



System Assessment and Validation for Emergency Responders (SAVER)

Small Platform Tactical Robots Market Survey Report

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Prepared by Space and Naval Warfare Systems Center Atlantic

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FOREWORD

The U.S. Department of Homeland Security (DHS) established the System Assessment and Validation for Emergency Responders (SAVER) Program to assist emergency responders making procurement decisions. Located within the Science and Technology Directorate (S&T) of DHS, the SAVER Program conducts objective assessments and validations on commercially available equipment and systems, and develops knowledge products that provide relevant equipment information to the emergency responder community. The SAVER Program mission includes:

- Conducting impartial, practitioner-relevant, operationally oriented assessments and validations of emergency response equipment; and
- Providing information, in the form of knowledge products, that enables decision-makers and responders to better select, procure, use, and maintain emergency response equipment.

SAVER Program knowledge products provide information on equipment that falls under the categories listed in the DHS Authorized Equipment List (AEL), focusing primarily on two main questions for the responder community: “What equipment is available?” and “How does it perform?” These knowledge products are shared nationally with the responder community, providing a life- and cost-saving asset to DHS, as well as to Federal, state, and local responders.

The SAVER Program is supported by a network of Technical Agents who perform assessment and validation activities. As a SAVER Program Technical Agent, the Space and Naval Warfare Systems Center (SPAWARSYSCEN) Atlantic has been tasked to provide expertise and analysis on key subject areas, including communications, sensors, security, weapon detection, and surveillance, among others. In support of this tasking SPAWARSYSCEN Atlantic developed this report to provide emergency responders with information gathered during a market survey of commercially available small platform tactical robots which fall under AEL reference number 03OE-07-ROBT titled Robots.

Visit the SAVER website on First Responder.gov (<http://www.firstresponder.gov/SAVER>) for more information on the SAVER Program or to view additional reports on small platform tactical robots or other technologies.

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1. INTRODUCTION

Small platform tactical robots are typically used for information gathering when deployed to potentially hazardous incidents. Their use allows law enforcement personnel to maintain a safe distance and still obtain valuable data, such as video and audio. Small platform tactical robots may also facilitate communication between law enforcement and those at the center of the incident. To provide emergency responders with information on small platform tactical robots, the System Assessment and Validation for Emergency Responders (SAVER) Program conducted a market survey.

This market survey report is based on information gathered from November 2013 to May 2014 from vendors, Internet research, industry publications, an emergency responder focus group, and a government-issued Request for Information (RFI) that was posted on the Federal Business Opportunities website. For inclusion in this report, the small platform tactical robots had to have a chassis weight of less than of 60 pounds. Robots considered ‘throwable’ (i.e., under 10 pounds and with no articulating arm) are not included in this report.

Due diligence was performed to develop a report that is representative of products in the marketplace.

2. SMALL PLATFORM TACTICAL ROBOTS OVERVIEW

To avoid compromising officer safety, law enforcement agencies may choose to use small platform tactical robots for deployment into potentially hazardous situations while allowing law enforcement personnel to remain at a safe distance. The command control unit (CCU), audio communications, and various attachments (including articulating flippers, articulating arms, cameras, etc.) are some of the key features of these robots.

2.1 Command Control Unit

The CCU, sometimes referred to as the remote control, is one of the most important and highly variable components of a small platform tactical robot system. CCUs can weigh anywhere from a few pounds up to 20 pounds and can be a proprietary handheld unit or a game system-style remote that works in tandem with a laptop computer (Figure 2-1). Software is typically installed on the proprietary handheld unit or laptop and is used to control the robot. In addition, users can view multiple camera feeds as well as additional pertinent data (e.g., audio, robot speed, position of the robot). CCUs often allow for an auxiliary USB or Ethernet connection and/or a video output to provide a remote viewing capability on other monitors or handheld viewers. Most CCUs use rechargeable batteries.



Figure 2-1. CCUs

Images courtesy of Space and Naval Warfare Systems Center (SPAWARSYSCEN) Atlantic

2.2 Audio Communication

Robots may feature one- or two-way communication. One-way communication permits the operator to gain intelligence on a situation by listening in on the robot's immediate surroundings. Two-way communication adds an additional capability, enabling the user to also communicate with people near the robot. Two-way communication may be beneficial when conducting negotiations or when information needs to be communicated to persons in the vicinity of the robot.

