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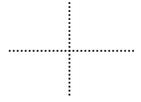
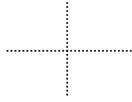
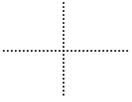
RESPONSE ROBOTS

DHS/NIST Sponsored Evaluation Exercises

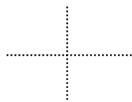
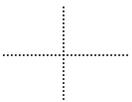
Maryland Task Force 1 Training Facility
August 19-21, 2006



Pocket Guide
Version
2006.2



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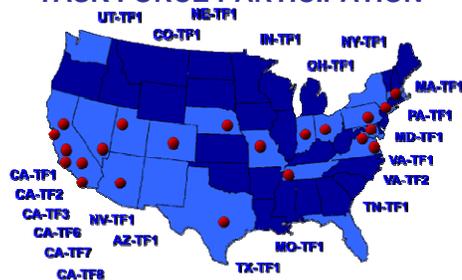
Program Overview

Application-specific robot standards and repeatable performance testing with objective performance metrics will accelerate the development and deployment of mobile robotic tools for US&R responders, enhancing the effectiveness of these teams while reducing the risks to personnel during disaster response. Currently, no such standards or performance metrics exist.

In order to address this need, the DHS Science and Technology (S&T) Directorate initiated an effort in fiscal year 2004 with the National Institute of Standards and Technology (NIST) to develop comprehensive standards related to the development, testing, and certification of effective robotic technologies for US&R applications. These standards will address robot mobility, sensing, navigation, planning, integration into operational caches, and human factors. Such standards will allow DHS to provide guidance to local, state, and federal homeland security entities regarding the purchase, deployment, and use of robotic systems for US&R applications.

This standards development effort focuses on fostering collaboration between US&R responders, robot vendors, and robot developers to generate consensus standards for task specific robot capabilities and interoperability of components. Furthermore, the effort includes the development and administration of technology readiness level (TRL) assessment exercises. These exercises will generate statistically significant performance data for developmental and field-able robotic systems.

TASK FORCE PARTICIPATION



Event Introduction

The third in a series of response robot informal evaluation exercises for DHS/FEMA US&R teams will be hosted at the Montgomery County Fire Rescue Training Academy in Rockville, Maryland (near Washington DC). This event will finalize the test methods targeted for the initial (Wave 1) set of standards as well as initiate experimentation with onboard payloads, especially for Chemical, Biological, Radiological, Nuclear, and Explosive (CBRNE) sensing. Therefore, emphasis will be on (a) robots that can address the deployment categories relevant to Wave 1 standards and (b) deploying CBRNE sensors on these robots. The three robot deployment categories selected by responders to be emphasized in Wave 1 are: ground peek robots that are small and throwable, ground wide-area survey robots that can traverse non-collapsed structures or areas external to the collapse, and aerial survey or loiter robots. Manufacturers of robots, purchasable and/or developmental, that can address these areas, are invited to take part in this exercise, which will highlight operationally relevant US&R scenarios.

Maryland Task Force 1 Training Facility



Site Overview



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Safety

Safety

Safety of all personnel participating in this event is our first concern. The fact that we have robotics personnel generally unaccustomed to working within the hazardous environments at these US&R training sites is particularly problematic. Having emergency responders generally unaccustomed to working with robots is also a concern. Please follow these simple guidelines:

- Appropriate personal protective equipment (PPE) must be worn at all times while on site (see associated page on PPE). Compliance with PPE rules are mandatory.
- Rubble piles and other difficult scenarios present the most risk to novices. If your robot needs to be extracted, please ask your associated emergency responder to retrieve it.
- Always maintain awareness of others working within your scenario and communicate your intentions *before* doing whatever you have in mind.
- Robots can do unpredictable things; the bigger/heavier the robot the more space you should allow it when operating. Always verify that the robot is powered off before interacting with it. Never stick your fingers into wheels, tracks, manipulator pinch points, etc. while the robot is powered on. Remotely teleoperated robots may be the most dangerous because the remote operator may not know you decided to perform on-the-spot maintenance! Always familiarize yourself with the EMERGENCY STOP procedures first -- and last -- before interacting with or operating robots. Some implementations are more predictable than others.
- If you see anything you consider unsafe in our environment, please inform the Test Director or any emergency responder on site, and let's discuss it at the daily after action briefing to be sure every potential hazard is addressed.
- **Everybody on site is a safety officer!**

Personal Protective Equipment

Personal protective equipment (PPE) is a must for working within any US&R scenario at the site. People in street clothes or without helmets/gloves/etc as shown below are limited to paved roads only. If you are working within a scenario, you must wear ALL the equipment shown below. Compliance with these personal protective equipment rules are mandatory - it is standard practice for US&R environments.



- **Helmet**

Hard hats are okay. We have some to borrow or you can purchase at www.thefirestore.com for \$75 and up.

- **Ear protection**

We'll supply these.

- **Eye protection**

Sunglasses are okay.

- **Long sleeve shirt**

- **Work gloves**

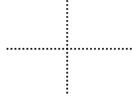
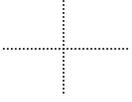
- **Long pants**

Army surplus stores sell typical BDU and EMT pants.

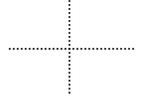
- **Boots**

Preferably steel toe.

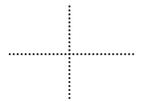
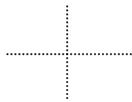
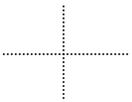
Additional protective padding for knees and elbows is optional, but good for rubble piles.



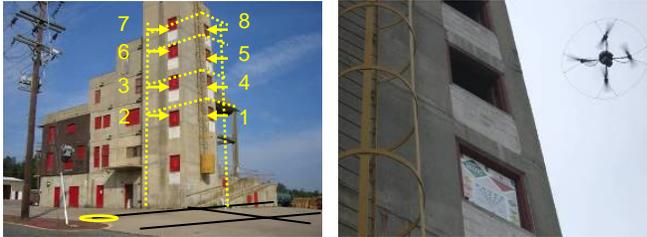
Test Methods



Test
Methods



Aerial Station Keeping



Requirements (Metric):

- Mobility: Aerial: Station Keeping
(# of axis)
- Mobility: Aerial: Area of Coverage
(square kilometers/hour)
- Human-System Interaction: Initial Training
(hours)
- Human-System Interaction: Proficiency Education
(hours/year)
- Human-System Interaction: Acceptable Usability
(effectiveness, percent of targets)
- Human-System Interaction: Assistive: Auto Notification
(yes:no)
- Human-System Interaction: Assistive: Path Tracing
(yes:no)

Test Method:

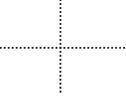
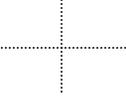
- Measure the operator's ability to remotely control the robot to look in each window of a building while operating the robot through the operator interface and radio communications link.
- Visual acuity charts and hazmat labels are positioned inside the windows, some flush mounted and others recessed inside, to give the operator some tasks to perform.
- Prescribed paths from window to window are performed without direct line of sight from the operator to the robot.
- Test in ambient light and dark environments, radio and tether (if available) communications separately.

Cache Packaging, Weight, Setup, Tools



Requirements (Metric):

- Logistics: Cache Packaging: Volume (#pelicans: #hardiggs: #ropacks)
- Logistics: Cache Packaging: Weight (kilograms)
- Logistics: Cache Packaging: Setup Time (minutes)
- Logistics: Cache Packaging: Transportation Restrictions (yes:no)
- Logistics: Field Maintenance: Spares and Supplies (percent of robot weight)
- Logistics: Field Maintenance: Tools (none:typical:special)
- Human-System Interaction: Portability (kilograms)
- Power: Voltage Compatibility With Cache (yes:no)



Test Methods

Test Method:

- Quantify logistics requirements for system to remain operational for 72 hours without re-supply, and on site for 10 day deployment
- Count qualified containers containing all system components and supplies
- Measure shipping weight and deployed robot weight
- Measure set-up time from unpacking to deployment down-range
- Identify tools required for setup and field maintenance
- Check list or choose appropriate selection from a specifically defined scale for each requirement

Confined Space

(ZIG-ZAG or FIGURE-8)



Requirements (Metric):

- Mobility: Locomotion: Sustained Speed - Obstacles (kilometers/hour)
- Mobility: Locomotion: Endurance - Obstacles (hours)
- Mobility: Tumble Recovery Within Terrain Type (none:self-righting:invertible continuous operations)

Test Method:

- Measure the operator's ability to remotely traverse/negotiate a confined space passage while operating the robot through the operator interface and communications link.
- Random stepfield pallets (full cubic) provide complex flooring and ceiling obstacles.
- Adjustable posts heights provide diminishing void space for increased difficulty.
- Test in ambient light and dark environments, radio and tether communications separately.

