Ghost Vision™ 60 | Q-UGV™

GHOSTROBOTICS
Robots That Feel the World®

Ghost Vision™ 60 (v4.x) mid-sized high-endurance IP68 unmanned ground drone, with platform-wide SDK for defense, industrial, mining, energy, construction, logistics and public safety markets

Tele-op or autonomous. Inspection, security, comms meshing and payload delivery applications

rev 4.0
Shown w/out optional leg & body bumpers.
Patents Pending

Benefits of Legs vs. Wheels & Tracks

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

Legs are not only good at traversing complex terrains, but they have greater agility and endurance, and substantially improve user acceptance if designed well.

But the complexity to build a low-cost, durable and agile legged robots has been insurmountable to-date.

Why Ghost Q-UGVs

Ghost is developing the next-generation of legged robots to with a modular field-repairable, agile, high-endurance and customizable platform.

Users and partners can leverage Ghost's robust SDK to enhance and build new behaviors, integrate any sensor, radio or electronics, and create a host of solutions from tele-operated to self-charging autonomous solutions.

Vision Series

From very-small, fast, lightweight expendable ISR, inspection & personal Q-UGVs; to medium-sized asset inspection, scientific and in-building security platforms; and larger perimeter security, package & UAV delivery and in-field comms meshing task-mules.

Model	Size	Primary Uses
Vision 75	Medium	Security, Payload Mule
Vision 60	Small-Med	Inspect, Security, Payload Mule
Vision 45	Small	Inspect, Security
Vision 30E	Very Small	Inspect, Expendable

Key Features & Benefits v4.0

Fast & Agile. Up to 1.6 m/s (5.2 ft./sec) fast-walk; 2 m/s run * and eventually 3 meters/sec sprinting ^

Long Endurance. 8 - 10 hrs. mixed use and 21 hrs. standby. Travel 7.5 miles in 3 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

Very Robust. "Blind Locomotion" over unstructured terrain, sensing forces through the motors even with reduced or complete loss of vision sensing

Tele-Op. Any controller or Ghost Mobile™ Android w/ dual joystick. Support for DoD IOP/JAUS and ATAK

Field-Swappable. IP68 sealed actuators, compute, battery & sensor modules *

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

Autonomous. Ad-hoc or persistent autonomy using cameras or LIDAR. Wireless charging option ^

GPS-Denied Use. Odometry and sensor fusion for accurate GPS-denied positioning ^

Comms. 2.4, 5.8 GHz WiFi, 4G/LTE integrated; any IP/Ethernet or USB 3.1 radio including SAT & SDR

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

Custom Bumpers. Optional upper-leg & whole body

Patents Pending. Pilot Models, specs subject to change. (** partial release or currently in early use or beta stage. ^ future release)*

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General Specifications (rev 4.0)

Summary Specs: rev 4.0

Robot Design	All-electric, software-based compliance Q-UGV w/ quick-change sub-assemblies constructed of ALU & composites. Exoskeleton w/ optional bumper-skin. Fixed points or 1913 MIL-STD rails for mounts
Actuation, Legs & Toes	3-DOF 12-Motor, 340º articulation w/ quick-change toe options
Ingress Rating	IP68 Sub-assemblies: legs; compute & battery * & sensors heads ^
Key Dimensions cm (in.)	L: 85cm (33.5) | W leg-2-leg: 54cm (21.3) | H stand: 38-76cm (15-30)
Core Electronics | Compute | Sensors & Comms	Ghost proprietary | NVIDIA Xavier | Various 3rd party (see page 4)
Sensor & Comms I/O | Power	IP/Ethernet, USB 3.0 , M.2, MIPI CSI-2 | 37-42V, 12, 28V & Custom
Battery	850 WH Lithium-Ion or Polymer Batteries; 1,250 WH Li-Ion ^
Mass kg (lbs.)	Tare: 32kg (70) | w/ Base Battery: 39kg (86)
Available Payload@ kg (lbs.)	Max: 14kg (31) | w/ Base Battery: 7kg (15)
Endurance w/ Base Battery base config. (hrs.)	Standby: 21 | Mixed Use: 8 -10 | Continuous Walk: 3.5 *
General MTBF	Protypes TBD (Target 8,800+ hours for final release ^)

Available Configurations

Perception Package	• Vision 60, Pelican case, with battery & direct charge system • Software: Ghost OS, SDK, Ghost Mobile & safeguard avoidance • Comms: 2.4, 5.8 GHz Wi-Fi mesh and 4G/LTE • Tele-Op Controller: Dual joystick Android • Computing: (1) NVIDIA Xavier • Sensors: (1) stereo and (5) TOF
Autonomy Package ^	Perception, plus • Software: Ghost Autonomy
Options	• Task and special sensors • Radios & Tele-op Controllers ^ • Wireless Charging ^ • Robot admin & mgmt ^

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Ghost OS™, SDK & Software Specs (rev 4.0)

Ghost OS & Platform

Comprehensive, from low-level firmware with 1kHz (2kHz *) closed-loop robot control, to higher-level sensing, autonomy, comms and admin, 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

General. Walk at 1 m/s (3.3 ft./sec) up to 1.6m/s (5.2 ft./s); Run at 2m/s (6.6 ft./s) *; Crawl*, crouch and crab; Leap gaps up to 1m (3.3 ft) ^; Ground clearance 0-55cm (0-22 in.)