2.3 Attachments

Most small platform tactical robots offer a variety of attachments or accessories that add functionality to the device. Accessories and attachments may be included with purchase or available for an additional cost.

2.3.1 Articulating Flippers

Articulating flippers are an additional set of banded tracks that move independently of the main tracks on the robots (Figure 2-2). They may be located in the front and/or rear of the robot. Articulating flippers aid the robot in performing a variety of tasks, such as climbing stairs, crossing uneven terrain, and obtaining a higher perspective of the surroundings. In addition, articulating flippers may assist in preventing the robot from flipping. In the event the robot flips over, articulating flippers may be helpful in righting the robot.



Figure 2-2. Articulating Flippers

Image courtesy of iRobot Corporation

2.3.2 Articulating Arm

An articulating arm typically consists of a series of jointed segments that allow the user to extend and move the arm in a variety of directions (Figure 2-3). When equipped with a camera, the articulating arm enables operators to use the robot to scan the environment and see under and over obstructions. Some articulating arms are also equipped with a gripper, enabling the robot to perform additional functions, such as picking up objects and opening doors. Some systems permit frequently used articulating arm and gripper positions to be programmed on the CCU and the robot will assume the pre-programmed position when prompted, allowing the user to focus on other important tasks. A secondary function of an articulating arm is that it may provide a counterbalance for the robot when crossing uneven terrain and traversing stairs.



Figure 2-3. Articulating Arm Equipped with a Gripper and Camera

Image courtesy of ICOR Technology Inc.

2.3.3 Cameras

All small platform tactical robots come with cameras, though the number, location, and quality often vary. Most robots offer drive cameras, which are typically a lower resolution (i.e., 640x480 pixels) to aid in the navigation of the robot. These cameras are often located on the front, rear, and/or sides of the robot. Several vendors also offer pan tilt zoom (PTZ) cameras (Figure 2-4), which typically attach to the articulating arm and higher resolution (i.e., 976x582 pixels) as well as offer much greater range of motion and thus viewing angles. Visible and/or infrared (IR) lights, as well as cameras with low lux ratings assist in providing useful video of the robot's surroundings when operations are performed in poorly lit conditions. In addition, other camera options offered by some vendors, such as IR and thermal imaging cameras, may also be helpful in low-light conditions.



Figure 2-4. PTZ Camera

Image courtesy of SPAWAR

2.3.4 Firing Mechanisms

Some vendors offer firing mechanisms or a shock tube initiator for use in explosive ordnance disposal (EOD) situations. These typically attach to the robot's articulating arm and can work in tandem with a recoilless disrupter for use on suspicious devices.

3. PRODUCT INFORMATION—VENDOR PROVIDED

This section provides information on eight small platform tactical robots. All of the robots feature color cameras, rechargeable batteries, visible and IR lights, at least one-way audio communication, and are water resistant. Table 3-1 provides general product specifications and the following sections provide product specific information. Product information presented in this section was obtained directly from vendors and their websites. The information has not been independently verified by the SAVER Program. Clarification on certain specifications in Table 3-1 is provided below, listed in alphabetical order:

Articulating Arm indicates if an articulating arm attachment is available.

Camera Location refers to the location of each of the standard cameras and if the camera is a PTZ camera.

Camera Zoom refers to the ratio of the shortest focal length to the longest. Camera zoom is not an indication of image magnification; camera zoom is only indicative of the focal length range.

Robot Battery Runtime (hours) refers to the maximum amount of time the robot can be used before the battery requires charging or replacement.

