Tactical Ground Robotics Research and Development at SPAWAR Systems Center Pacific

San Diego, CA

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Unmanned Systems Branch

- 50 Government scientists and engineers
- Unmanned Systems Naval Reserve Unit
- 30 years in unmanned ground, air, and surface vehicles R&D
- Over 30 currently active projects
- Funding from:
  - OSD JGRE, RS-JPO, NAVSEA, PM-FPS, FCS, MANSCEN, CECOM NVESD, ARL, DARPA, DTRA, ONR, NSWG, SOCOM, PM-CCS, REF, and others
- All work products are government owned.

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Business Areas

- Autonomy: developing advanced intelligent behaviors
  - Automatic urban exploration, tip-over prevention, EOD retro-traverse, etc.
- Command and control: simultaneous control of multiple robotic assets
  - MRHA, MOCU (tactical), JBC2S (force protection)
- Perception and visualization:
  - Urban environment modeling, tunnel mapping, terrain characterization, etc.
- Security and force protection: data fusion, intelligent decisions, and command and control of large number of assets
  - Combat Outpost Surveillance and Force Protection System (COSFPS)
  - Joint Force Protection Advanced Security System (JFPASS) JCTD
  - Mobile Detection Assessment and Response System (MDARS)
  - Networked Remotely Operated Weapons System (NROWS)
  - CBRNE and gunfire-detection payloads
- Rapid response: quick-turnaround technology insertion, prototyping, and limited-rate production to meet emerging requirements

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Projects of Interest

- Retro-traverse/autonomy box
- RoboZap
- Tunnel mapping
- Active camouflage
- ISR robot
- Communication relays
- Maritime Interdiction Operations UGV

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JIEDDO Retro-traverse/Autonomy Box

- Controls both *PackBot* and *Talon* robots using the same autonomy box and software
- Supporting NAVEODTECHDIV
- Responding to JUONS-CC0333
- Hosts the Autonomous Capabilities Suite (ACS) software

<u>Demonstrated Behaviors:</u>

- Basic retro-traverse (with or without route optimization)
- Retro-traverse upon loss of communications
- Retro-traverse to rally point
- Retro-traverse to actively moving OCU
- Waypoint navigation
- Human-robot and robot-robot leader-follower
- Interface with *Ahura* chemical detector
- Plug-and-play detection of ladar/*Ahura*/*PackBot*/*Talon*
- Simple installation/field servicing
- Control *PackBot* from *Talon* OCU (running MOCU) with *PackBot* radio

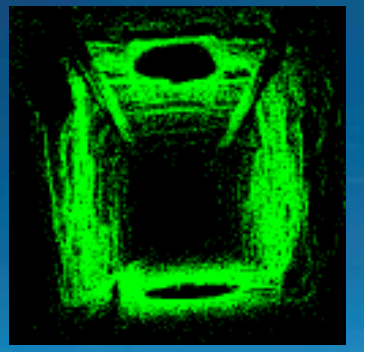
- More kits are being produced for other autonomy research projects at SPAWAR

Tunnel Exploitation, Mapping, and Characterization

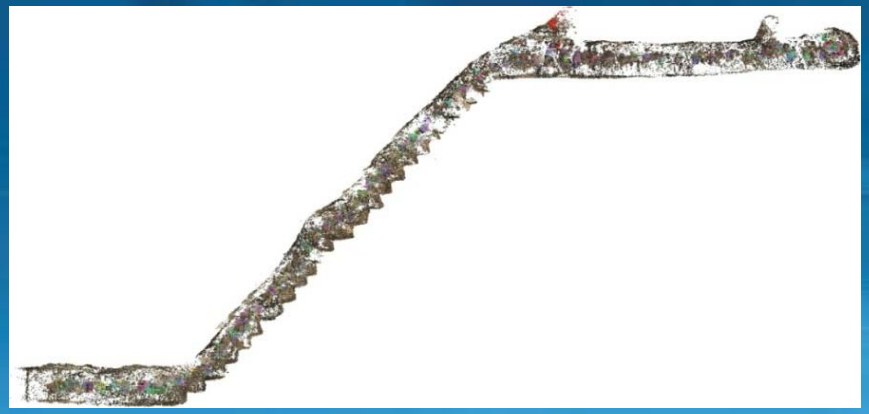
Joint AFRL/SPAWAR project, funded by JGRE