Directed Perception



Requirements (Metric):

- Payload: Manipulation: Sensor Manipulation
(yes:no, holes/level)
- Payload: Manipulation: Max Reach
(centimeters , holes/level)
- Chassis: Illumination: Variable
(yes:no)
- Sensing: Real-time Color Video: Near Field Acuity
(smallest chart line)
- Sensing: Remote Temperature
(yes:no)
- Sensing: Audio: Two-way (volume control:listen always-
push to talk:stereo:direction indicator)
- Sensing: Hazmat Detection (PH+O₂,LEL,CO, H₂S,RAD :
plus WMD and TIC detection/classification : plus Tentative
WMD and TIC identification : plus WMD and TIC sampling)
- Human-System Interaction: Initial Training
(hours)
- Human-System Interaction: Proficiency Education
(hours/year)
- Human-System Interaction: Acceptable Usability
(effectiveness, percent of targets)
- Human-System Interaction: Assistive: Auto Notification
(yes:no)
- Human-System Interaction: Assistive: Path Tracing
(yes:no)

Test Method:

- Measure the operator's ability to remotely position sensors near holes in box stacks to identify assorted targets placed inside while operating the robot through the operator interface and communications link.
- Box stacks surround the robot on three sides (front, left, right) with holes on facing and top surfaces. Each level is tested sequentially up to four levels high (72 inch / 180 cm). Holes are offset from the centerline robot position.
- Visual targets inside the holes require positioning a camera with adjustable illumination into two different horizontal viewing angles at each level to read visual acuity charts (0° directly through the hole) and hazmat labels (approximately 25° inward toward the centerline).
- Other targets/sensors can be used including chemical, radiological, explosive, thermal, etc. which also allow first detection measurements.
- Various terrain pallets to increase difficulty include flat floor, pitch ramp, roll ramp, and random stepfields.
- Test in ambient light and dark environments, radio and tether communications separately.

Grasping Dexterity



Requirements (Metric):

- Payload: Manipulation: Sensor Manipulation
(yes:no, blocks/level)
- Payload: Manipulation: Max Reach
(centimeters, blocks/level)
- Payload: Delivery
(kilograms at max reach, blocks/level)
- Payload: Retrieval
(centimeters at max reach, blocks/level)
- Payload: Emplacement
(yes:no, blocks/level)

Test Method:

- Measure the operator's ability to remotely grasp and place blocks onto shelf stacks with three different access approaches while operating the robot through the operator interface and communications link.
- Shelf stacks surround the robot on three sides (front, left, right) with nine objects placed in designated quadrants of one given surface. All surfaces have nine quadrants clearly marked.
- Objects placed on any given test level must be grasped and placed onto the remaining stacks at that level, requiring three different access approaches (open, under, over). Each object should be placed in the correlating quadrant of each stack. Each level is tested sequentially up to four levels high (72 in / 180 cm).
- Other objects can be used including simulated pipe bombs, water bottles with shock tube, communications devices, emplaced sensors, etc..
- Various terrain pallets including flat flooring, pitch ramp, roll ramp, and random stepfields increase difficulty.
- Test in ambient light and dark environments, radio and tether communications separately.

Human Systems Interactions



Requirements (Metric):

- Human-System Interaction: Operator Ratio (operators/robot)
- Human-System Interaction: Context: Protective Clothing (yes:no)
- Human-System Interaction: Context: Lighting Conditions (dark:daylight:glare)
- Human-System Interaction: Context: Mobility (stationary:portable:mobile)
- Human-System Interaction: Context: Operator Disengagement (yes:no)
- Human-System Interaction: Context: Co-Located Information Sharing (yes:no)
- Human-System Interaction: Context: Remote Information Sharing (meters)
- Human-System Interaction: Display: Dashboard (yes:no)
- Human-System Interaction: Display: Mission Data Integration (yes:no)
- Human-System Interaction: Interaction: Component Controls (yes:no, diagnostics)
- Human-System Interaction: Interaction: Adjustable Noise Filtering (yes:no)

Requirements (Metric) Continued:

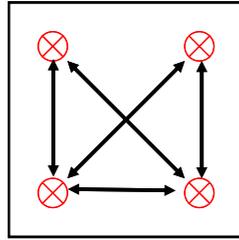
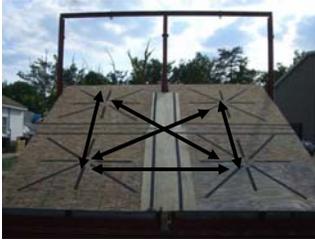
- Human-System Interaction: Assistive: Unattended Sampling (yes:no)
- Human-System Interaction: Assistive: Auto Notification (yes:no)
- Human-System Interaction: Assistive: Path Tracing (yes:no)
- Human-System Interaction: Assistive: Re-acquire Communications (yes:no)
- Human-System Interaction: Assistive: Station Keeping (# of axes)
- Human-System Interaction: Assistive: Self Extraction (yes:no)
- Human-System Interaction: Assistive: Emergency Stop (yes:no)
- Sensing: Real-time Color Video: Pan/Tilt Orientation Indicator (yes:no)

Test Method:

- Identify assorted operational features demonstrated during setup, practice, and/or testing.
- Check list or choose appropriate selection from a specifically defined scale for each requirement.

Inclined Plane

(WALL CLIMBING and INVERTED OPERATIONS)



Requirements (Metric):

- Mobility: Locomotion: Sustained Speed - Obstacles (kilometers/hour)
- Mobility: Locomotion: Sustained Speed - Soft (kilometers/hour)
- Mobility: Locomotion: Sustained Speed - Firm (kilometers/hour)
- Mobility: Tumble Recovery Within Terrain Type (none: self-righting: invertible continuous operations)

Test Method:

- Measure the operator's ability to remotely traverse an inclined/vertical/inverted plane while operating the robot through the operator interface and communications link.
- A pattern of goal positions on the plane provide prescribed straight line paths to traverse including directly ascending, directly descending, diagonal and cross incline paths.
- The incline can be adjusted from 20° - 80° for ground robots, 90° for wall climbing robots, or 100° to 180° for robots capable of inverted operations.
- The incline can be covered in a variety of surfaces (including random stepfields), but is initially simple oriented strand board (OSB)
- Test in ambient light and dark environments, radio and tether communications separately

Mobility/Endurance

(ZIG-ZAG or FIGURE 8)

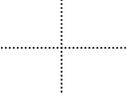


Requirements (Metric):

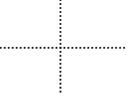
- Mobility: Locomotion: Sustained Speed - Obstacles (kilometers/hour)
- Mobility: Locomotion: Sustained Speed - Soft (kilometers/hour)
- Mobility: Locomotion: Sustained Speed - Firm (kilometers/hour)
- Mobility: Locomotion: Endurance - Obstacles (hours)
- Mobility: Locomotion: Endurance - Soft (hours)
- Mobility: Locomotion: Endurance - Firm (hours)
- Mobility: Tumble Recovery Within Terrain Type (none:self-righting:invertible continuous operations)
- Power: Working Time (single charge) (1 hour: 4 hours: 12 hours)
- Logistics: Field Maintenance: Intervals (12hours:24hours:72hours:10days)
- Logistics: Field Maintenance: Duration (minutes)
- Logistics: Shock Resistance: (drop test, vibration test)
- Logistics: Mean Time Before Failure (hours)

Test Method:

- Measure the operator's ability to remotely traverse/negotiate various terrain types within a fixed course to show mobility or endurance while operating the robot through the operator interface and communications link.
- Walls define the courses in the "Mobility/Endurance" test methods.
- Various repeatable terrain pallets can be used including flat floors, pitch ramps, roll ramps, and random stepfields to increase difficulty. Other terrains can be used including gravel, tarmac, snow, etc.
- Endurance testing can include logistics requirements for failures and repairs.
- Test in ambient light and dark environments, radio and tether communications separately.



Other Operational Features



Requirements (Metric):

- Chassis: Tether Point
(yes:no)
- Chassis: System Component Interoperability
(yes:no)
- Power: Run Time Indicator
(yes:no)
- Power: Dwell Time
(12 hours: 24 hours: 72 hours: 10 days)
- Sensing: Internal: Orientation Reporting
(# of axis)
- Sensing: Structural: Void Detection
(yes:no)
- Sensing: Structural: Range Finder
(yes:no)
- Sensing: Victim Indicators: Thermal Imaging
(industry:military:US&R needs such as leaks, fire, etc)
- Sensing: Victim Indicators: Seismic
(yes:no)

Requirements (Metric) Continued:

- Passive Data Logging Offboard: System Health (yes:no)
- Passive Data Logging Offboard: Location (yes:no)
- Passive Data Logging Offboard: Hazmat (yes:no)
- Passive Data Logging Offboard: Victim Indicators (yes:no)
- Passive Data Logging Offboard: Video (yes:no)
- Passive Data Logging Onboard: System Health (yes:no)
- Passive Data Logging Onboard: Location (yes:no)
- Passive Data Logging Onboard: Hazmat (yes:no)
- Passive Data Logging Onboard: Victim Indicators (yes:no)
- Passive Data Logging Onboard: Video (yes:no)

Test Method:

- Identify assorted operational features demonstrated during setup, practice, and/or testing.
- Check list or choose appropriate selection from a specifically defined scale for each requirement.