Table 3-1. Small Platform Tactical Robots Specifications–Vendor Provided

Vendor	Product Name	Camera Location	Camera Resolution (pixels)	Camera Lux Rating	Camera Zoom	Camera Auto-Focus	Articulating Arm	Two-Way Audio Communication	Robot Battery Runtime (hours)	Robot Battery Charge Time (hours)	Training Included with Purchase	Warranty (months)
ICOR Technology Inc.	Mini-CALIBER	Front	976x582	NP		✓	✓	✓	5	4		24
		Rear	976x582	NP		✓						
		Gripper	640x480	NP		✓						
		Mast	1024x768	0.5		✓						
		Articulating Arm (PTZ)	720x480	1.5	10x	✓						
iRobot Corporation	310 Small Unmanned Ground Vehicle (SUGV)	Front	640x480	0.5		✓	✓	✓	6	3		12
		Rear		0.5		✓						
		Chassis		0.5		✓						
		Gripper		1.5	12x	✓						
	510 PackBot	Front Turret	640x480	0.5		✓	✓	✓	8 [‡]	3		12
		Upper Gripper	640x480	0.5		✓						
		Lower Gripper	640x480	0.5		✓						
		Articulating Arm (PTZ)	768x494	1.4	12x [†]	✓						
Macro USA Corporation	Armadillo/EOD V4.5	Front	976x582	0.001		NP	✓		4.5	6	✓	12
		Rear	640x480	0.01		NP						
		Left Side	640x480	0.01	2x	✓						
		Right Side	640x480	0.01	2x	✓						

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Vendor	Product Name	Camera Location	Camera Resolution (pixels)	Camera Lux Rating	Camera Zoom	Camera Auto-Focus	Articulating Arm	Two-Way Audio Communication	Robot Battery Runtime (hours)	Robot Battery Charge Time (hours)	Training Included with Purchase	Warranty (months)
Macro USA Corporation	Scorpion SUGV	Front	976x582	0.001		NP	✓		8	6	✓	12
		Rear	640x480	0.01								
		Left Side	640x480	0.01								
		Right Side	640x480	0.01								
QinetiQ North America Inc.	Dragon Runner 10 (DR-10) Micro Unmanned Ground Vehicle (MUGV)	Front	640x480	0.2		✓	✓	✓	3	NP	NP	12
		Rear		0.2		✓						
		Gripper		0.2		✓						
		Articulating Arm (PTZ)		1.5		40x						
	Dragon Runner 20 (DR-20) Small Unmanned Ground Vehicle (SUGV)	Front	640x480	0.2		✓	✓	✓	5	NP	NP	12
		Rear		0.2		✓						
		Left Side		0.2		✓						
		Right Side		0.2		✓						
		Gripper		0.2		✓						
		Articulating Arm (PTZ)		1.5		40x						

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Vendor	Product Name	Camera Location	Camera Resolution (pixels)	Camera Lux Rating	Camera Zoom	Camera Auto-Focus	Articulating Arm	Two-Way Audio Communication	Robot Battery Runtime (hours)	Robot Battery Charge Time (hours)	Training Included with Purchase	Warranty (months)
Roboteam North America	MTGR (Micro Tactical Ground Robot)	Front	720x480	0.01		✓	✓	✓	4	2	✓	12
		Rear				✓						
		Left Side				✓						
		Right Side				✓						
		Gripper				✓						
		Front (PTZ)			6x	✓						
		Articulating Arm (PTZ)			10x	✓						
Notes: †12x optical zoom, 26x digital zoom ‡Runtime with 4 batteries ✓—robot is equipped with corresponding feature NP—information not provided												

Information in the table is based on data gathered from vendors and their websites from November 2013 to May 2014.

3.1 ICOR® Technology Inc. Mini-CALIBER®

The Mini-CALIBER comes standard with front and rear wide-angle drive cameras; a PTZ camera; a gripper camera; a mast camera; a CCU; front and rear articulating flippers; an articulating arm with gripper; and a 24-month limited warranty. The robot measures 24.0x15.8x9.5 inches without the articulating arm attached and 33.8 inches in length when the flippers are extended. It weighs 40 pounds in the basic configuration and 60 pounds with all standard attachments. The CCU weighs 5.2 pounds (5.7 pounds with 24 Volt (V) EOD firing mechanism) and features a 5.8-inch daylight-readable, anti-glare LCD screen.



A non-proprietary rechargeable lithium-iron-phosphate (LFP) battery powers the robot. The CCU is powered by one non-proprietary, rechargeable lithium-ion battery. The robot is environmentally sealed and is chemical-biohazard washdown safe. Accessories and attachments available for an additional cost include:

- 24 V EOD firing mechanism;
- Water disrupter;
- Shock tube initiator;
- Gripper enhancement kit provides for remote cutting, towing, and extending the articulating arm reach;
- Backpack; and
- Secondary handheld viewer.