Objectives:

- Develop prototype robotic system (AFRL)
  - Deployable through 20 cm borehole into non-planar, hand-dug tunnels 3 to 30 m in depth
  - Transit up to 800 m round trip
- Map tunnel and generate 3D model (SPAWAR)
  - Localize the entry within 1 m of accuracy
  - Generate 3D model of the tunnel environment for characterization, measurement and analysis



CMU



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Adaptive Electronic Camouflage

- Biologically-inspired “smart skin” adapts to any environment
- Custom camouflage pattern generation
  - o Camera samples environment
  - o Texture synthesis and morphing used to generate seamless pattern


Sample image


Synthesized image


Sample image


Synthesized image


Sample image


Synthesized image

- Uses electronic paper (e-paper) technology
  - o Thin and flexible enough to go around corners
  - o Reflective displays require no backlight
  - o Zero power consumption to maintain image
- DARPA seedling project

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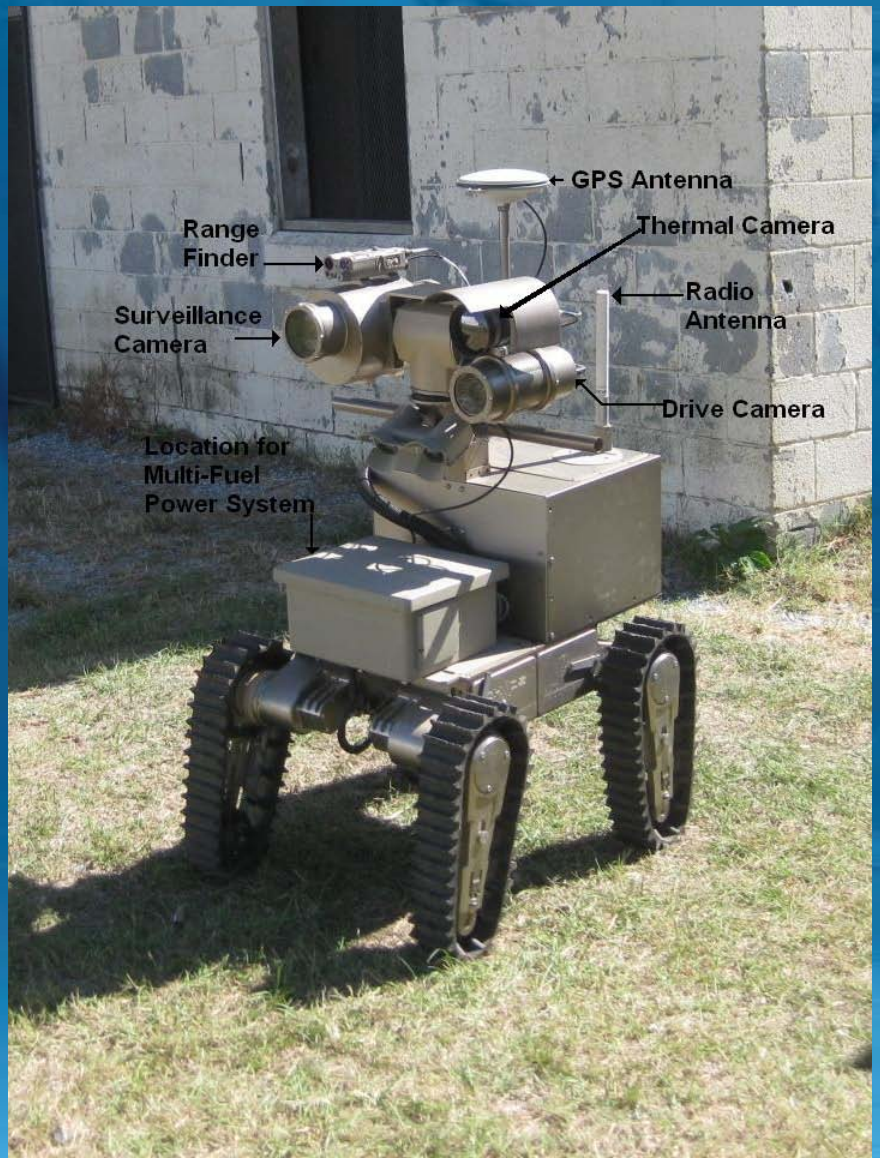
Intelligence, Surveillance, Reconnaissance (ISR) Robot

