V60 v5 shown with Optional Body and Leg Bumpers/Panels & Antennas

The Vision 60® Q-UGV® (5th gen 5.1D or later), is a mid-sized high-endurance, agile and durable all-weather ground drone for use in a broad range of unstructured urban and natural environments for defense, homeland and enterprise applications.

While it's early days for legged robots, Ghost Q-UGVs are architected to allow rapid adaptation to new environments using our proprietary blind-mode control core that mimics how mammals operate across a range of urban and natural environments. Even if the environment is completely unknown, vision sensors degrade or fail, you can be assured that when our legged robot does fail, slip or fall, it will get right back up and continue moving.

And our Q-UGVs are more software than hardware, so as we learn about new terrains and uses, we can quickly adapt and improve our robot without long-cycle hardware updates at lower cost.

Our Q-UGV is just a platform, and without the right sensor, comms, manipulation and user-specific payloads, application software or AI, it's useless. That's why our Q-UGV has a broad range of integrated connectivity and communication options and an integrated NVIDIA® Xavier, the leading application and AI GPU in the market. A robust SDK and simulation environment supports creating the most cutting-edge applications for inspection, security, asset management and military and homeland security specific uses.

Our goal is to make our Q-UGVs an indispensable tool and continuously push the limits to improve its ability to walk, run, crawl, climb and eventually swim in complex environments that our customers must operate in, day in and day out. Ultimately, our robot is made to keep our warfighters, workers and K9s out of harm's way.

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Q-UGV®

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Why Legs

Legs outperform wheeled and tracked unmanned ground vehicles (UGVs) at smaller scale on unstructured terrain… uneven surfaces, debris fields, the great outdoors and even stairs.

Legs also offer greater agility with a wide degree of freedom, unlike fixed chassis wheel and track robots, and can flex the legs and move the body to point sensors, lights and other attachments.

Like a mammal, legged robots should be able to feel the environment to adjust leg and body position while in motion, stay agile and quickly stabilize like a trail runner, and even absorb recoil forces from an EOD disruptor, like a human absorbing forces from a firearm.

Better than the Competition

Yet, typical legged robots use harmonic drives with high gear ratios so the motors are not able to feel the environment or external forces and must be paired with toe/leg force sensors. Many also manage compliance through springs, which are not efficient and less precise. Couple that with the absolute requirement to have camera-based object avoidance for locomotion, and you end up with a robot that is slower, less agile, with poor stability and safety, especially in unknown and more difficult terrains.

Ghost believes in "more software than hardware" approach. We use software springs that allow very accurate control of compliance by measuring forces through the legs at 2kHz/sec, through its high-bandwidth actuators, and giving our robots the fidelity of life.

The V60 Q-UGV uses a standard drive-train with no exotic motors. It requires no leg force sensors or vision sensors to move across unstructured environments, allowing it to explore further, move faster, and recover after falls and other failures. When used in conjunction with safeguard avoidance and vision sensors, blind-mode allows for safer and more robust stability.

Open Architecture

We believe in an open architecture to allow for innovation. We'll supply the legs so you can create a mobile IoT solution to sense and capture data, a moving mesh node to enhance communications, or extend your arms as remote manipulation system.

Users and partners can leverage Ghost's robust SDK to build applications, integrate any sensor, radio or electronics using industry standard ROS/ROS2 framework, or go deep into our ARM controller and build your own behaviors with C/C++.

Energy Efficient

Operating robots shouldn't get you bogged down by constant battery changes.

The heart of the V60 is a computationally efficient control core, with the entire robot running on an ARM microcontroller, making it highly secure and very efficient. The robot can operate up to 9.6 km (6.0 miles) on a single charge with full 360º sensors activated.

And now our new IP65 ^ AgileCharge wireless charging pad can make autonomous inspection and security solutions a reality.

Vision Series

Our Vision series robots are dual use government and enterprise Q-UGVs. The Vision 60 will be expanded with additional robots in the future.

