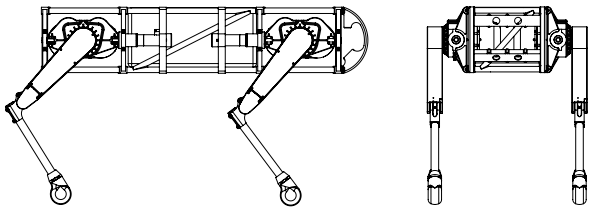
GR Vision™ 60 | Q-UGV™

GHOSTROBOTICS
Robots That Feel the World®

Ghost Vision™ 60 (rev 2.5) mid-sized tele-op and autonomous all terrain ground drone, with SDK for enterprise, military and public safety markets

Persistent and ad-hoc for security, safety, asset inspection, scientific and warfare applications



Benefits of Legs vs. Wheels & Tracks

Simply put, legs outperform wheeled and tracked unmanned ground vehicles (UGVs) on unstructured terrain: uneven surfaces, debris fields, the great outdoors, stairs and even verticals surface climbs.

Legs are not only good at traversing complex environments, they can be programmed to manipulate, pull latches and even push elevator buttons.

But the complexity to build usable legged robots has been insurmountable to-date, with few viable vendors.

Ghost Robotics Platform

Ghost is developing the next generation of legged robots to tackle unstructured terrain and manipulate the environment with a low cost, size-scalable, modular, high-endurance and easily customized design.

Users, ISVs and VARs can leverage Ghost's SDK to enhance and build new behaviors, and create a host of solutions from ad-hoc tele-operated asset and situational awareness robots, to persistent self-charging autonomous in-building and perimeter security rovers.

Vision Series

From small ultra-fast lightweight ISR, infrastructure inspection Q-UGVs with expendable plastic designs; to medium-sized asset inspection, scientific and in-building security devices; and larger perimeter security, mobile UAV carriers and in-field comms hub task-mules.

Model	Size	Primary Uses
Vision 75	Large	Security, Task Mule
Vision 60	**Med**	**Inspect, Security, Task Mule**
Vision 45	Small	Inspect, Security
Vision 30E	Expendable	Inspect, Security, Kinetic

Ghost Vision 60 (rev 2.5 pilot)

An all-weather unstoppable, modular and self-charging Q-UGV mobile sensor platform at 20 kg (44 lbs.) tare, supporting a total vehicle payload of 14 kg (31 lb.). The Ghost OS™ and SDK supports a range of customizations, with flexible 3rd party software and hardware integration options for any use case.

Key Features & Benefits

Long Endurance. 8 - 10 hrs. mixed use and 21 hrs. standby. Travel 7.5+ miles in 3.5 hrs. on single charge

Any Terrain. Traverse a range of unstructured terrains and substrates, and even stairs

Unstoppable. Designed to self-right from any immobilization, and even operate when inverted

Tele-Op. Most controllers or Ghost Mobile™ Android app. Support for DoD IOP/JAUS and ATAK

Object Avoidance. Ghost or 3rd party safeguard avoidance AI under tele-op and autonomy modes

Autonomous with Wireless Charging. Ad-hoc or persistent autonomy using stereo cameras or LIDAR

GPS-Denied Use. State-of-the-art odometry and sensor fusion for accurate GPS-denied positioning

Communications. 2.4 GHz, mesh LTE/4G and Wi-Fi; any IP/Ethernet or USB 3G, SAT or SDR supported

Task Sensors. Any IP/Ethernet or USB camera or specialty sensor with a range of mounting points

Modular. Field repairable and swappable sealed actuators, computing, comms & sensor modules

Customize. As a mobile sensor platform, security guard, and even as a UAV flight deck mule

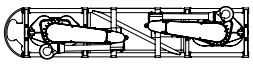
Pilot Models. Specifications subject to change, not yet released or in beta

Ghost Robotics Corp., Philadelphia. PA USA | www.ghostrobotics.io | twitter | **Sales:** sales@ghostrobotics.io

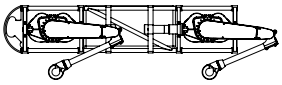
GR Vision 60 | Q-UGV

GHOSTROBOTICS
Robots That Feel the World®

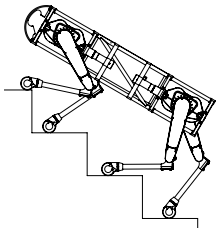
General Specifications (rev 2.5)