Radio Communications

(LINE OF SIGHT, BEYOND LINE OF SIGHT)



Requirements (Metric):

- Communications: Range: Line of Sight (meters)
- Communications: Range: Beyond Line of Sight (meters)
- Communications: Security (shielded from jamming and interference in none:commands:data and commands)
- Communications: Data Logging: Status and Notes (yes:no)

Test Method:

- Measure the operator's ability to remotely control the robot down-range while operating the robot through the operator interface and radio communications link.
- Line of Sight: Read visual acuity and hazmat label targets straight down-range to demonstrate control and data communications channels are functional.
- Beyond Line of Sight: At the end of the line of sight test, turn 90° around the corner of an appropriately large building. Maintain the robot within 1.2 meters along the building's wall and read near field visual acuity charts and hazmat labels at equally spaced intervals from the corner until command or data communications fail.

Random Maze



Requirements (Metric):

- Human-System Interaction: Initial Training (hours)
- Human-System Interaction: Proficiency Education (hours/year)
- Human-System Interaction: Acceptable Usability (effectiveness, percent of targets)
- Human-System Interaction: Assistive: Path Tracing (yes:no)
- Sensing: Location: Absolute (topological from start : plus mapping onto floor plans : plus 3D GIS map)
- Sensing: Location: Relative Accuracy (meters)
- Sensing: Location: Absolute Accuracy (meters)
- Sensing: Mapping: Spatial Modeling (yes:no)
- Sensing: Mapping: Waypoint Annotation (manual : manual and automatic : fully automatic and integrated)
- Sensing: Mapping: Operator Annotations (yes:no)
- Sensing: Mapping: Equipment Setup Time (minutes)

Test Method:

- Measure the operator's ability to remotely traverse/negotiate a random maze of hallways and rooms while operating the robot through the operator interface and communications link.
- Walls define the random maze of 1.2 meter wide hallways.
- Various repeatable terrain pallets can be used including flat floors, pitch ramps, roll ramps, and random stepfields to increase difficulty. Other terrains can be used including gravel, tarmac, snow, etc.
- Mission goals can be to simply find a path end to end, find a path end to end with target identifications along the way, right hand wall following techniques, completeness of search space, etc.
- Test in ambient light and dark environments, radio and tether communications separately.

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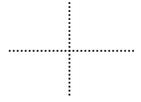
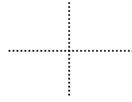
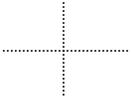
Stairs

(ASCENDING AND DESCENDING)



Requirements (Metric):

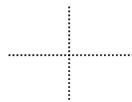
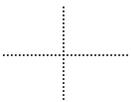
- Mobility: Locomotion: Sustained Speed - Obstacles (kilometers/hour)
- Mobility: Locomotion: Endurance - Obstacles (hours)
- Mobility: Tumble Recovery Within Terrain Type (none:self-righting:invertible continuous operations)



Test
Methods

Test Method:

- Measure the operator's ability to remotely control the robot to ascend and descent stairs while operating the robot through the operator interface and radio communications link.



Visual Acuity

(WITH VARIABLE ILLUMINATION)



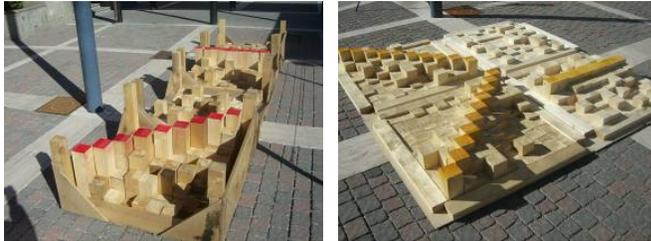
Requirements (Metric):

- Sensing: Real-time Color Video: Far Field Acuity (smallest chart line)
- Sensing: Real-time Color Video: Near Field Acuity (smallest chart line)
- Sensing: Real-time Color Video: Field of View (degrees)
- Sensing: Real-time Color Video: Pan (degrees)
- Sensing: Real-time Color Video: Tilt (degrees)
- Sensing: Real-time Color Video: Pan/Tilt Rate (degrees/second)
- Sensing: Real-time Color Video: Pan/Tilt Orientation Indicator (yes:no)
- Chassis: Illumination: Adjustable (yes:no)

Test Method:

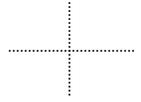
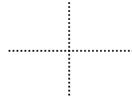
- Measure the operator's ability to remotely read standard visual acuity charts, both near field and far field, while operating the robot through the operator interface and communications link.
- Measure each camera's field of view, pan, tilt, and associated rates.
- Identify functionality of pan/tilt indicator on operator interface.
- Test in ambient light and dark environments, radio and tether communications separately.

Props: Repeatable Terrain



Random Stepfield Pallets:

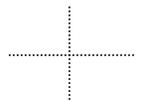
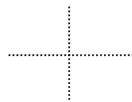
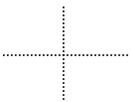
- Levels of difficulty:
 - Half-cubic stepfield pallets (orange) provide repeatable surface topologies for orientation complexity in static tests such as “Directed Perception” or “Grasping Dexterity.”
 - Full-cubic stepfield pallets (red) provide repeatable surface topologies for test methods such as “Confined Space” and “Mobility/Endurance.”
- Scalable sizes:
 - Small-size robots use pallets made of 2x2 posts (5 cm x 5 cm)
 - Mid-size robots use pallets made of 4x4 posts (10 cm x 10 cm) (shown)
 - Large-size robots use pallets made of clusters of (4) 4x4 posts (10 cm x 10 cm)
- Assorted topologies:
 - Random flat pallets
 - Random hill pallets
 - Random diagonal hill pallets



Test
Methods

Pitch/roll Ramps:

- 5°, 10°, and 15° pitch and roll ramps provide non-flat flooring for orientation complexity within test methods such as “Directed Perception,” “Grasping Dexterity,” “Random Maze,” or “Mobility/Endurance.”



Props: Targets And Objects



Visual Acuity Charts:

- Far-field and near-field charts provide easy to recognize “tumbling E’s” with standard metrics to measure an operator’s ability to discern details in the video image when viewed remotely through the operator interface and communications link. These charts are used in test methods such as “Directed Perception,” “Radio Communications,” “Random Maze,” “Station Keeping,” and “Visual Acuity.”

Hazmat Labels:

- Various hazmat labels provide operationally significant targets in the environment to identify colors, shapes, icons, numbers and letters, which relate directly back to the visual acuity charts. Hazmat labels are used in test methods such as “Directed Perception,” “Radio Communications,” “Random Maze,” “Station Keeping,” and “Visual Acuity.”



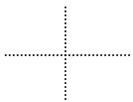
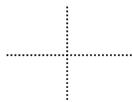
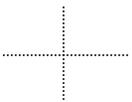
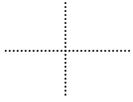
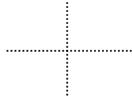
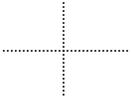
Test
Methods

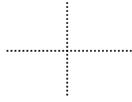
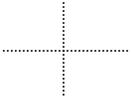
Wood Blocks:

- Simple wood blocks of two different lengths (one short enough to grasp from any direction, one long enough to require a vertical grasp for most grippers) are used in the “Grasping Dexterity” test method to provide abstract but repeatable grasping tasks that emphasize manipulator dexterity.

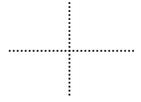
Others:

- Simulated pipe bombs and mineral water bottles with shock tube detonators provide operationally recognizable shapes and weights for use in test methods such as “Directed Perception” or “Grasping Dexterity” or “Random Maze.”
- Thermal heating pads and trace sources of chemical, radiological, and explosive samples are also used in test methods such as “Directed Perception” and the “Random Maze.”