Model	Size	Primary Uses
Vision 75	Med	Security, Payload, Mesh
Vision 60	**S-Med**	**Inspect, Security, Payload, Mesh**
Vision 45	Small	Inspect, Security, Mesh
Vision 30E	V-Small	Inspect

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Key Features & Benefits

Fast and Agile
1 m/s (3.3 ft/sec) standard walk. Up to 1.6 m/s (5.2 ft/sec) fast-walk; 2.2 m/s (7 ft/sec) run. 3 m/s (10 ft/sec) sprint.^ Dependent on payload, terrain and temp

Long Endurance
6.8 – 12.8 km (4.2 - 8 miles) per charge Li-Ion, 8 - 10 hrs. mixed use and 21 hrs. standby

Any Environment
IP67^ sealed to water and dust and operating temp range of -40° to 55°C (-40° - 131°F) with Extreme temp battery pack & sensor options

Robust Operation
"Blind-Mode" operation on difficult terrain, at high-speeds, in tall grass, confined spaces, and recovery behaviors that are far superior to proprioceptive sensor-focused designs

Any Terrain
Traverse a range of terrains & substrates, including stairs using vision and blind-mode

Unstoppable
Self-right from any immobilization, and even operate fully inverted when seconds count

Autonomy Modes
Integrated GPS waypoint and record-and-playback route autonomation from OCU

High-Bandwidth 360° Sensing
GMSL2 16-channel integrated RGB and depth sensors for surround-sensing. Add thermal/IR or any sensor via GMSL2, USB or ethernet

Flexible Comms Architecture
Integrated 2.4, 5.8 GHz Wi-Fi & 4G/LTE; GigE switch supports any external radio including 5G, SDRs & SAT

Field Repair Entire Robot
Quick-swap sub-assemblies within minutes (legs, battery, compute, sensors…)

Powerful NVIDIA Edge Computing
Same powerful Xavier 32GB RAM used in leading autonomous vehicles; deploy any application, autonomy or AI

ROS2 & Simulation
High-level API with ROS, ROS2 and MAVLink support, and lower-level C/C++ API. Full 1:1 simulation support in Gazebo environment

Wireless Charge Kit
Portable wireless charging station for in/outdoor persistent 24x7 operation

New: Manipulator & Specialty Sensors
Recently added HDT Global® customizable arm. CBRN and specialty sensing kits

V60 v5 shown with Optional Body Bumpers, Antennas, HDT Arm, Honeywell MultiRAE Gas & Raman Spectroscopy Sensors

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Base Q-UGV Specifications

Export Control | HC	US ECCN: EAR-99 | 8479.50.00.00 Industrial Robots
General Robot Design	All-electric direct charge Q-UGV w/ quick-change sub-assemblies constructed of AL & composites. Exoskeleton protecting core integrated electronics. T-slot, frame points or 1913 MIL-STD rails for mounting w/ optional body panels
Packaging & Tools	SKB wheeled hardcase, quick-changes toolset and spare Vibram® toes
IP Rating | Operating Temp	IP67^ | -40º to 55º C (-40º to 131º F)
Operating Certs | MTBF Target	CE certification pending^ | 8,000 hours estimated
Key Dimensions cm (in)	L: 85cm (33.5) | W leg-2-leg: 54cm (21.3) | H stand: 38-76cm (15-30)
Mass kg (lbs)	Tare: 38kg (84) | w/ Battery: 45.4kg (100) | w/ Hardcase: 78.5kg (173)
Battery | Endurance (mi)	1,250 WH Li-Ion | 6.8 - 12.8 km (4.2 - 8) (payload & terrain dependent)
Battery Life (hrs)	Standby: 21 | Mixed: 8 - 10 | Continuous: 2 - 4 hrs (payload & terrain dependent)
Available Payload@ kg (lbs)	9kg +/- (20 +/-) w/ base battery installed
Actuation, Legs & Toes	3DOF 12-Motor back-drivable drive-train, 340º articulation w/ Vibram toes
Core Compute | App Compute	ARM® MCU | NVIDIA® Xavier 32GB RAM w/ 16 channel GMSL2, 2TB NVMe SSD
I/O | Regulated Power	GMSL2, ethernet, USB 3, CANBus | 12/24/28V (up to 42V unreg) 8amp max
Integrated Sensors | Comms	(5) RGB GSML2 & (4) Depth USB | 2.4, 5.8 GHz WiFi & 4G/LTE GigE switch
Tele-Op Controller	Samsung® Active Tab 3 standalone or in combination w/ dual joystick OCU^
Software Applications	Ghost OS & Ghost Mobile; Base gait library & safeguard autonomy
Low-level | High-Level API	C/C++ | ROS, ROS2, MAVLink Compatible w/ 1:1 Gazebo SIM support