- Acts as a remote observation post
- Power duration of up to 72 hours using hybrid diesel/electric power system
- Extremely mobile due to availability of four independent articulated tracks (*CHAOS* platform)
- Extended-range communications--2.5km non-line-of-sight through heavy vegetation
- Integrated, configurable sensor suite provides accurate targeting information
- Operator interface has been optimized through several rounds of user feedback
- Recently participated in Exercise Cobra Gold 2012 (Thailand)
- Funded by the JGRE



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Automatically Deployed Communication Relays (ADCR)

Operational Relevance.

- Demonstrates automatic maintenance of high-bandwidth communication link between advancing robot and remote operator.
- Relay deploying module monitors network and automatically ejects relay “bricks” as needed.

First-generation Deployment module

Relay Brick

Technology Development

- Self-righting relay brick with extending antenna.
- Deployment module carrying six relay bricks.

Automatic Payload Deployment System (APDS)

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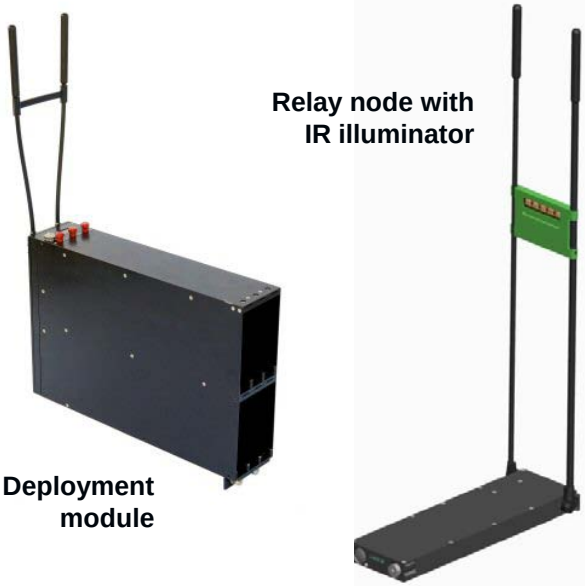
Operational Relevance

- Based on the Automatically Deployed Communication Relays (ADCR) system, funded by the JGRE
- Demonstrates extended range and non-line of sight operations by deploying relaying radios.
- Also allows automatic and manually-controlled deployment of leave-behind sensors.
- Capable of delivering supplies and other payloads, e.g., stand-alone video/vibration sensor, IR illuminator, etc.



Technology Development

- Use of higher bandwidth radios minimizes latency of vehicle response to operator commands.
- Deployment unit can carry variable sized (1x-3x) payloads.
- Modular design allows third-party UGV adaptors and payloads

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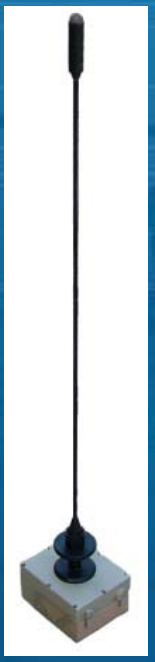
Manually-Deployed Communication Relays (MDCR)

- Supporting NAVEODTECHDIV and RS-JPO in response to JUONS-CC0412
- Provides a Counter Remotely Controlled IED Electronic Warfare (CREW)-compatible communication mesh network using all available nodes
- Allows *PackBots*, *SUGVs*, and *Talons* to relay for each other and to use each other's relay nodes (robots also act as relays)
- Provides more CONOPS flexibility for culvert, urban, and other operations
- Distance between nodes tested at over 2km line-of-sight
- 10 kits for *PackBot* 510 and 5 kits for *SUGV* assessed CONUS and in Afghanistan
- Data package prepared for mass production
- Working on improvements: flexible/foldable antennas and quick-connect forks



PackBot 510 kit

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Maritime Interdiction Operations UGV