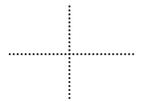
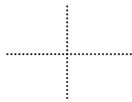
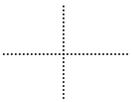




Ground Robots



Ground
Robots



EyeBall R1

Remington Tech. Div.
www.remingtonTD.com
301-208-8686/Pat Moore



Manufacturer's Specs:

- Circumference 3.25" (8.25 cm)
- Weight: 1.25 lbs (.566kg)
- Turning Diam: 0"
- Max Speed: rotates 4 RPM
- Power Source: battery
- Endurance: 3 hours
- Tether: none
- Control: eyes-on, remote teleop
- Sensors: camera
- Payload: N/A
- Manipulator: N/A

Radio Tx: 2400 MHz, 902-928MHz (RF)
Radio Rx: 2400 MHz, 902-928MHz (RF)

EyeBall R1

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____

Directed Perception (boxes with holes):

Level 1: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 2: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 3: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 4: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:

Ground
Robots

Grasping Dexterity (shelves with objects):

Level 1: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 2: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 3: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 4: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain: (flat), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)
Terrain: (ramps), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)
Terrain: (stepfields), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): near field (x.x), far field (x.x), zoom (x.x)
Dark (x lumens): near field (x.x), far field (x.x), zoom (x.x) – var. illumination: (yes/no)

ToughBot

Omnitech Robotics International LLC
www.omnitech.com
303-922-7773/Dave Parish



Manufacturer's Specs:

- Width: 3.14" (8 cm)
- Length: 4.3" (11 cm)
- Height: 4.3" (11 cm)
- Weight: 2 lb (.9 kg)
- Turning Diam: 0"
- Max Speed: TBD
- Power Source: battery
- Endurance: 1 hour
- Tether: none
- Control: eyes-on, remote teleop
- Sensors: 2 camera (wide and narrow)
- Payload: N/A
- Manipulator: N/A

Radio Tx: 2400 MHz, 868MHz
Radio Rx: 2400 MHz, 868MHz

ToughBot

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____

Directed Perception (boxes with holes):

Level 1: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 2: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 3: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 4: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:



Grasping Dexterity (shelves with objects):

Level 1: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 2: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 3: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 4: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain: (flat), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)
Terrain: (ramps), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)
Terrain: (stepfields), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

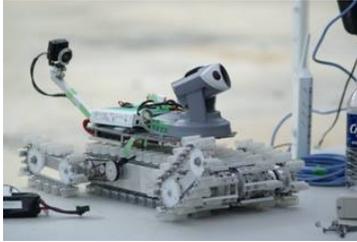
Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): near field (x.x), far field (x.x), zoom (x.x)
Dark (x lumens): near field (x.x), far field (x.x), zoom (x.x) – var. illumination: (yes/no)

Iris

Toin University of Yokohama
Chiba Institute of Technology
koyanagi@furo.org



Manufacturer's Specs:

- Width:
- Length:
- Height:
- Weight:
- Turning Dia:
- Max Speed:
- Power Source:
- Endurance:
- Tether:
- Control:
- Sensors:
- Payload:
- Manipulator:

Specifications Unavailable

Radio TX:
Radio RX:

Iris

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____

Directed Perception (boxes with holes):

Level 1: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 2: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 3: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 4: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:

Ground
Robots

Grasping Dexterity (shelves with objects):

Level 1: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 2: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 3: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 4: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain: (flat), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)
Terrain: (ramps), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)
Terrain: (stepfields), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): near field (x.x), far field (x.x), zoom (x.x)
Dark (x lumens): near field (x.x), far field (x.x), zoom (x.x) – var. illumination: (yes/no)

LRV

Applied Research Associates
www.ARA.com
303-795-8106/Andrew Poulter



Manufacturer's Specs:

- Width: 20" (51 cm)
- Length: 14" (36 cm)
- Height: 6.5" (16 cm)
- Weight: 14 lbs (6.3 kg)
- Turning Diam: 20" (51 cm)
- Max Speed: 6 fps (1.8 mps)
- Power Source: 8.5 AH Lithium Polymer
- Endurance: 60-240 min
- Tether: Option
- Control: Remote tele-operation
- Sensors: Color / IR Cameras
- Payload: 1.2 lb(0.5 kg) , drag 20 lb (9 kg)
- Manipulator: N/A –future option, existing boom reach is 18 in (45 cm)

Radio Tx: 75MHz(75mW), 900 MHz(100mW),2400MHz(200mW)
Radio Rx: 75 MHz , 900 MHz , 2400 MHz

LRV

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____

Directed Perception (boxes with holes):

Level 1: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 2: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 3: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 4: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:



Grasping Dexterity (shelves with objects):

Level 1: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 2: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 3: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 4: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain: (flat), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)
Terrain: (ramps), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)
Terrain: (stepfields), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

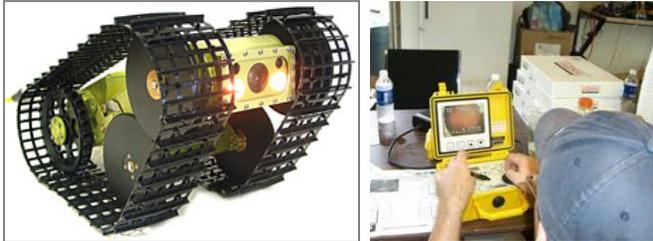
Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): near field (x.x), far field (x.x), zoom (x.x)
Dark (x lumens): near field (x.x), far field (x.x), zoom (x.x) – var. illumination: (yes/no)

VGTV-Extreme

Inuktun
www.inuktun.com/
1-877-468-5886/ Derek Naughton



Manufacturer's Specs:

- Width: 10.9" (27.7 cm)
- Length: 16.8" (42.7 cm)
- Height: 5.5" (14 cm) Lowered
- Weight: 14-20lbs(6.2-9.1kg)
- Turning Diam: 0" (0 cm)
- Max Speed: 1.5 fps (.45 mps)
- Power Source: lithium ion battery
- Endurance: >360 min
- Tether: power, comms
- Control: eyes-on, remote teleop
- Sensors: tilt camera 300°
- Payload: 10 lb (4.5 kg)
- Manipulator: N/A

Radio Tx: (tether only)
Radio Rx: (tether only)

VGTV-Extreme

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____

Directed Perception (boxes with holes):

Level 1: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 2: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 3: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 4: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:

Ground Robots

Grasping Dexterity (shelves with objects):

Level 1: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 2: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 3: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 4: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain: (flat), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)
Terrain: (ramps), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)
Terrain: (stepfields), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): near field (x.x), far field (x.x), zoom (x.x)
Dark (x lumens): near field (x.x), far field (x.x), zoom (x.x) – var. illumination: (yes/no)

Dragon Runner

Automatika, Inc.
www.automatika.com
412-968-1022 /William Crowley



Manufacturer's Specs:

- Width: 12.2" (31 cm)
- Length: 16.6" (42 cm)
- Height: 6" (15.2 cm)
- Weight: 14 lbs (6.4 kg)
- Turning Diam: Zero-Turn; Swept
- Max Speed: 7.5 - 29 fps (5 - 20 mph)
- Power Source: battery (NimH baseline)
- Endurance: 45 min @ 13 mph on flat ground
- Tether: none
- Control: remote teleop, loss-of-comms
back-tracking, cruise-control
- Sensors: thermal (PIR), acoustic, visual
(wide-angle FF lens; IR illuminator)
- Payload: 10 lb (4.5 kg)
- Manipulator: TBD

Radio Tx: Low S-Band MHz(1 – 1k mW)L-Band MHz (1–1K mW)
Radio Rx: n/a

Dragon Runner

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____

Directed Perception (boxes with holes):

Level 1: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 2: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 3: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 4: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:

Ground
Robots

Grasping Dexterity (shelves with objects):

Level 1: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 2: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 3: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 4: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain: (flat), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)
Terrain: (ramps), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)
Terrain: (stepfields), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): near field (x.x), far field (x.x), zoom (x.x)
Dark (x lumens): near field (x.x), far field (x.x), zoom (x.x) – var. illumination: (yes/no)

BomBot

WVHTC Foundation
www.wvhtf.org
304-368-4518/Carey Bulter



Manufacturer's Specs:

- Width: 18" (45.72 cm)
- Length: 20" (50.8 cm)
- Height: 32" (81.28 cm)
- Weight: 15 lbs (6.8kg)
- Turning Diam: 2ft. (60.96 cm)
- Max Speed: 35 mph (56.32 km/hr)
- Power Source: battery
- Endurance: 30 mins
- Tether: none
- Control: eyes-on, remote teleop
- Sensors: none
- Payload: 10 lbs (4.5kg)
- Manipulator: N/A

Radio Tx: 2400 MHz
Radio Rx: 2400 MHz

BomBot

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____

Directed Perception (boxes with holes):

Level 1: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 2: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 3: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 4: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:

Ground
Robots

Grasping Dexterity (shelves with objects):

Level 1: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 2: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 3: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 4: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain: (flat), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)
Terrain: (ramps), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)
Terrain: (stepfields), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): near field (x.x), far field (x.x), zoom (x.x)
Dark (x lumens): near field (x.x), far field (x.x), zoom (x.x) – var. illumination: (yes/no)

MarcBot

Exponent
www.exponent.com
623-587-4143/John Pye



Manufacturer's Specs:

- Width: 19" (48.3 cm)
- Length:
- Height: 13.5"-24" (34.2-61 cm)
- Weight: 25 lbs (11.3 kg)
- Turning Dia:
- Max Speed:
- Power Source:
- Endurance:
- Tether:
- Control:
- Sensors:
- Payload:
- Manipulator:

Specifications Unavailable

Radio TX:
Radio RX:

MarcBot

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____

Directed Perception (boxes with holes):

Level 1: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 2: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 3: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 4: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:



Grasping Dexterity (shelves with objects):

Level 1: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 2: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 3: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 4: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain: (flat), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)
Terrain: (ramps), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)
Terrain: (stepfields), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): near field (x.x), far field (x.x), zoom (x.x)
Dark (x lumens): near field (x.x), far field (x.x), zoom (x.x) – var. illumination: (yes/no)

Marv

Mesa Robotics, Inc.
www.mesa-robotics.com
256-464-7252/Mike Cole



Manufacturer's Specs:

- Width: 13.5" (34.29 cm)
- Length: 20.5" (52.07 cm)
- Height: 12" (30.48 cm)
- Weight: 25 lbs (11.33 kg)
- Turning Dia: zero in
- Max Speed: 4 mph (6.4 km/hr)
- Power Source: 12VDC, NiMH battery
- Endurance: 60 – 120 min
- Tether: none
- Control: remote teleop
- Sensors: future option
- Payload: 10 lbs (4.5 kg)
- Manipulator: future option

Radio TX: 900 MHz control, 2400 MHz video
Radio RX: 900 MHz control, 2400 MHz video

Marv

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____

Directed Perception (boxes with holes):

Level 1: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 2: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 3: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 4: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:

Ground
Robots

Grasping Dexterity (shelves with objects):

Level 1: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 2: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 3: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 4: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain: (flat), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)
Terrain: (ramps), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)
Terrain: (stepfields), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): near field (x.x), far field (x.x), zoom (x.x)
Dark (x lumens): near field (x.x), far field (x.x), zoom (x.x) – var. illumination: (yes/no)

Negotiator Tactical Surveillance Robot

Robotic FX, Inc.
www.RoboticFX.com
708-448-4264/Eric Webber



Manufacturer's Specs:

- Width: 16" - 22" (40.6-55.9 cm)
- Length: 25"(63.5 cm)
- Height: 7.6 in (19.3 cm)
- Weight: 25-35 lbs (11.3 -15.9 kg)
- Turning Diam: Turns in place
- Max Speed: 4.4-7.3 fps (1.3-2.2 mps)
- Power Source: battery (NiMH)
- Endurance: 180 to 360 min
- Tether (optional): comms
- Control: remote teleop, telemetry
- Sensors: All sensors (open system)
- Payload: Up Stairs = 10 lb (4.5 kg) / Flat
Ground = 75 lb (34 kg)
- Manipulator: 6 DoFs, reach 42 in (106 cm)

Radio TX: Data 900 MHz / Video 2400MHz / (Opt.) Digital
Video 300MHz UHF
Radio RX: Data 900 MHz / Video 2400MHz / (Opt.) Digital
Video 300MHz UHF

Negotiator Tactical Surveillance Robot

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____

Directed Perception (boxes with holes):

Level 1: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 2: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 3: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 4: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:

Ground Robots

Grasping Dexterity (shelves with objects):

Level 1: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 2: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 3: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 4: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain: (flat), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)
Terrain: (ramps), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)
Terrain: (stepfields), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): near field (x.x), far field (x.x), zoom (x.x)
Dark (x lumens): near field (x.x), far field (x.x), zoom (x.x) – var. illumination: (yes/no)

Soryu

International Rescue System Institute
www.rescuesystem.org
Shigeo Hirose



Manufacturer's Specs:

- Width: 5.9" (15 cm)
- Length: 47.2" (120 cm)
- Height: 5.1" (13 cm)
- Weight: 28.6 lbs (13 kg)
- Turning Diam: 1.0 m
- Max Speed: 0.3 mps
- Power Source: battery
- Endurance: 20 min
- Tether: comms
- Control: remote teleop
- Sensors: thermal, camera, GAS(CO, O2, SO, CH)
- Payload: none
- Manipulator: none

Radio Tx: (tether only)
Radio Rx: (tether only)

Soryu

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____

Directed Perception (boxes with holes):

Level 1: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 2: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 3: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 4: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:

Ground
Robots

Grasping Dexterity (shelves with objects):

Level 1: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 2: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 3: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 4: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain: (flat), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)
Terrain: (ramps), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)
Terrain: (stepfields), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): near field (x.x), far field (x.x), zoom (x.x)
Dark (x lumens): near field (x.x), far field (x.x), zoom (x.x) – var. illumination: (yes/no)

Soryu V

International Rescue System Institute
www.rescuesystem.org
Shigeo Hirose



Manufacturer's Specs:

- Width: 7.9" (20.2 cm)
- Length: 45.6" – 54.3" (116 - 138 cm)
- Height: 5.7" (14.5 cm)
- Weight: 37.47 lbs (17 kg)
- Turning Diam: 50.3" (128 cm)
- Max Speed: 0.25 mps
- Power Source: battery (14.4V, 7400mAh)
- Endurance: 40 min
- Tether: comms
- Control: remote teleop
- Sensors: Camera
- Payload: unknown
- Manipulator: none

Radio Tx: (tether only)
Radio Rx: (tether only)

Soryu V

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____

Directed Perception (boxes with holes):

Level 1: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 2: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 3: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 4: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:

Ground
Robots

Grasping Dexterity (shelves with objects):

Level 1: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 2: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 3: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 4: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain: (flat), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)
Terrain: (ramps), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)
Terrain: (stepfields), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): near field (x.x), far field (x.x), zoom (x.x)
Dark (x lumens): near field (x.x), far field (x.x), zoom (x.x) – var. illumination: (yes/no)

PacBot EOD

iRobot
www.irobot.com
781-345-0200/Tom Ryden



Manufacturer's Specs:

- Width: 16"- 20" (40 - 50 cm)
- Length: 27" (69 cm)
- Height: 7.5" (19 cm)
- Weight: 48 lbs (22 kg)
- Turning Dia: 34" (86.36 cm)
- Max Speed: Variable 0 - 5 mph (0 - 8 km/hr)
- Power Source: battery
- Endurance: 2-12 hours / 6+ mi (10+ km)
- Tether: optional
- Control: Teleop
- Sensors: Zoom, FLIR cameras, omni direct mic
- Payload: 8 additional
- Manipulator: arm

Radio TX: 2400 MHz
Radio RX: 2400 MHz

PacBot EOD

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____

Directed Perception (boxes with holes):

Level 1: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 2: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 3: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 4: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:



Grasping Dexterity (shelves with objects):

Level 1: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 2: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 3: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 4: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain: (flat), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)
Terrain: (ramps), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)
Terrain: (stepfields), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): near field (x.x), far field (x.x), zoom (x.x)
Dark (x lumens): near field (x.x), far field (x.x), zoom (x.x) – var. illumination: (yes/no)

PacBot Explorer

iRobot
www.irobot.com
781-345-0200/Tom Ryden



Manufacturer's Specs:

- Width: 16" - 20" (40 - 50 cm)
- Length: 27" (69 cm)
- Height: 7.5" (19 cm)
- Weight: 48 lbs (22 kg)
- Turning Dia: 34" (86.36 cm)
- Max Speed: Variable 0 - 5 mph (0 - 8 km/hr)
- Power Source: battery
- Endurance: 2-12 hours / 6+ mi (10+ km)
- Tether: optional
- Control: Teleop
- Sensors: Zoom & FLIR cameras, omni dirc mic
- Payload: Supports up to 8
- Manipulator: surveillance head is mounted on a 12" (.3m) mast with a 360° pan and 270° tilt

Radio TX: 2400 MHz
Radio RX: 2400 MHz

PacBot Explorer

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____

Directed Perception (boxes with holes):

Level 1: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 2: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 3: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 4: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:



Grasping Dexterity (shelves with objects):

Level 1: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 2: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 3: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 4: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain: (flat), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)
Terrain: (ramps), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)
Terrain: (stepfields), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

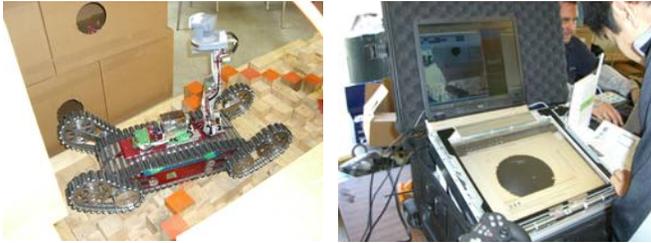
Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): near field (x.x), far field (x.x), zoom (x.x)
Dark (x lumens): near field (x.x), far field (x.x), zoom (x.x) – var. illumination: (yes/no)

Hibiscus

Toin University of Yokohama
Chiba Institute of Technology
koyanagi@furo.org



Manufacturer's Specs:

- Width: 14.5" (37 cm)
- Length: 38.5" (98 cm)
- Height: 7" (18 cm)
- Weight: 49.6 lbs (22.5 kg)
- Turn Diam: diagonal for skid steer
- Max Speed: .7 mph (1.2 km/ph)
- Power Source: battery
- Endurance: 60 min
- Tether: none
- Control Features: diagnostics, wall following, centering
- Sensors: URG, Heat, Voice
- Payload: none
- Manipulator: Sensor arm 4DOF: Length: 14.1" (36cm)

Radio TX: 2400 MHz
Radio RX: 2400 MHz

Hibiscus

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____

Directed Perception (boxes with holes):

Level 1: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 2: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 3: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 4: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:

Ground
Robots

Grasping Dexterity (shelves with objects):

Level 1: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 2: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 3: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 4: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain: (flat), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)
Terrain: (ramps), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)
Terrain: (stepfields), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): near field (x.x), far field (x.x), zoom (x.x)
Dark (x lumens): near field (x.x), far field (x.x), zoom (x.x) – var. illumination: (yes/no)

Cphea

Toin University of Yokohama
Chiba Institute of Technology
koyanagi@furo.org



Manufacturer's Specs:

- Width: 20" (52 cm)
- Length: 40" (102 cm)
- Height: 9.4" (24 cm)
- Weight: 49.6 lbs (22.5 kg)
- Turn Diam: diagonal for skid steer
- Max Speed: .37 mph (0.6 km/ph)
- Power Source: battery
- Endurance: 60 min
- Tether: none
- Control: diagnostics, wall following, centering
- Sensors: URG, Heat, Voice
- Payload: none
- Manipulator: Sensor arm 2DOF: Length (30cm)

Radio TX: 2400 MHz
Radio RX: 2400 MHz

Cphea

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____

Directed Perception (boxes with holes):

Level 1: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 2: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 3: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 4: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:

Ground
Robots

Grasping Dexterity (shelves with objects):

Level 1: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 2: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 3: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 4: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain: (flat), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)
Terrain: (ramps), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)
Terrain: (stepfields), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): near field (x.x), far field (x.x), zoom (x.x)
Dark (x lumens): near field (x.x), far field (x.x), zoom (x.x) – var. illumination: (yes/no)

Shinobi

Univ Electro-Communications

http://www.hi.mce.uec.ac.jp/matsuno-lab/matsuno_eng.html

Noritaka Sato



Manufacturer's Specs:

- Width: 15.74" (40 cm)
- Length: 31.49" (80 cm)
- Height: 15-74" – 31.49" (40cm- 80cm)
- Weight: 57.32 lbs (26 kg)
- Turning Dia: 0
- Max Speed: .21 mps (.33 kms)
- Power Source: battery
- Endurance: 60 min
- Tether: none
- Control: teleop
- Sensors: thermal , chemical (CO₂)
- Payload: none
- Manipulator: none

Radio TX: 5200 MhZ (10mW)
Radio RX: 5200 MhZ (10mW)

Shinobi

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____

Directed Perception (boxes with holes):

Level 1: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 2: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 3: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 4: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:

Ground
Robots

Grasping Dexterity (shelves with objects):

Level 1: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 2: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 3: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 4: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain: (flat), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)
Terrain: (ramps), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)
Terrain: (stepfields), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): near field (x.x), far field (x.x), zoom (x.x)
Dark (x lumens): near field (x.x), far field (x.x), zoom (x.x) – var. illumination: (yes/no)

Matilda

Mesa Robotics, Inc.
www.mesa-robotics.com
256-464-7252/Mike Cole



Manufacturer's Specs:

- Width: 21" (53.34 cm)
- Length: 30" – 34" (76.2cm- 86.36cm)
- Height: 12" (30.48 cm)
- Weight: 61 lbs (27.66 kg)
- Turning Dia: zero
- Max Speed: 2.0 mph
- Power Source: 12VCD battery, NiMH
- Endurance: 360 – 480 min
- Tether: fiber optic cable (data,video, audio)
- Control: remote teleop
- Sensors: biological, chemical, radiological
- Payload: 125 lbs
- Manipulator: 5 DOF with 44 in reach (adds 45lbs/20.4kg to weight)

Radio TX: 900 MHz control, 1800 MHz video, 469 MHz audio
Radio RX: 900 MHz control, 1800 MHz video, 469 MHz audio

Matilda

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____

Directed Perception (boxes with holes):

Level 1: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 2: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 3: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 4: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:

Ground
Robots

Grasping Dexterity (shelves with objects):

Level 1: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 2: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 3: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 4: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain: (flat), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)
Terrain: (ramps), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)
Terrain: (stepfields), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): near field (x.x), far field (x.x), zoom (x.x)
Dark (x lumens): near field (x.x), far field (x.x), zoom (x.x) – var. illumination: (yes/no)

Talon

Foster-Miller

www.foster-miller.com/lemming.htm
781-684-3960/Joanne Maxwell



Manufacturer's Specs:

- Width: 16" (40.64 cm)
- Length: 19" (48.26 cm)
- Height: 11"-52" (27.9 cm - 132 cm)
- Weight: 115 to 140 lb (52kg to 64 kg)
- Turning Dia: turns in place
- Max Speed: 0 to 5.2 mph (0-8.3 km/hr)
- Power Source: Single Lithium-ion Battery or Dual Lead-Acid Battery Pack
- Endurance: 4.5 hr (7.2 km/hr)
- Tether: Optional 300 or 500 m buffered fiber optic cable
- Control: digital/analog, 500-800 m LOS
High Gain antenna range to 1200m LOS
- Sensors: Chemsentry 150 C, ADP 2000, RAE System MultiRAE, Canberra AN-UDR-14, RayTek temp. probe, targeting laser
- Payload: 100 lb (45 kg)
- Manipulator: 30 in-lb of gripping strength, 6 in wide opening, manual 340 degree wrist, OCU controllable 360 degree rotating wrist (optional)

Radio TX: Data 2400MHz / Video 1700-1800MHz
Radio RX: Data 2400MHz / Video 1700-1800MHz

Talon

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____

Directed Perception (boxes with holes):

Level 1: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 2: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 3: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 4: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:

Ground
Robots

Grasping Dexterity (shelves with objects):

Level 1: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 2: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 3: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 4: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain: (flat), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)
Terrain: (ramps), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)
Terrain: (stepfields), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

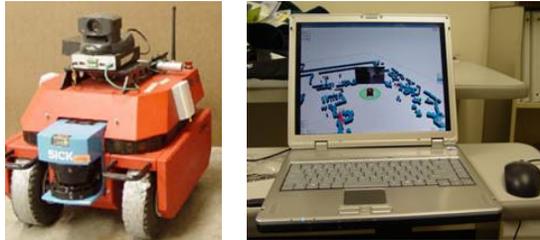
Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): near field (x.x), far field (x.x), zoom (x.x)
Dark (x lumens): near field (x.x), far field (x.x), zoom (x.x) – var. illumination: (yes/no)

ATRV mini

Idaho National Lab
www.inl.gov/adaptiverobotics
208-526-8659 /Curtis Nielsen



- Width: 22" (55.8 cm)
- Length: 27" (68.6 cm)
- Height: 25" (63.5 cm)
- Weight: 125 lbs (56.7 kg)
- Turning Diam: 0 (turns on center off robot)
- Max Speed: 6.5 fps (2 mps)
- Power Source: battery
- Endurance: 30-45 min
- Tether: none
- Control: eyes-on, remote teleop, waypoints, go to landmarks, drive intent
- Sensors: color video, laser range scanner, ultrasonic
- Payload: 35 lb (15.9 kg)
- Manipulator: none

Radio TX: 900 MHz (500 mW), 2400 MHz (500 mW)
Radio RX: 900 MHz (500 mW), 2400 MHz

ATRV mini

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____

Directed Perception (boxes with holes):

Level 1: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 2: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 3: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 4: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:

Ground Robots

Grasping Dexterity (shelves with objects):

Level 1: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 2: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 3: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 4: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain: (flat), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)
Terrain: (ramps), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)
Terrain: (stepfields), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): near field (x.x), far field (x.x), zoom (x.x)
Dark (x lumens): near field (x.x), far field (x.x), zoom (x.x) – var. illumination: (yes/no)

Mini-Andros II

REMOTEC, Inc.
www.remotec-andros.com
865-483-0228/Jim Daniels



Manufacturer's Specs:

- Width: 24.5" (62 cm)
- Length: 53" (134c m)
- Height: 27" (68 cm)
- Weight: 225 lbs (102.6 kg)
- Turning Dia: length of vehicle
- Max Speed: 1.1 mph(1.7 km/hr)
- Power Source: 24VDC - gel cell battery pack
Battery
- Endurance: 3-6 hr
- Tether: Fiber-Optic Cable or hard tether
cable
- Control: tethered, Radio Control
- Sensors: Color Camera
- Payload: 15 lbs (6.8 kg)
- Manipulator: 78" (2 m) telescoping arm with
four degrees of freedom