Summary of Option (not all options available for export)

Integrated	• Dual antenna RTK-GNSS (w/in exoskeleton) • AgiliCharge™ wireless charge system (receiver + transceiver) • Sensors: Add'l IP67^ RGB & TOF sensors; range of Thermal/IR options • Software: Advanced Gaits (run, crawl…); TAK; Autonomy and Fleet • Govt Software: CBRN, Autonomy, TAK integration • Batteries: Baseline 1,250 WH or Extreme temp Li-on packages • Body and upper leg panels; Vibram® aggressive substrate & climbing toes • Ghost IP67 dual joystick w/ Samsung slot-in
3rd Party External (Certain specialty and government application options not-listed available directly from partners)	• Sensors: Laser (Ouster®, GeoSlam®): Gas (Honeywell®); Thermal/IR (FLIR®); CBRN (Thermo Fischer®, Smith®, FLIR® …); Audio and Specialty… • Radios: Rajant® WiFi mesh, Silvus® and Persistent® SDR; 5G^ … • HDT Adroit® robotic arm/manipulator • LED lighting kits • Conex or low-profile wireless charging doghouse & command station^

Patents Pending. Model specifications subject to change at any time. (^ beta or future release)

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GHOST VISION 60®
Q-UGV®

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Ghost OS and Robot Software

Comprehensive, low-level core control to higher-level application development environment and APIs, simulation, diagnostics tools, and applications.

Ghost SDK

Leverage the Ghost SDK to create your own Q-UGV behaviors and autonomy applications. Build integrated solutions with external enterprise and DoD applications, cloud services, onboard and remote sensors, radios, and even other robot platforms.

Low-Level API (Behaviors)

- Direct access to motor torques & leg forces
- Libraries available for higher-level leg/arm impedance and velocity control and force estimates; proprioception & IMU sensor fusion and state estimation; logging, power control, OCU interaction, and messaging
- Implement feedback-stabilized behaviors
- Low-latency sensor data availability

High-Level API (Applications)

- NVIDIA DeepStream, TensorRT and CUDA toolkit
- ROS infrastructure w/ no recompilation of code
- High-level access with set modes for attitude control, body velocity, direction & heading, obstacle avoidance and waypoints
- Flexible: new sensors added with minimal changes; Interact with OCU for telemetry transmission, signals, mode selection, velocity commands
- Single operator to multi-operator/multi-robot^

Simulation. 1:1 simulation to real-world porting in Gazebo

Ghost Mobile™

- Android® mobile application can be used standalone or with joystick controller add-on
- Admin, diagnostics, sensor and video mgmt^
- Mission control & record-playback automation
- DoD ATAK compatible & IOP /JAUS compliant

Behaviors

General. Walk at 1 m/s (3.3 ft./sec), fast walk up to 1.6m/s (5.2 ft./s) and run at 2.2m/s (7.0 ft./s); Sprint 3 m/s (10 ft/sec), crawl gait and leap gaps^

Ground clearance. Up to 55cm (22 in.)