Technical support is provided for the life of the product and is available 24/7 by e-mail or phone.

3.2 iRobot® Corporation 310 Small Unmanned Ground Vehicle (SUGV)

The 310 SUGV comes standard with front and rear wide-angle drive cameras; a wide-angle chassis camera; a gripper camera; a CCU; front articulating flippers; an articulating arm with gripper; and a 12-month limited warranty. The robot measures 24x17.2x 9.0 inches without the articulating arm attached, 35.3 inches high with the articulating arm attached and fully extended, and 30.0 inches long when the flippers are extended. It weighs 29 pounds. The CCU weighs 2 pounds and features a 5.6-inch LCD daylight-readable display screen.



One or two BB-2590/U rechargeable lithium-ion batteries power the robot. The CCU is powered by one BB-2590/U rechargeable lithium-ion battery. The robot is environmentally sealed and is chemical-biohazard washdown safe. Accessories and attachments available for an additional cost include:

- Thermal imaging camera;
- Adaptive specialty tool kit containing rakes, probes, and cutters; and
- Various disrupter mounts.

Technical support is provided for the life of the product and is available Monday through Friday, 8:00 a.m. to 8:00 p.m. Eastern Time by live chat, e-mail, or phone.

3.3 iRobot Corporation 510 PackBot®

The 510 PackBot comes standard with a front turret camera; upper and lower gripper cameras; a PTZ camera; a CCU with laptop; front articulating flippers; an articulating arm with gripper; and a 12-month limited warranty. The robot measures 27.0x20.5x7.0 inches without the articulating arm attached and 35 inches long when the flippers are extended. It weighs 24 pounds with no accessories attached. The CCU features a handheld controller that connects to the laptop. The laptop weighs 11.9 pounds and features a 15.1-inch daylight-readable screen that displays two camera views simultaneously as well as a 3-D active model of the robot.



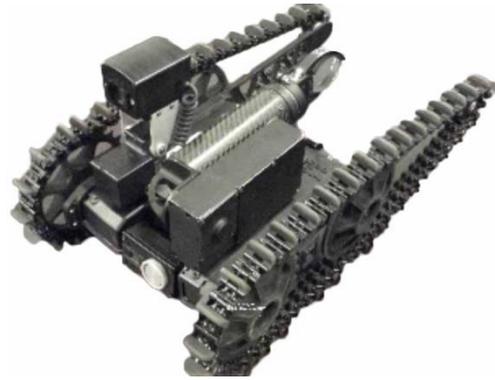
One to four BB-2590/U rechargeable lithium-ion batteries power the robot. The CCU is powered by the laptop that uses a proprietary rechargeable battery. The robot is environmentally sealed and is chemical-biohazard washdown safe. Accessories and attachments available for an additional cost include:

- Thermal imaging camera;
- Wide-angle camera;
- Autonomy package, which utilizes GPS to automatically return the robot to the originating location by retracing its path if communications are lost;
- HazMat detection kit;
- Route clearance kit;
- Mechanical cable cutters; and
- Various disrupter mounts.

Technical support is provided for the life of the product and is available Monday through Friday, 8:00 a.m. to 8:00 p.m. Eastern Time by live chat, e-mail, or phone.

3.4 Macro USA® Corporation Armadillo/EOD V4.5

The Armadillo/EOD V4.5 comes standard with front and rear drive cameras; left and right side cameras; a CCU; a tilt mechanism to assist with traversing rough terrain; and a 12-month limited warranty. The robot measures 22.5x11.8x9.1 inches with the mobility kit attached and 12.6 inches long without the mobility kit. It weighs 15.2 pounds without the mobility kit attached. The CCU weighs 3.5 pounds and features a 5.6-inch daylight-readable LCD color display.



