect your data. The data that Spot gathers is accessible in one place, with flexible communication options to keep you connected and informed. Our software allows you to easily operate one Spot or an entire fleet either locally or remotely, so you always have the latest data on your operations.

Future Opportunities for Spot in the Automotive Industry

With bi-annual software releases, new inspection modalities and other enhancements to Spot are continuously being introduced that add value to improving automotive industry operations.

Quality control inspections

With arm sensor pointing, Spot will be able to inspect points that are high up or hidden in and around a vehicle chassis - allowing inspection of vehicles at various stages of assembly and final product inspections.

Conclusion

Spot can help improve the efficiency and accuracy of operations at automotive manufacturing plants by repeatedly navigating the plant, collecting copious amounts of accurate and reliable data. This data can be fed into a digital twin, giving operators an up-to-date, enterprise-wide view of all aspects of plant operations. Workers no longer have to do the tedious, time-consuming work of collecting data. Instead, they can be redeployed to do more valuable tasks such as analyzing the data to make better predictive maintenance and operational decisions. With Spot performing complete inspections at regular intervals, the digital twin is always based on up-to-date, dependable data so technicians can make better maintenance decisions. Costly line shutdowns can be avoided by catching issues before they become critical failures. Technicians can plan predictive maintenance repairs on assets rather than reactively replacing them after they have failed, which is far more expensive. They can model impacts of changes such as installing new equipment and using different parts when equipment in the plant has to be adjusted for building new vehicle models.

Ready to get started? Contact our expert sales team today to find the right implementation to meet your application needs and start your journey to a simple, scalable robotics solution.

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