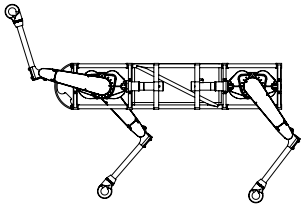
Folded



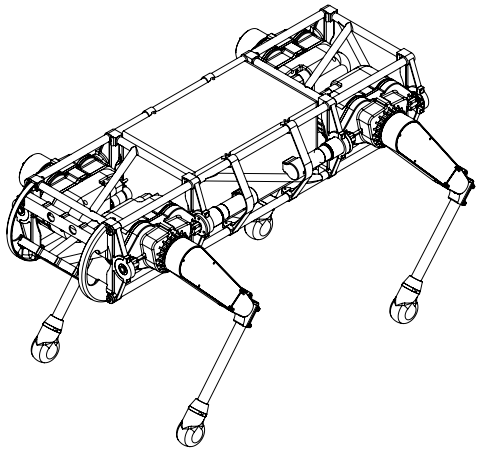
Crouching



Stair Climbing



Manipulate



Summary Specs (pilot model)

Robot Design	All weather Q-UGV with exoskeleton design constructed from aluminum, CF and PLA. Modular sealed actuation, leg, computing, battery and sensor enclosures. Direct or wireless charging Li-Po batteries. MIL-STD-1913 rails for multi-point sensor mounting.
Ingress Rating | General MTBF	IP-55 modular enclosures, moving to IP-67 | TBD
Key Dimensions cm (in.)	L: 83 cm (33) | W leg-2-leg: 46 cm (18) | H standing: 64 cm (25)
Control Electronics | Computing	Ghost electronics | Multiple NVIDIA TX2
Actuation, Legs & Toes	12-Motor 3-DOF, with 360° articulating 2-link leg & replaceable toes
Sensor & Comms I/O | Power	IP/Ethernet, USB 3.0 , M.2, MIPI CSI-2 | 33.6, 24 & 12V
Mass kg (lbs.)	Tare: 20kg (44) | w/ 1x Battery: 24kg (53) | w/ 2x Battery: 27kg (59)
Available Payload@ kg (lbs.)	Max: 14 kg (31) | 1x Battery: 4 kg (9) | 2x Battery: 7 kg (15)
Endurance @ 2x Battery (avg. sensor config.)	Standby: 21 | Mixed Use: 8 -10 | Continuous Walk: 3.5

Available Configurations

Standard	• Vision 60, Pelican case, with battery & charge system of choice* • Software: Ghost OS, SDK and Mobile Android app; GCS admin tool • Comms: 2.4Ghz radio with dual joystick remote
LTE Perception	Standard, plus • Software: Ghost Perception with tele-op safeguard avoidance • Comms: LTE/4G cellular & Wi-Fi mesh radio • Computing: (2) NVIDIA Jetson computers • Perception: (2) Stereo cameras fore, and (1) Stereo aft-mounted
LTE Autonomy	LTE Perception, plus • Software: Ghost Autonomy
* Li-Po Battery & Charging Options	Wireless, plug-charge or direct; with (1x) 500 or (2x) 1 kWh packs

Pilot Models. Specifications subject to change, not yet released or in beta

Ghost Robotics Corp., Philadelphia. PA USA | www.ghostrobotics.io | twitter | **Sales:** sales@ghostrobotics.io

GR Vision™ 60 | Q-UGV™

GHOSTROBOTICS
Robots That Feel the World®

Ghost OS™, SDK & Autonomy Software Specs

Ghost OS & Platform

Comprehensive, from low-level firmware with 1 kHz closed-loop robot control, to higher-level sensing, autonomy, comms and admin applications, and SDK.

Ghost SDK

Leverage the Ghost SDK to create your own Q-UGV behaviors and autonomy applications. Build integrated solutions with fixed sensor, UAS, enterprise and DoD ecosystem platforms and task applications.

Low-Level API

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

High-Level API

- High-level access with set modes: body & limb/arm velocity; direction & heading; waypoint & geo-fence; (de)activate obstacle avoidance…
- Messaging-based, no recompilation of core code
- 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

Ghost Mobile™ & GCS Admin Tool

- Mobile: Android mobile controller, admin, telemetry and video streaming application
- GSC: Mobile & web robot admin and setup

Behaviors

Walk & Run. Walk at 1 m/s (3.3 ft./s) and run at 2 m/s (6.6 ft./s); 0 - 60 cm (24 in.) ground clearance

General. Crouch, crawl and extended-leg walking; Jump gaps and onto ledges, and crabbing

Self-Right & Inverted Operation. Self-right from any immobilization; operate in inverted position

Stairs. Ascend and descend stairways

Sloped Surface. Varies by surface friction and toe

Manipulate. Using robot appendages, AgiliArm™ or 3rd party independent manipulator

Ghost Autonomy™

Safeguard Avoidance. Minimizes collision risk with environmental objects under autonomous or tele-operation; with tunable parameters

Object Detection. API accessible deep learning platform for creating use-specific applications

Autonomous Operation. Pre-defined mission routes or ad-hoc area exploration and mapping