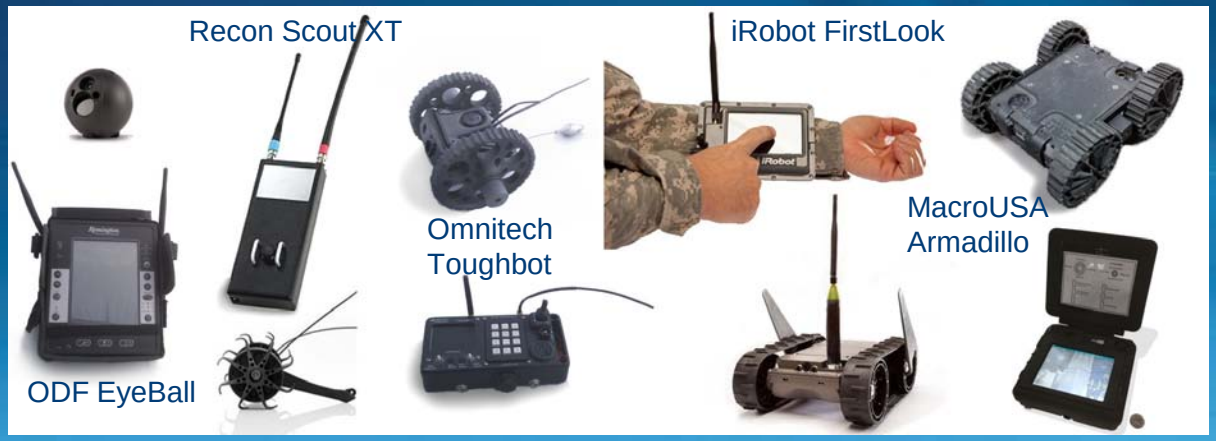
- A throwable UGV for Navy Visit, Board, Search, and Seizure (VBSS) operations
- Funded by the JGRE
- Provide ability to inspect:
  - The target ship's deck before boarding
  - Below deck and ship compartments

Ship-in-a-Box test facility

Approach:

- Perform market survey to identify candidate UGVs for testing
- Perform user tests with Navy VBSS teams to identify ideal characteristics for RFP
- Monitor contract for development of prototypes

Systems tested:



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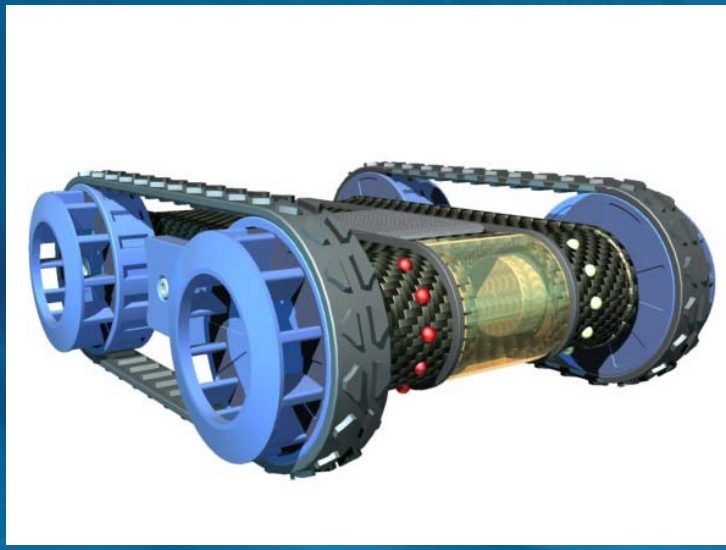
Maritime Interdiction Operations UGV: MacroUSA *Stingray*

Contract:

- Prototype system (OCU and 2 robots) to be delivered July 2012

Some characteristics:

- Small size, fits in a MOLLE-pouch or can be clipped onto a MOLLE vest
- Light weight (under 1.5 Kg)
- Good traction and mobility on dirty ship deck and grating
- Can survive a 5m drop onto a steel deck
- Robot is waterproof (IP67), OCU is splash-proof (IP64)
- Attachment points for rope and telescopic pole
- Simple OCU that allows operation with tactical gloves
- Internal antennas, no protrusions that can get caught
- Bandolier-style strap (no neck strap) for OCU
- Robust communication against jamming
- OCU can operate 2 robots at the same time
- The robot not currently under control provides motion detection and notification to OCU
- Positive buoyancy and ability to drive on water surface
- Strobe distractor and locating aid
- Video and audio sensors; Picatinny rail and power/IO port for additional add-on sensors



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