Blind-Mode. Traverse unstructured terrain by feeling the environment without force sensors (toe or motor force, or series elastic)

Self-Right. Self-right from any immobilization

Inverted Body Operation. All behaviors supported, excluding visible/IR assisted stairclimbing

Stairs. Ascend and descend stairways using sensors and/or in combo w/ blind-mode

Sloped Surface. Up to 35° - 40°, depending on surface friction, weather conditions and toe

Manipulate. Attach 3rd party robot arms (HDT Adroit series 6DOF or custom configuration)

Ghost Autonomy™

Safeguard Avoidance. Minimizes collision risk with environmental objects under autonomous or tele-operation including stairclimbing mode, with tunable parameters

Object Recognition. API accessible using DeepStream TensorRT, or other 3rd party ML models

Record-Playback. Pre-defined mission route automation using route record-playback from OCU or any command-control station

Mission Control. Human readable scriptable mission format with reusable task-based plug ins

AgiliCharge™ Wireless Charging. Autonomous Q-UGV docking and charging^

Autonomy Applications

Any Ghost supplied or 3rd party (Neya®, Draper®…)

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GR-UGV™ Actuators & Core Electronics

Actuator Pod, Module & Leg
- IP67^ sealed single-piece construction quick-change 3DOF leg pod with motors located proximally to minimize inertia
- Removable Vibram standard & substrate-specific toes. Future aggressive angle and ice options^

Motor Controllers
- EtherCAT w/ current control including position, velocity, current and voltage sensing
- Input 18-43V; current 80A peak, 30A RMS

Mainboard
- ARM microcontroller & 2kHz control core
- EtherCAT comms with calibrated high-grade IMU
- Customizable: for security and govt users; AI, optical & specialty edge processing integration

Power Output Options
- Regulated 12, 24V. 8A, max not to exceed 150W
- Unregulated 42V from battery

Computing

Integrated (mid-body, accessible from back)
Sealed IP67^ field-change sub-assembly: Integrated NVIDIA, GR-UGV mainboard, communications, GNSS, and other electronics

Compute
- NVIDIA® Xavier CPU/GPU with I/O 2x Ethernet, 1x USB3, 16-channel GMSL2 sensor carrier board

Communications
- WiFi 2.4 & 5.8 GHz with Dual SIM 4G/LTE
- 5G in testing^
- Managed GigE switch supports any IP/Ethernet compatible radio (Silvus, Persistent, other Manet, Satellite...)

Lighting
- Multi-point LED array in development^

Operational & Task Sensors

Integrated (fore, aft, port, starboard & belly)
Sealed IP67^ quick-change sub-assembly w/ integrated multi-colored system status LEDs

- (4) Depth 87x58° FOV, 640x480 at 90FPS (fore, aft and belly)
- (5) RGB 132x86° FOV, 1910x1080 at 60FPS (fore, aft, port and starboard)
- Optional thermal/IR with a range of options
- Acoustic array (w/ speaker) in development^

Optional Body-Wide Mounting of Task Sensors
- Any GMSL2, IP/Ethernet or USB compatible: camera, radar, LIDAR, mineral, CBRN...
- Fixed body-wide mounting points w/ T-slot back-belly rail system with picatinny conversion kit