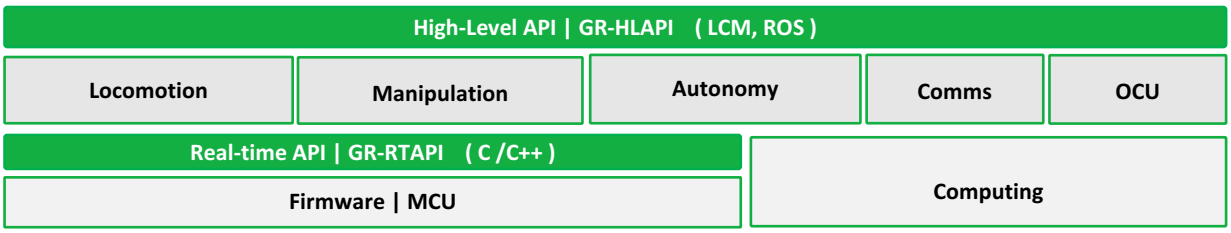
AgiliCharge™ Wireless Charging. Autonomous Q-UGV docking and charging

Autonomy Applications

Baseline Apps. Defined person follow-me; visible and thermal spectrum people detector

3rd Party or Build Custom. Room clearing, scientific, object or acoustic detection, targeting, kinetic…

Ghost SDK accessible components



Pilot Models. Specifications subject to change, not yet released or in beta

Ghost Robotics Corp., Philadelphia. PA USA | www.ghostrobotics.io | twitter | **Sales:** sales@ghostrobotics.io

GR Vision 60 | Q-UGV

GHOSTROBOTICS
Robots That Feel the World®

Actuator, Electronics & Energy Specs

Actuators and electronics also sold Individually for arm, biped, quad and other ground, marine and general R&D

GR-UGV™ Actuators & Electronics

Actuator Pod, Module & Leg

- 3DOF 3-motor hip module; geared dual-motor integrated actuator pod & linked shoulder motor
- Sealed dual-motor actuator: Each actuator capable of 27Nm continuous torque, 105Nm peak, 225W (@30V), 190RPM no-load
- Replaceable 360° articulating 2-link leg with removeable multi-surface foot-toe options

Motor Controller

- EtherCAT interface with voltage, read back position, velocity and current control
- Input 8-36V; current >80A peak, 30A RMS; with 12 bit absolute encoder
- 1kHz control loop: position, speed & impedance

Mainboard VN

- EtherCAT comms with onboard IMU: regulated 12, 24v output power
- Control up to 30 motors

Communication, Control & Telemetry

- Radios: 2.4Ghz; LTE/4G and 802.11 Wi-Fi mesh
- Video Streaming: Dedicated 5.8Ghz radio, LTE/4G and 802.11 Wi-Fi
- Any IP/Ethernet compatible

Tele-Op Controller

Joystick Controller Options

- 2.4 Ghz FrSky Taranis w/ dual joysticks or 3rd party OCU platform and input device
- DoD IOP /JAUS compatible

Ghost Mobile™ Android

- Phone & Phablet support, touchscreen control, or combined w/ physical controller
- Display odometry (pose, power, enviro…) and video; with integrated Ghost GSC™ server admin
- DoD ATAK compatibility

Computing

- Up to 2 NVIDIA® Jetson TX2s with breakout board in sealed enclosure with core electronics; I/O 2x Ethernet, 2x USB 3, 1x M.2 & 1x CSI-2
- Add'l NVIDIA Jetsons mountable in exo-frame

Sensors

Navigation & Perception Cameras

- Stereo cameras @ 60 FPS, 640x480
- 2-camera fore, and 1-camera aft options with sealed sensor mounts within exo-frame faces

Task Cameras & Others

- Any IP/Ethernet or USB compatible: visible and IR cameras, LIDAR, environmental, CBRNE…
- MIL-STD-1913 rails for body-wide mounting

GNSS

- Swift DURO® centimeter accurate, multi-band and constellation RTK GPS L1/L2 and IMU; IP-57

Ghost Environ™

- Temp, humidity, gases, acoustic…

Energy Options

- Li-Po 500 or 1 kWh hour batteries supporting 3.5 hour continuous walking for 7.8 miles, and up to 12 hours standby. Li-On future option
- Sealed enclosure with charging electronics
- Custom options: Fuel cell and multi-fuel engines

AgiliCharge™ Wireless Charging

- 300W hybrid inductive-resonant charging
- Wireless transceiver base with wall, floor or custom outdoor mounting kit

Pilot Model Operating ℃ *w/out optional cooling tech*	
GR-UGV Actuators	0 – 45 (113 °F)
GR-UGV Motor Controllers	0 – 45 (113 °F)
GR-UGV Mainboard*	0 – 70 (158 °F)
3rd party Electronics	varies

*Regulated power output dependent

Pilot Models. Specifications subject to change, not yet released or in beta

Ghost Robotics Corp., Philadelphia. PA USA | www.ghostrobotics.io | twitter | **Sales:** sales@ghostrobotics.io