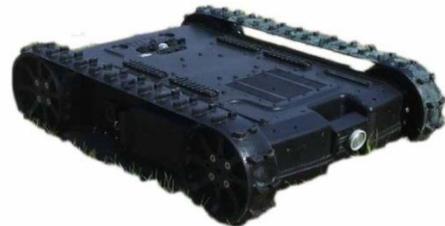
Two proprietary lithium-ion rechargeable batteries power the robot. The CCU uses proprietary rechargeable batteries. The robot is environmentally sealed and is chemical-biohazard washdown safe. Accessories and attachments available for an additional cost include:

- Mobility kit, which includes extended track arms, larger sprockets, and customized track links;
- Stair climbing kit;
- Two-hinged articulating arm;
- Three-hinged articulating arm;
- Thermal imaging camera;
- Color PTZ camera with 10x zoom and auto-focus;
- Upward-looking camera for under-vehicle inspections;
- Mobile DVR for harsh environments; and
- Multiple tactical pouches, slings, and backpacks.

Technical support is provided for the life of the product and is available Monday through Friday, 9:00 a.m. to 5:00 p.m. Pacific Time by e-mail or phone.

3.5 Macro USA Corporation Scorpion SUGV

The Scorpion SUGV comes standard with color front and rear drive cameras; left and right side cameras; a CCU; and a 12-month limited warranty. The robot measures 21.9x19.1x8.7 inches and weighs 28 pounds without the articulating arm attached. The CCU weighs 2.4 pounds and features a 5.6-inch daylight-readable LCD color display.



A proprietary lithium-ion rechargeable battery powers the robot. The CCU is powered by proprietary rechargeable batteries. The robot is environmentally sealed and is chemical-biohazard washdown safe. Accessories and attachments available for an additional cost include:

- Two-hinged articulating arm;
- Three-hinged articulating arm;
- Thermal imaging camera;
- PTZ color 10x zoom auto-focus camera;
- Upward-looking camera for under-vehicle inspections;
- Mobile DVR for harsh environments; and
- Multiple tactical pouches, slings, and backpacks.

Technical support is provided for the life of the product and is available Monday through Friday, 9:00 a.m. to 5:00 p.m. Pacific Time by e-mail or phone.

3.6 QinetiQ® North America Inc. Dragon Runner™ 10 (DR-10) Micro Unmanned Ground Vehicle (MUGV)

The DR-10 MUGV comes standard with front and rear drive cameras; a gripper camera; a PTZ camera; a CCU; an articulating arm with gripper; and a 12-month limited warranty. The robot measures 15.5x13.8x6.0 inches without the articulating arm attached. It weighs 11 pounds with no accessories attached. The CCU weighs 6.9 pounds and features a 6.5-inch display.

An internal lithium-ion rechargeable battery powers the robot. The CCU is powered by one BB-2590/U rechargeable lithium-ion battery. The robot is environmentally sealed and is chemical-biohazard washdown safe. Accessories and attachments available for an additional cost include:

- Thermal imaging camera;
- Disrupter mounts;
- Extended tracks; and
- Small unit sensor system.

Technical support is provided for the life of the product and is available Monday through Friday, 7:30 a.m. to 5:00 p.m. Eastern Time by e-mail or phone.



3.7 QinetiQ North America Inc. Dragon Runner 20 (DR-20) Small Unmanned Ground Vehicle (SUGV)

The DR-20 SUGV comes standard with front and rear drive cameras; a gripper camera; left and right side cameras; a PTZ camera; a CCU; front articulating flippers; an articulating arm with gripper; and a 12-month limited warranty. The robot measures 16.6x12.2x6.0 inches without the articulating arm attached. It weighs 20 pounds with no accessories attached. The CCU weighs 11 pounds and features a 6.5-inch display.



The robot is powered by one BB-2590/U rechargeable lithium-ion battery. The CCU is powered by one internal rechargeable lithium-ion battery. The robot is environmentally sealed and is chemical-biohazard washdown safe. Accessories and attachments available for an additional cost include:

- Thermal imaging camera;
- Disrupter mounts;
- Extended tracks; and
- Small unit sensor system.

Technical support is provided for the life of the product and is available Monday through Friday, 7:30 a.m. to 5:00 p.m. Eastern Time by e-mail or phone.

3.8 Roboteam™ North America MTGR™ (Micro Tactical Ground Robot)

The MTGR comes standard with front and rear drive cameras; left and right side cameras; a second front camera with zoom; a gripper camera; a PTZ camera; a CCU; front articulating flippers; an articulating arm with gripper; and a 12-month limited warranty. The robot is 18.6x18.5x6.5 inches and weighs 19 pounds without the articulating arm attached. The CCU weighs 5 pounds with the battery and features a 7-inch daylight-readable, anti-glare LCD screen.



