



Military Robotics



Military Robotics

“Military Robotics” is an overarching category involving a diversity of robotic platforms, possessing a diversity of capabilities, and addressing a diversity of missions

- **UxVs: where x is Air, Underwater, Surface, Ground (on-road, off-road, MOUT, USAR, etc)**
- **$>10^4$ range in size (mass) from micro to maxi**
- **Systems development important**



“Military Robotics” Comprises:

- **UxVs with competent mobility and navigation**
- **Useful sensor and effector (weapons, etc) mission payloads**
- **Competent mission-level behaviors**
- **Integration with the force structure**
 - **Interface -> Interaction -> Interoperability with humans**
 - **Robotic teams and swarms**
- **Tactics and doctrine to exploit robotic strengths, mitigate robotic weaknesses**

Major Labs and Investigators (UAVs)

General Atomics Aeronautical Systems

The RQ-1 Predator is a medium-altitude, long-endurance unmanned aerial vehicle system. It is a Joint Forces Air Component Commander-owned theater asset for reconnaissance, surveillance and target acquisition in support of the Joint Force commander.



Northrop Grumman Integrated Systems.

RQ-4A Global Hawk Unmanned Aerial Vehicle is a high-altitude, long-endurance unmanned aerial reconnaissance system designed to provide military field commanders with high resolution, near real-time imagery of large geographic areas



Major Labs and Investigators (UGVs)

GENERAL DYNAMICS
Robotic Systems



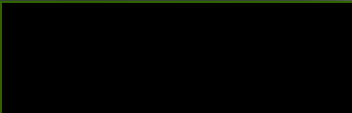
LOCKHEED MARTIN



iRobot *Robots for the Real World*



PackBot products are built on the battle-proven PackBot chassis deployed by U.S. ground troops in Afghanistan (2002) and Iraq (2003).



PackBot #129
Killed In Action
April 8, 2004
Iraq

Major Labs and Investigators (UUVs)



UGVs at Universities

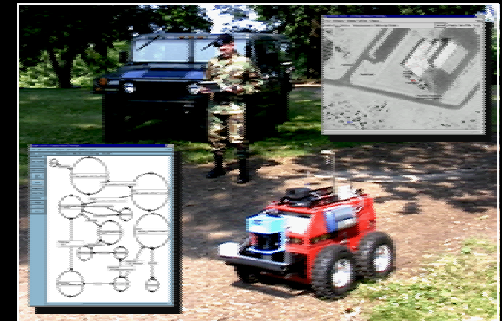
- CMU
 - *Robotics Institute*
 - *National Robotics Engineering Consortium*
 - *National Center for Defense Robotics*
- Georgia Tech
 - *Mobile Robot Lab*
 - *Intelligent Machine Dynamics Lab (IMDL)*
- USC
 - *Interaction Lab*
 - *Embedded Systems Lab*
- MIT
 - *Computer Science and AI Lab (CSAIL)*
 - *Field and Space Robotics Lab*
- And Many More...



NavLab, CMU



Perceptor, CMU



MARS 2020, GT



Cardea, MIT



Multi-Robots, USC

FFRDC and Govt Labs

- ARL - autonomous unmanned recon vehicles, horizontal intel fusion, portable robots
- SPAWAR – air, land, water autonomy, deployment
- Sandia – multi-robot cooperation

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• **Manned Systems**



ICV



C2V



Mounted Combat System



Reconnaissance and Surveillance



NLOS Cannon

Source: U.S. Army



NLOS Mortar

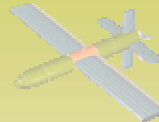
• **Unmanned Air Platforms**



Class I



Class II



Class III



Class IV

• **Unmanned Ground Vehicles**



Armed Robotic Vehicle

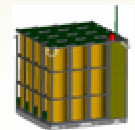


Mule
Armed Robotic Vehicle-Light

• Unmanned Payloads

• Unattended Ground Sensors

• Unattended Munitions
 • NLOS LS
 • Intelligent Munitions



Maintenance and Recovery



Medical Treatment, Evacuation



Army Position on FCS Life Cycle Costs
(FY 03 \$ in Billions)

Appropriation	Amount
RDT&E	\$18.1
Procurement	66.7
MILCON	0.6
Military Personnel	36.7
Operations & Maintenance	25.9
Army Capital Working Fund	1.3
Total	\$149.3



Major accomplishments and practical embodiments in the past 10 years

- **Operational fielding of tactical surveillance AUVs (Raptor, Predator, etc).**
- **Explosion of AUV companies and the creation of an AUV industry.**
- **Operational deployment of Portable Robots (PackBot, Talon)**
- **Future Combat Systems built on concept of Unmanned Ground Vehicles.**
- **UGV development heavily funded by DOD.**
- **Operational fielding of UUV in Persian Gulf for close to shore surveillance and mine clearance.**
- **UUV support and deployment built into Navy's newest littoral combat ships.**



Major unsolved problems and challenges

- **Robust, secure communication links**
- **Safe, long duration, lightweight power storage**
- **Robust autonomous control for tactically significant missions**
 - **Perception for real-world navigation and for mission operations**
- **Mobility in challenging environments (e.g., MOUT, USAR)**



Need System Development strategies as well as Research Breakthroughs

- **Identify the “best” application opportunities (in terms of technical feasibility, payoff, constituency)**
- **Leverage deployment of useful near-term capabilities to accelerate long-term development of advanced systems**
- **Exploit machine learning and adaptation**



Research Goals

- **AUVs: Safe navigation and transit over densely populated civilian areas in the presence of other air traffic.**
- **UGVs: Robust autonomous navigation through operationally significant terrain (cities, forests, mountain paths, etc).**
- **UGVs: Tactical mission planning and execution in a dynamic environment.**
- **UGVs: Better power and communications.**
- **UUVs: Improved autonomous navigation in a near off-shore environment.**
- **UUVs: Better power and communications.**

Major accomplishments in other countries

Hermes 450 (Israel)



Guardium - Autonomous
Security Vehicle
IAI/Lahav (Israel)



*UUV: Hugin 3000 AUV.
Norway*





International cooperation

- **Research on power systems and long range secure communications.**
- **Research on 3d vision, multi-spectral camera systems and sound localization systems.**
- **Research on dense, shock hardened computer systems.**