Radio TX: tethered or RF
Radio RX: tethered or RF

Mini-Andros II

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____

Directed Perception (boxes with holes):

Level 1: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 2: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 3: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 4: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:

Ground
Robots

Grasping Dexterity (shelves with objects):

Level 1: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 2: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 3: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 4: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain: (flat), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)
Terrain: (ramps), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)
Terrain: (stepfields), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): near field (x.x), far field (x.x), zoom (x.x)
Dark (x lumens): near field (x.x), far field (x.x), zoom (x.x) – var. illumination: (yes/no)

Andros F6A

REMOTEC, Inc.
www.remotec-andros.com
865-483-0228/Jim Daniels



Manufacturer's Specs:

- Width: 29" (73 cm)
- Length: 52" (132 cm)
- Height: 56.5" (140 cm)
- Weight: 485 lb (219.99kg)
- Turning Dia: within the length of vehicle
- Max Speed: 3.5 mph (5.6 km/hr)
- Power Source: 24VDC 35 amp-hr gel-cell battery pack
- Endurance: 3-6 hr
- Tether: Interchangeable Fiber Optic Cable reel, RF system, or Hard-line cable reel system
- Control: tethered or RF
- Sensors: Color camera with low-light
- Payload: 45 lbs (20.4 kg)
- Manipulator: Arm -Vertical reach 109" (2.76 m) with tracks down and arm fully extended, Horizontal reach 56" (1.42 m) from front of vehicle

Radio TX: tethered or RF
Radio RX: tethered or RF

Andros F6A

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____

Directed Perception (boxes with holes):

Level 1: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 2: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 3: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 4: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:

Ground
Robots

Grasping Dexterity (shelves with objects):

Level 1: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 2: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 3: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 4: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain: (flat), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)
Terrain: (ramps), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)
Terrain: (stepfields), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): near field (x.x), far field (x.x), zoom (x.x)
Dark (x lumens): near field (x.x), far field (x.x), zoom (x.x) – var. illumination: (yes/no)

BOZ I

BOZ Robotics
www.bozrobot.com
847-574-0168/Jamie Alvarez



Manufacturer's Specs:

- Width: 26.4 in (67 cm)
- Length: 67.3 in (171 cm)
- Height: 53.2 in (135 cm)
- Weight: 1,300 lbs (600 kg)
- Turning Dia: 360 degrees
- Max Speed: 6.7 km/h
- Power Source: battery
- Endurance: 3 - 4 hrs to continuous w/generator
- Tether: 100 meter; 1 km remote los
- Control: computer w/case and joystick
- Sensors: ultra sound distance sensors (to the cm) 5 cameras; 3 infrared
- Payload: 265 lb (120 kg) lifting capacity w/arm straight; 441 lbs (200 kg) arm bent
- Manipulator: Hydraulic gripper w/12,717 lbs (5,770 kg) of opening force, reach 11.5 ft (350 cm) and four joints independently operated to tear off car doors, trunks, & dexterity to pour a soda bottle in a glass

Radio TX: 2400 MHz
Radio RX: 2400 Mhz

BOZ I

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____

Directed Perception (boxes with holes):

Level 1: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 2: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 3: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 4: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:

Ground
Robots

Grasping Dexterity (shelves with objects):

Level 1: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 2: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 3: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:
Level 4: Open: (x of 9), Under (x of 9), Over (x of 9), Objects: Block, Time:

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain: (flat), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)
Terrain: (ramps), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)
Terrain: (stepfields), Working time (x hrs.), MTBF: (x hrs.), Field maint. duration (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

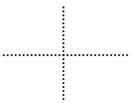
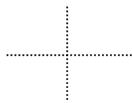
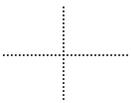
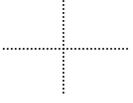
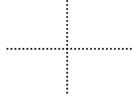
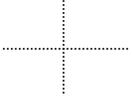
Coverage: (x%), Time: (x min), Targets: (x of x)

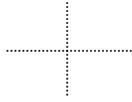
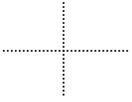
Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

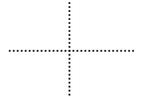
Visual Acuity:

Ambient (x lumens): near field (x.x), far field (x.x), zoom (x.x)
Dark (x lumens): near field (x.x), far field (x.x), zoom (x.x) – var. illumination: (yes/no)

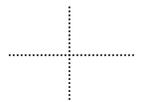
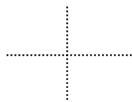




Wall Climbers



Wall
Climber



VMRP

Vortex HC LLC.
www.vortexhc.com
919-462-8828



Manufacturer's Specs:

- Width: 8.5" (21.5 cm)
- Length: 6.5" (16.5 cm)
- Height: 4" (10 cm)
- Weight: 1.87 lbs (.84kg)
- Turning Dia: TBD
- Max Speed: 6"/sec. (.154m/sec)
- Power Source: battery
- Endurance: 20- 40 minutes
- Tether: none
- Control: teleoped
- Sensors: 2 color camera (boom pan drive camera)
- Payload: 1 lbs (.45kg) (scalable)
- Manipulator: n/a

Radio TX: 2400 MHz (Bluetooth) video 1200 MHz
Radio RX: 2400 MHz (Bluetooth)

VMRP

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Directed Perception (boxes with holes):

Level 1: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 2: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 3: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 4: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Visual Acuity:

Ambient (x lumens): near field (x.x), far field (x.x), zoom (x.x)
Dark (x lumens): near field (x.x), far field (x.x), zoom (x.x) – var. illumination: (yes/no)

Wall
Climber

NanoMag

Inuktun
www.inuktun.com/
1-877-468-5886



Manufacturer's Specs:

- Width: 17" (43.1cm)
- Length: 12" (30.4 cm)
- Height: 3.5" (8.8 cm)
- Weight: 5 lbs (2.26kg)
- Turning Dia: TBD
- Max Speed: 0-5 ft/min (0-1.5 m/min)
- Power Source: TBD
- Endurance: TBD
- Tether: 100ft (30m)
- Control: teleoped
- Sensors: TBD
- Payload: TBD
- Manipulator: n/a

Radio Tx: (tether only)
Radio Rx: (tether only)

NanoMag

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Directed Perception (boxes with holes):

Level 1: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 2: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 3: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:
Level 4: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

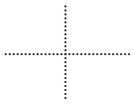
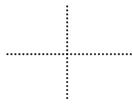
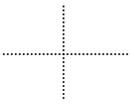
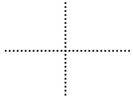
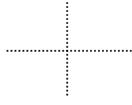
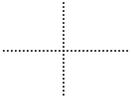
Radio Communications:

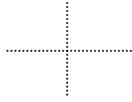
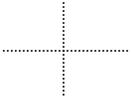
LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Visual Acuity:

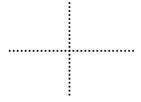
Ambient (x lumens): near field (x.x), far field (x.x), zoom (x.x)
Dark (x lumens): near field (x.x), far field (x.x), zoom (x.x) – var. illumination: (yes/no)

Wall
Climber

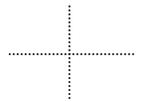
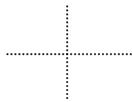




Aerial Robots



Aerial
Robots



Blimp

ARACAR
www.aracar.org/index.html
985-845-3774



Manufacturer's Specs:

- Blimp span:
- Length: 10' -20' (3 m-6 m)
- Weight: < 0! lbs (< 0! kg)
- Range: 150 ft (50 m) tethered
- Speed: 0 km/hr (or tether vehicle speed)
- Launch: vertical pay out of tether
- Recovery: vertical retrieval of tether
- Propulsion: none
- Altitude: 150 ft (50 m)
- Endurance: TBD
- Control: none
- Payload: small camera

Radio TX:
Radio RX:

Blimp

Aerial Station Keeping (single charge):

Targets: (flush: x of x), (recessed: x of x), Total: (y of y), Time: (x min.)

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____

Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Directed Perception (boxes with holes):

Level 1: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:

Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:

Level 2: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:

Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:

Level 3: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:

Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:

Level 4: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:

Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Visual Acuity:

Ambient (x lumens): near field (x.x), far field (x.x), zoom (x.x)

Dark (x lumens): near field (x.x), far field (x.x), zoom (x.x) – var. illumination: (yes/no)

Aerial
Robots

AirRobot

AirRobot GmbH
www.AirRobot.com
49 2932 54 77 40/info@airrobot.de



Manufacturer's Specs:

- Rotor span: 36" (1097 cm)
- Length: 36" (1097 cm) diameter
- Weight: less than 2.2 lbs (less than 1 kg)
- Range: up to 1640 ft (up to 500 m)
- Speed: approximate 25 mph
- Launch: vertical
- Recovery: vertical
- Propulsion: electric, LiPo Battery 14.8 V, 2.05 Ah
- Altitude: up to 492 ft (150m)
- Endurance: 20-25 min
- Control: video glasses or Tablet PC
- Payload: 0.44 lb (0.2 kg)

Radio TX: 35 MHz (200 mW)
Radio RX: 35 MHz

AirRobot

Aerial Station Keeping (single charge):

Targets: (flush: x of x), (recessed: x of x), Total: (y of y), Time: (x min.)