A BB-2557/U rechargeable lithium-ion battery powers the robot. The CCU is powered by a BB-2557/U rechargeable lithium-ion battery. The robot is environmentally sealed and is chemical-biohazard washdown safe. Accessories and attachments available for an additional cost include:

- Range extender;
- Directional antenna; and
- Glenair® connector, which allows a variety of accessories to be added to the Picatinny rails.

Technical support is provided for the life of the product and is available 24/7 by e-mail or phone.

4. PRODUCT INFORMATION—RESEARCHED

This section provides general product specifications on five small platform tactical robots. None of the robots have an articulating arm attachment available. Specifications presented in Table 4-1 were obtained from Internet and industry publication research. The information has not been independently verified by the SAVER Program.

Table 4-1. Small Platform Tactical Robots Specifications—Researched

Vendor	Product Name	Warranty (months)	Robot Dimensions (inches)	Robot Weight (pounds)	Articulating Flippers	Camera Location	Camera Type	Two-Way Audio Communication	Accessories Available for Additional Cost
Mesa Robotics Inc.	Element	6	30x21x12	40		Front	NP		<ul style="list-style-type: none"> • Payload equipment mount that accepts a variety of sensors, cameras, lights, and tactical tools • Extended length track packs
						Rear			
	Scorpion	6	30x21x12	40		Front	NP		
						Rear			
	G2Bot	3	20.5x13.5x12	25		Front	Color		
						Rear	Black and white		
RoboteX Inc.	AVATAR III Security Robot	12	24.4x15.4x6.1	25	Front and rear	Front	Color	✓	<ul style="list-style-type: none"> • High angle stabilizers, which attach to the robot and allow it to climb up and over steeper inclines • Hitch and trailer • Tactical deployment backpack • Gas and radiation detector mount • Sling for remote control
						Rear			
						Chassis (PTZ)			
	AVATAR III Tactical Robot	12	24.4x15.4x6.1	25	Front and rear	Front	Color	✓	
						Rear			
						Chassis (PTZ)			
<p>Notes: ✓—robot is equipped with corresponding feature NP—information not provided</p>									

Information in the table is based on data gathered from Internet and industry publication research from November 2013 to May 2014.

5. VENDOR CONTACT INFORMATION

Additional information on the small platform tactical robots included in this market survey report can be obtained from the vendors listed in Table 5-1.

Table 5-1. Vendor Contact Information

Vendor	Phone Number	Website/E-Mail Address
ICOR Technology Inc.	(877) 483-7978	http://icortechnology.com sales@icortechnology.com
iRobot Corporation	(888) 776-2687	http://www.irobot.com sales@irobot.com
Macro USA Corporation	(916) 333-5950	http://www.macrousa.com sales@macrousa.com
Mesa Robotics Inc.	(256) 258-2130	http://www.mesa-robotics.com info@mesa-robotics.com
QinetiQ North America Inc.	(781) 684-4000	https://www.qinetiq-na.com contactus@qinetiq-na.com
Roboteam North America	(301) 820-2260	http://www.robo-team.com salesus@robo-team.com
RoboteX Inc.	(650) 838-9191	http://www.robotex.com info@robotex.com

6. SUMMARY

This market survey report provides information on 13 small platform tactical robots. The products differ in the number and location of cameras, availability of articulating arms, audio communication, battery runtime, battery charge time, availability of training, and warranty duration. All 13 of the robots had at least two cameras and a warranty of at least 3 months. Of the eight vendor-verified products, all had at least four cameras on the robot, a 12-month or longer warranty, a battery runtime of at least 3 hours, a battery charge time of no more than 6 hours, and a variety of accessories and attachments. In addition, most had the option of an articulating arm, two-way communication, non-proprietary batteries, training, and technical support availability of at least 5 days a week. More specific information regarding accessories and attachments can be obtained from the vendors.

Emergency responder agencies that consider purchasing small platform tactical robots should carefully consider each product's overall capabilities and limitations in relation to their agency's operational needs.