Blind-Mode. Traverse unstructured terrain by feeling the environment without visual sensors

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. By attaching 3rd party robot arms

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 ^

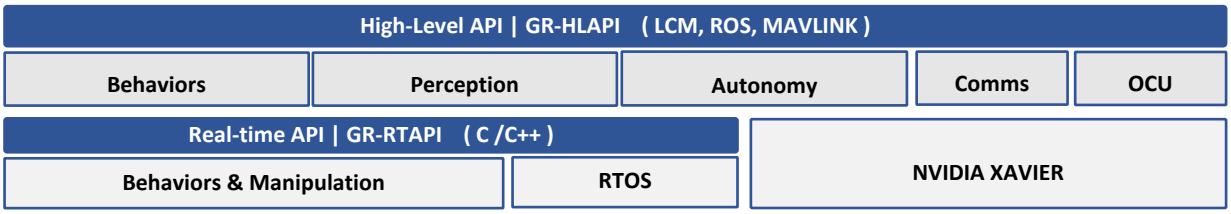
AgiliCharge™ Wireless Charging. Autonomous Q-UGV docking and charging ^

Autonomy Applications

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

Ghost Partner, 3rd Party or Custom. Room clearing, scientific, object, gas or acoustic detection… ^

Ghost SDK accessible components *



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Actuator, Electronics & Energy Specs (rev 4.0)

Actuators and electronics also sold Individually for R&D; building agile arms, bipeds & multi-leg robots; exo-limbs & other back-drivable motor applications

GR-UGV™ Actuators & Core Electronics

Actuator Pod, Module & Leg

- Single-piece quick-change 3DOF leg pod with motors located proximally to minimize inertia; removable multi-surface & substrate-specific toes
- IP68 sealed single-piece construction *

Motor Controllers

- EtherCAT w/ current control; position, velocity, current, voltage, speed & impedance sensing
- Input 18-43V; current >80A peak, 30A RMS

Mainboard

- Microcontroller RTOS; 1kHz (2kHz*) control loop
- EtherCAT comms with calibrated high-grade IMU
- Onboard multi-band RTK GNSS ^; Optional AI, optical & specialty processor integration ^

Regulated Power Output

- 12V or 28V, Optional 5-30V; not to exceed 150W

Communication, Control & Telemetry

- Radios: 2.4 & 5.8 GHz Wi-Fi, and 4G/LTE; 5G ^
- Video Streaming: 5.8Ghz or LTE/4G; 5G ^
- Any IP/Ethernet compatible radio (SAT, SDR…)

Tele-Op Controllers

- 2.4, 5.8 GHz Wi-Fi & 4G/LTE dual joystick Android
- Optional: IP67 ruggedized dual joystick Android w/ Wi-Fi, LTE, 5G or SDR radio pack options ^
- Most 3rd party joystick or touchpad controllers
- DoD ATAK compatible & IOP /JAUS compliant

Pilot Model Ambient Operating °C *	
Vision 60 Robot	0 – 50 (122 °F)
GR-UGV Electronics & Actuators	0 – 50 (122 °F)
3rd party Electronics	varies

Computing

- NVIDIA® Xavier CPU/GPU with I/O 2x Ethernet, 2x USB 3, 1x M.2 & 1x CSI-2
- Sealed IP68 enclosure w/ integrated NVIDIA, GR-UGV Mainboard, radios, router & other core electronics; external diagnostic screen *

Sensor Heads

Integrated Nav & Perception (fore, aft & sides)

- (1) RealSense fisheye w/ 163 ±5° FOV, and (5) TOF 3D image, 45fps, 224 x 171 and 62 -45°FOV
- Optional thermal camera 320 x 256 and 50°FOV
- *Sealed IP68 sensor heads w/ embedded 360° MIPI CSI RGB, TOF & mmWave sensors in future release^*

External Sensors

- Any IP/Ethernet or USB 3.1 compatible: cameras, radar, LIDAR, environmental, mineral, CBRNE…
- Fixed body-wide mounting points

GNSS ^

- Mainboard integrated multi-band RTK GNSS

Ghost Environ™ ^

- Temp, humidity, acoustic and base gases; custom options covering a broad range of specialty gas

Energy & Lighting

- Li-ion or Li-Po 850 WH battery; optional 1250 WH ^
- Sealed IP68 enclosure with integrated electronics and diagnostics screen *
- Fixed LED headlamp on fore & aft sensor heads ^
- Optional: PEM fuel cell configuration ^

AgiliCharge™ Wireless Charging ^

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

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