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____

Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Directed Perception (boxes with holes):

Level 1: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:

Level 2: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:

Level 3: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:

Level 4: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:
Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Visual Acuity:

Ambient (x lumens): near field (x.x), far field (x.x), zoom (x.x)

Dark (x lumens): near field (x.x), far field (x.x), zoom (x.x) – var. illumination: (yes/no)



Yamaha Helicopter

SkeyesUnlimited Inc.
www.skeyesunlimited.com/index.html
412-661-0292



Manufacturer's Specs:

- Rotor span: 10.2 ft (3.1 m)
- Length: 11.8 ft (3.6 m)
- Weight: 207 lbs (94 kg)
- Range: 492 ft (150 m) LOS
- Speed: TBD
- Launch: vertical takeoff
- Recovery: vertical landing
- Propulsion: 21 hp, 246 cc, 2-stroke, gas/oil mix
- Altitude: TBD
- Endurance: 60 min
- Control: auto waypoint following
- Payload: 3-D laser scanner

Radio TX: TBD
Radio RX: TBD

Yamaha Helicopter

Aerial Station Keeping (single charge):

Targets: (flush: x of x), (recessed: x of x), Total: (y of y), Time: (x min.)

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____

Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Directed Perception (boxes with holes):

Level 1: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:

Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:

Level 2: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:

Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:

Level 3: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:

Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:

Level 4: Face: Eye (x of 3), Haz. (x of 3), Chem. (x of 3), Therm. (x of 3) Time:

Top : Eye (x of 6), Haz. (x of 6), Chem. (x of 6), Therm. (x of 6) Time:

Radio Communications:

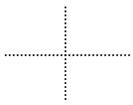
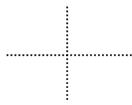
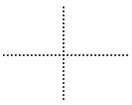
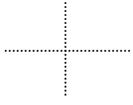
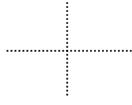
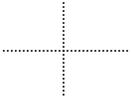
LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

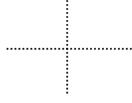
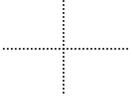
Visual Acuity:

Ambient (x lumens): near field (x.x), far field (x.x), zoom (x.x)

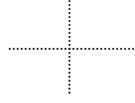
Dark (x lumens): near field (x.x), far field (x.x), zoom (x.x) – var. illumination: (yes/no)

Aerial
Robots

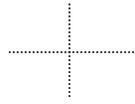
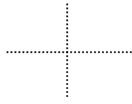
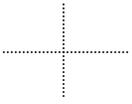


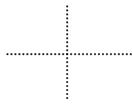
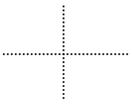
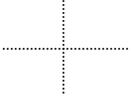
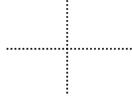
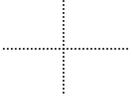


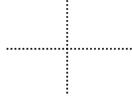
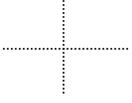
Aquatic Robots



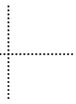
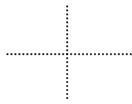
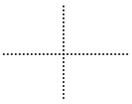
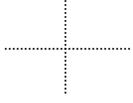
Aquatic Robots







Sensors



GammaRAE II Responder

RAE Systems, Inc
www.raesystems.com



- Width: 2.7 "(6.8 cm)
- Length: 4.9 " (12.5 cm)
- Height: 1.4 "(3.5 cm)
- Weight: 0.625 lbs (0.24 kg)
- Sensitivity: (Cs-137, Co-60, Am-241)
- Energy range: 60 keV to 3.0 MeV
- Exposure rate range: 1 μ R/h to 10 R/h
- Response with angle if incidence: $\pm 20\%$ from 0° for -45° to 45° (Cs-137)
- Type of detector: CsI(Tl)+photodiode & energy-compensated PIN diode
- Data transmission type: Bluetooth
- Battery type and lifetime: 2xAA alkaline, 500hr
- Display type: Backlit LCD
- Alarm type: Audible, Visual LEDs, Built-in vibration
- Control: Manual
- Radio frequency immunity:
- Radiated emission: omplies with FCC Part 15
- Shock resistance: Passes drop tests from 59" (1.5 m)

ICS-4000 Radionuclide Identifier

XRF Corporation
www.xrfcorp.com / www.laurussystems.com
410-465-5558



- Width: 3.4"
- Length: 10.2"
- Height: 1.2"
- Weight: 1.75 lbs
- Sensitivity: Cs-137: 90 cps/mR/h,
Co-60: 25 cps/mR/h,
Am-241: 2900 cps/mR/h
- Energy range: 10 keV – 2 MeV
- Exposure rate range: 50 mR/h – 1 R/h
- Response with angle if incidence: -3.3% 0° for -45° to 45° (Cs-137)
- Type of detector: Solid state CdTe for dose rate & radionuclide ID
- Data transmission type: Bluetooth
- Battery type and lifetime: 24 hours
- Display type: LCD w LED backlight
- Alarm type: Audible & visual
- Control: Remote / manual
- Radio frequency immunity: Class A per standard EN 61326 (1997) + A1 (1998) + A2 (2001)
- Radiated emission: Class B per standard EN 61326 (1997) + A (1998) + A2 (2001)
- Shock resistance: Conditional per ANSI N42.34

Inspector-1000

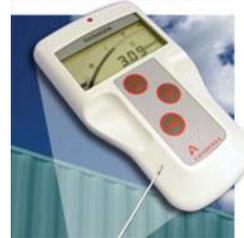
Canberra Industries
www.canberra.com



- Width: 7.5 in (19 cm)
- Length: 6.5 in (16.5 cm)
- Height: 2.5 in (6.4 cm)
- Weight: 2.2 lbs (1.0 kg)
- Sensitivity: (Cs-137, Co-60, Am-241)
- Energy range: 50-3000 keV
- Exposure rate range: 1000 mR/h
- Response with angle if incidence: 95% from 0° for -45° to 45° (Cs-137)
- Type of detector: GM + (either NaI(Tl) or LaBr) with radionuclide ID
- Data transmission type: USB
- Battery type and lifetime: 12, hours
- Display type: LCD 320 x 200 Hi-res color display
- Alarm type: audible, visual
- Control: eyes-on, manual
- Radio frequency immunity: yes
- Radiated emission: yes
- Shock resistance: yes

Radiogem

Canberra Industries
www.canberra.com



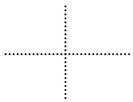
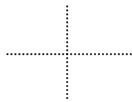
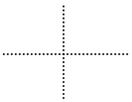
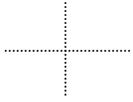
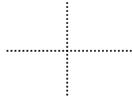
- Width: 5.9 in (15.0 cm)
- Length: 3.3 in (8.5 cm)
- Height: 1.8 in (4.5 cm)
- Weight: .66 lbs(0.300 kg)
- Sensitivity: yes (Cs-137, Co-60, Am-241)
- Energy range: 30 - 2000 keV (probe dep.)
- Exposure rate range: 0.03-10,000mR/h
- Response with angle if incidence: 95% from 0° for - 45° to 45° (Cs-137)
- Type of detector: GM, or NaI, Plastic
- Data transmission type: RS-232
- Battery type and lifetime: 80 hours
- Display type: LCD display
- Alarm type: audible, visual
- Control: eyes-on, manual
- Radio frequency immunity: yes
- Radiated emission: yes
- Shock resistance: yes

UltraRadiac

Canberra Industries
www.canberra.com



- Width: 2.61 in (6.6 cm)
- Length: 3.95 in (10.0 cm)
- Height: 1.14 in (2.9 cm)
- Weight: .6 lbs (0.269 kg)
- Sensitivity: yes (Cs-137, Co-60, Am-241)
- Energy range: 60 - 1300 keV
- Exposure rate range: 0.001 – 500,000 mR/h
- Response with angle if incidence: 95% from 0° for - 45° to 45° (Cs-137)
- Type of detector: GM
- Data transmission type: RS-232
- Battery type and lifetime: 150 hours
- Display type: LCD display
- Alarm type: audible, visual, vibration
- Control: yes-on, manual
- Radio frequency immunity: yes
- Radiated emission: yes
- Shock resistance: yes



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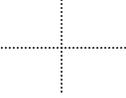
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