Digitization and Connected Construction

Volume Three: Construction Robotics

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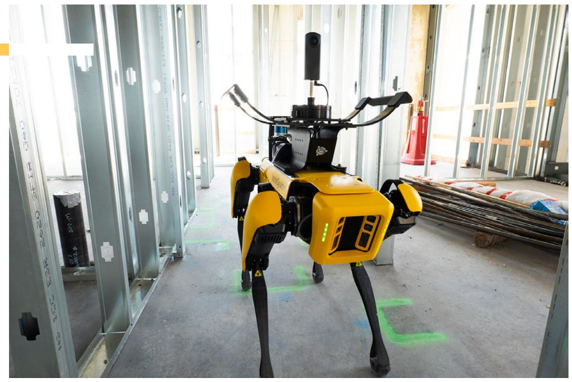
Introduction



In today's construction industry, 85% of construction projects experience overruns. Delivering a quality project on time and within budget requires comprehensive site visibility.

However, thorough site visibility requires substantial volumes of site data. The information needed can be difficult and time-consuming to capture with manual processes. Construction robotics is one tool that enables more automated data collection at field locations.

Why Use Agile Mobile Robots for Construction?

The primary reason for deploying agile mobile robots is safety. People are important, and construction sites include hazards and confined spaces.

Every supervisor wants to see everyone onsite heading home safely after every shift. Robots can safely perform data gathering tasks where there are health and safety concerns.

Robots can also take on repetitive data gathering activities. Fixed sensors can capture data, but compared to mobile robots, sensors limited and less cost-effective.

Most current sensors are fixed in place or connected to specific job sites or locations. This limits their capacity to capture site data at the comprehensive level required for progress monitoring.

Some sites try to address these limitations by adding drones or wheeled robots, but they also have restrictions. Regulations on drone use are a work-in-progress, and the permit process can be time-consuming, ambiguous and complicated. Drones also have limited flight times and require specialized skills to operate accurately and safely.

Robots with wheels have limited maneuverability in active, irregular field environments. They're less agile, and they have difficulty avoiding random obstacles.

Wheels require flat surfaces with sufficient traction for use. As a rule of thumb, for a wheel to pass over a vertical obstacle, its diameter must be double the obstacle's height.

Meet Spot, Construction's First Full-Fledged Robot

These are some of the reasons why Trimble partnered with Boston Dynamics to deploy the construction industry's first full-fledged robot. Its name is Spot, and it can help field crews streamline onsite data capture through automation.

Boston Dynamics approached Trimble to collaborate on Spot's development. Having reviewed the market, they determined that Trimble was the only company sharing their vision of using robotics to make site data capture more automated, safe and efficient for the construction industry.

Onsite teams can deploy Spot for more frequent data collection. Spot can autonomously tour the site, capturing information, measuring, and analyzing project progress without human intervention.

Spot is a best-in-class agile, mobile robot. It's the most advanced robotic quadruped on the market today. Boston Dynamics has been researching and developing mobile robots using legs for over 30 years.

Spot Platform

Spot can maneuver throughout job sites autonomously. Its five onboard cameras autonomously capture 360° images and video, indoors or outdoors.

Spot uses its cameras to map its surrounding environment, enabling it to avoid obstacles. It also performs automatic, dynamic stabilization using the cameras to identify reference points.

Unlike wheeled robots, Spot can go up and down stairs on its own. Its four dog-like legs also deliver exceptional agility on rough terrain.

To support task automation, Spot provides a 90-minute battery life. To put that in perspective, typical drone batteries last between 20 and 60 minutes.

When Spot's battery starts to run low, it automatically walks over to its docking station, self-charges, then gets back to work on its own. Spot's dependable power management system delivers reliable and persistent robotic performance for your job site.

Your team can enter custom missions into Spot and then schedule how often Spot should complete them. This enables automatic progress monitoring at regular intervals.

Designed for industrial use, Spot can handle payloads of up to 30 pounds. Its construction configuration includes the Trimble X7 laser scanner mounted on Spot's back. Crews can also attach the Ricoh Theta Z photographic camera to document progress using images.

FieldLink Robotics Module: Turn-Key Connected Field Solution

Spot Enterprise combines with Trimble's X7 3D laser scanner and FieldLink software, to provide a fully connected, turn-key field solution. It includes the docking station and an enhanced autonomy package, housed inside a lidar puck computer. The Spot Defender package ensures robust payload protection for all the robot's mounted equipment.

The FieldLink robotics module combined with Trimble's CloudEngine Design software enable cloud-based data sharing. This makes the data that Spot collects accessible to all project stakeholders wherever they work.