Battery
- Sealed IP67^ quick-change sub-assembly with integrated BMS and optional wireless charging electronics
- Standard: Li-ion 1250 WH
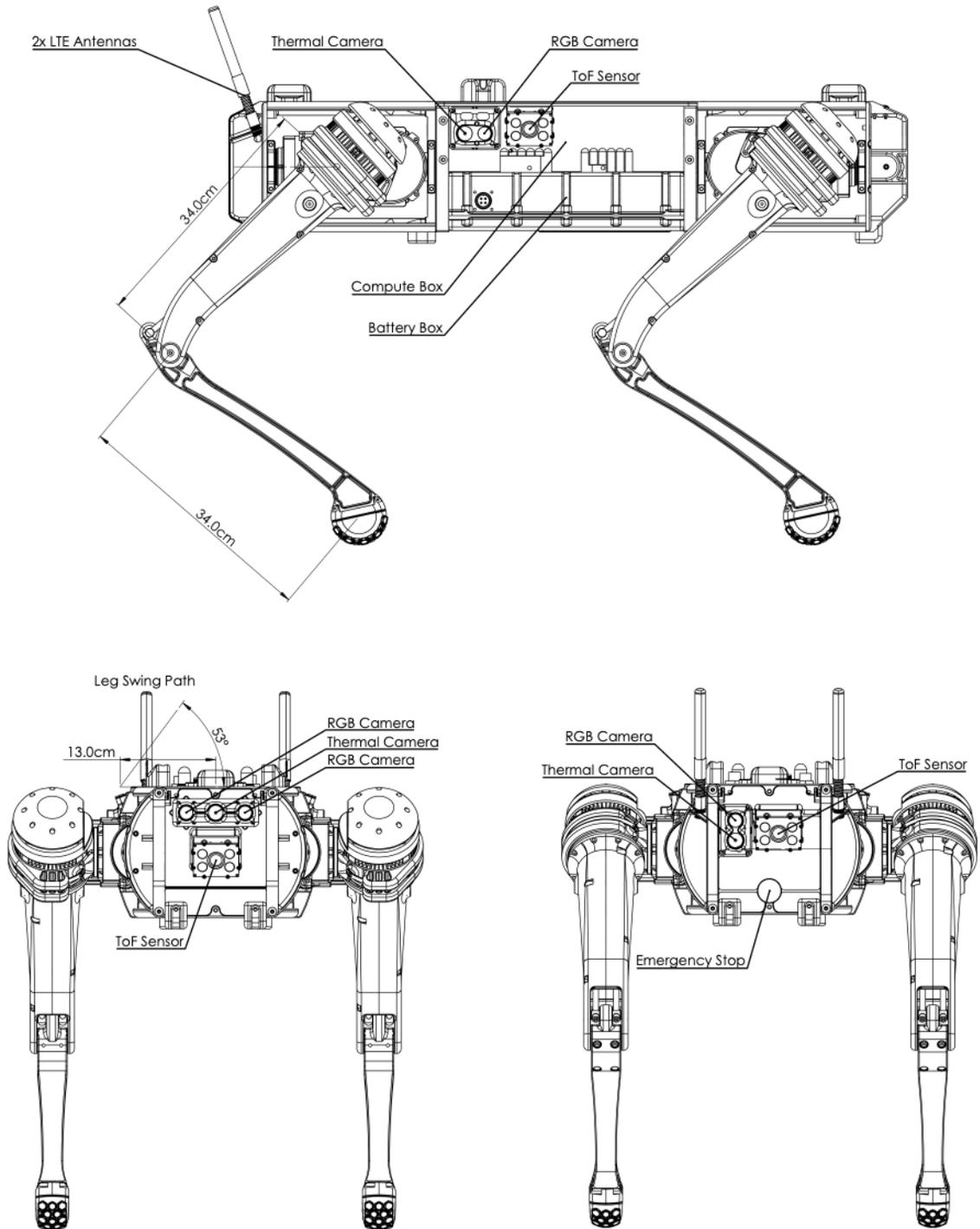- Optional extreme cold temp kit < -20C (-4F) consistent ambient temp

AgiliCharge™ Wireless Charging ^
- 500W hybrid inductive-resonant charging
- IP65 Wireless transceiver base with floor, doghouse or custom outdoor mounting kits
- Conex or low-profile all weather charging doghouse w/integrated HVAC and roll doors

Operator Control Unit ^
- Ghost IP66 ruggedized dual joystick w/ slot for Samsung Active Tab 3 Android tablet
- 2.4, 5.8 GHz Wi-Fi & 4G/LTE; with vest mounted radio cable kit supporting SDRs (Silvus...)
- Ghost software supports virtually any 3rd party joystick or touchpad controllers (Tomahawk®...)

Sensor Locations

2x LTE Antennas
Thermal Camera
RGB Camera
ToF Sensor
34.0cm
34.0cm
Compute Box
Battery Box

Leg Swing Path
53°
13.0cm
RGB Camera
Thermal Camera
RGB Camera
ToF Sensor

RGB Camera
Thermal Camera
ToF Sensor
Emergency Stop

I/O & Power Connectivity

92.0cm

56.0cm

RTK-GNSS Antenna

RTK-GNSS Antenna

Power
Regulated (5V, 12V, 24V, 28V)
Unregulated (28-42V)

RJ45   RJ45

USB C

Wifi Antenna

Wifi Antenna

6x GSML2