

TECH TALK: Quadruped robot – Spot (with ‘CAM+’ high resolution 360° camera)

Spot is a mobile, four-legged robot modelled on animal morphology (e.g. a dog).

The table below is intended to be a technology selection decision support tool and not a substitute for business procurement processes. All information is correct at time of last update.

What's in the box	Technical specifications	Set up investment and required skills
<div> </div> <p>Photo source: Boston Dynamics</p> <p>Hardware</p> <p> Manufacturer: Boston Dynamics Model and release date: Spot Explorer (16 Jun 2020) Price: AU\$104,354 (ex GST) Device: Spot Body x 1 Battery x 2 Tablet controller x 1 Charger x 1 Weight: 32.5kg Dimensions: 1100mm x 500mm Battery life: 90min of active use Recharge time: 60min (80%), 120min (100%) WiFi 2.4Ghz b/g/n </p>	<p>Features</p> <p> Payload capacity: 14kg Field of view: 360° Sensing Range: 4m Minimum lighting required: > 2 Lux (i.e. not very bright) Max Speed: 1.6m/s Max Slope: +/- 30° (recommended) Max Step Height: 300mm Operating Condition: Resistant to water & dust (IP54) Operating Temperature: -20°C to 45°C </p> <p>Key Additional Payloads</p> <p> Spot CAM+ (shown) High resolution 360° camera with bright LED illuminators (AU\$41,672, ex GST) Robot Arm (Spot arm) To perform physical work (AU\$84,044, ex GST) LIDAR (Spot EAP) Offers depth sensing to enhance the range and accuracy of Spot's autonomy system (AU\$25,843, ex GST) Spot Core AI To provide advanced processing (AU\$34,318, ex GST) </p> <p>For more information go to https://shop.bostondynamics.com</p>	<p>Operating System</p> <ul style="list-style-type: none"> • Linux Ubuntu 18.04 LTS • Windows 10 • MacOS 10.14 (Mojave) <p>Key Knowledge</p> <ul style="list-style-type: none"> • Experience with SDK (Software Development Kit) and API (Application Programming Interface) • Experience with Python programming language <p>Practical Task Setup</p> <p>(as experienced by engineers)</p> <ul style="list-style-type: none"> • Manual operation is straightforward including Autowalk setup • Fully functional remote operation requires development work of Spot Python packages • Commercialised software ‘Scout’ is available for fully functioning remote operation without any development work

PEOPLE PERSPECTIVE: Quadruped robot – Spot (with ‘CAM+’ high resolution 360° camera)

Task/Environment Suitability	Usability Features	Task/Environment Constraints	Usability Constraints	Key Opportunities & Applications	Guidance for Implementation
<p>Large areas that contain uneven terrain/steps</p> <p>Noisy environments</p> <p>High risk areas (e.g. confined spaces/ tanks, poor light & inadequate ventilation/ harmful gases)</p> <p>Repetitive tasks (e.g. site surveillance, ‘walk’ path can be automated)</p>	<p>Consistency Some controller functions (e.g. manoeuvring Spot via joysticks) are similar to those used in gaming (e.g. Nintendo switch) or other machinery</p> <p>Safety Built in sensors allow for collision avoidance with objects/people</p> <p>Performance High satisfaction with image quality and magnification capability (*using the high resolution camera), resulting in high confidence and trust in reliability of information provided through the images on controller</p>	<p>Mostly limited to visual inspections (i.e. can’t do any physical activities, like tighten a screw, once there)</p> <p>Access limits</p> <p>Specific areas (i.e. over 45 degree ladders, steps higher than 300mm)</p> <p>Limited capability in narrow spaces to check small/fine details (e.g. weld defects, thread protrusions in corner locations)</p> <p>Limited flexibility obtaining an alternate line of vision (i.e. requires changing Spot’s entire position; this may not be possible in the space available)</p> <p>Accuracy/performance may be reduced by: Unreliable or weak internet connectivity (e.g. such as when surrounded by lots of metal/steel)</p> <p>Temperatures - below 20°C & above 45°C</p>	<p>Performance Default/standard zoom function on controller lacks responsiveness (i.e. zoom-in/out occurred upon <i>release</i> of pressing button, not <i>as</i> pressing button)</p> <p>Protective roll bars around high resolution camera required additional manoeuvring of Spot at times to obtain unobstructed view</p> <p>Consistency Zoom function on controller was inconsistent with other familiar devices (i.e. zoom-in by pressing arrows rather than ‘pinch zoom’ directly on the interface)</p> <p>Safety User’s spatial awareness is limited with no sound[^] or visibility of broader environment (i.e. what’s adjacent or behind). [^]It is possible to relay sound via Spot but this was not utilised/assessed here.</p> <p>Use in a populated work environment could introduce additional hazards (e.g. people trip over it; Spot falls from elevated area)</p>	<p>Safety inspections/ information gathering and monitoring Security (e.g. perimeter/inventory checks – equipment correctly located; meter readings)</p> <p>Air quality assessment* (e.g. detect presence of gases)</p> <p>Safeguard support - emergency response (e.g. detect injured individuals)</p> <p>Workforce support and flexibility Locate and ‘fetch’ items*</p> <p>Expand job tasks able to be undertaken by physically injured employees/increase career longevity</p> <p>Enable remote work and alleviate requirement for isolated work</p> <p><i>*Some applications & performance are dependent on features of or access to specific payloads</i></p>	<p>Generally easy to use and likely to involve low training requirements to achieve acceptable proficiency. However, may need further investment to achieve greater expertise if more complex environment</p> <p>Using Spot for a once-off task was more time consuming than doing it ‘unassisted’. Likely need to target specific use cases e.g. hazardous environments</p> <p>Concerns centred on damaging Spot given the cost of investment</p> <p>When Spot loses connectivity, it shuts down (‘drops’ to the ground). This may be disconcerting to those who are not familiar and may create additional burden or safety risks depending on when and where this occurs</p> <p>Consideration will need to be given how to best integrate Spot’s camera/controller images with other images and interfaces so that users have a holistic understanding of an area, task, etc. considering possible increase in mental workload</p>

These suggestions are formulated from a human factors research trial examining use of the technology in a brief visual inspection task within a confined, semi-industrial environment. Selection and implementation of a technology should consider the abilities of the person doing the task, the task requirements, and the environment in which the work is to be undertaken.