Trimble FieldLink is designed to manage the complete construction layout and as-built collection process using a single software solution. It manages robotic total stations (RTSs) for layouts and communicates with global navigation satellite system (GNSS) receivers.

As we've seen, FieldLink is also the controller for Trimble's X7 scanners. That's why Trimble has extended FieldLink's functionality to enable field crews to use FieldLink to drive Spot. Onsite staff can manage all the devices in Trimble's connected field solution using a single tablet and the FieldLink app.

Spot Data Collection Workflow

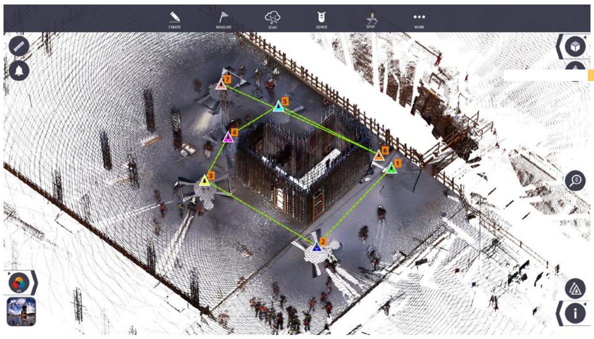
The data collection workflow for Spot consists of three phases:

1. Route Planning
2. Capture
3. Data Transfer

Route planning involves defining the field walk by driving the robot around your site. You'll indicate repeatable locations for data capture.

The Spot robot can then complete the data capture on its own. It will walk its defined route and capture data

according to the route plan. It will also respond to the dynamic environment by walking around objects like tools left in its way, for example.
Spot will then walk to its docking station. From there, the robot connects and transfers the data from the site to the office.



Route Planning

Onsite staff use FieldLink to define Spot's mission. They use a joystick to drive the Spot robot around the job site. They can define waypoints using the "start recording" button within FieldLink.

Having established the mission and route in FieldLink, field crews use the tablet to save the mission in the FieldLink app. The system synchronizes the data between the core, Spot's onboard computer, and the tablet.

Capture

Spot can begin its autonomous capture, even if the operator is not onsite. Crews can schedule the capture to begin immediately or at a scheduled future time.

Spot can complete its rounds without anyone driving it and can avoid obstacles like rebar cages on its own. When finished, it walks to its docking station and recharges to prepare for its next mission.

Design Validation

The design validation step for teams using Spot includes two phases. The first phase is infield visualization and analysis.

Field staff can use the FieldLink app on a tablet to monitor collected scans and compare them with the 3D design model. They can also use FieldLink for quality assurance, reconciling the scans Spot collects onsite with model specifications.

FieldLink can also upload the field data to Trimble CloudEngine for more in-depth validations. Cloud Engine can also produce reports and share information via the web.

The Spot robot can help crews complete a range of progress management tasks, such as floor inspections or clash detection. The Spot robot can complete these tasks without supervision, or even having humans onsite.

Autonomy Levels

Spot offers a range of reduced levels of autonomy, enabling operators to intervene when necessary. These can include tethered autonomy for hazardous sites where the operator needs to always keep Spot within WiFi range.

The observed autonomy level provides a longer signal range for situations where operators need to do other tasks while still having the option to intervene occasionally. With the unsupervised autonomy level, the robot is not in communication with the controller and completes its work autonomously.

Using the remote autonomy level, the operator can be any arbitrary distance away from the Spot robot, even in another city. An operator can use this mode to control Spot remotely from their office, or while working from home, for example.

Future Plans

As Trimble and Boston Dynamics continue their research and development, the Spot robot will be taking on additional tasks. For example, Spot will be able to communicate with multiple GPS satellites to position itself in open spaces for outdoor terrain scanning.

Trimble also plans to integrate Spot with its robotic total station (RTS) instruments. This will enable Spot to support layout projects. Spot will be able to take advantage of its greater agility than wheeled robots on stairs or corrugated decks, for example.

Construction Robotics

Trimble's construction robotics solution enables more comprehensive, automated data capture. This can provide the site visibility your team needs to deliver projects on-time, within budget, and in compliance with design requirements.

Robotics has the potential to transform the design, build, and operation lifecycle of construction projects. Through autonomous data capture in the field, Trimble and Boston Dynamics are enabling a 21st Century approach to managing onsite construction.

Contact BuildingPoint Canada today to discuss how the constructible process can help your business deliver construction projects more efficiently, profitably, and accurately.

BuildingPoint™

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