



TARDEC Ground Vehicle Robotics

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U.S. ARMY TANK AUTOMOTIVE RESEARCH, DEVELOPMENT AND ENGINEERING CENTER (TARDEC)

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Ground Vehicle Robotics (GVR) Mission

Provide Transition-Ready, Cost-Effective, and Innovative Robotics and Control System Solutions for Manned, Optionally-Manned, and Unmanned Ground Vehicles, driven by War Fighter Requirements, through Advanced Technology Research, Development, Experimentation, and System Integration



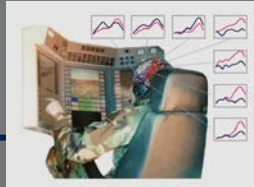
The Birthplace of Army Ground Robotics

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TARDEC Robotics



Transition

Requirements

Concepts

Analysis

Component Development

Component Testing

System Integration

Virtual Proving Ground

Vehicle Testing/Demo

Supporting the Current Force

Concepts → M&S → OEF/OIF



Local SA
Aerial SA
Interface



Pointman-Alpha



Mini Ripsaw

Pointman-Bravo

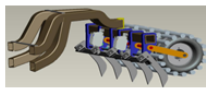


HDT Platform with Flail

Pointman-Charlie



Seaway RMP



TARDEC Countermine Roller



Enabling the Future Fight



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GVR Activities

Outreach & Universities



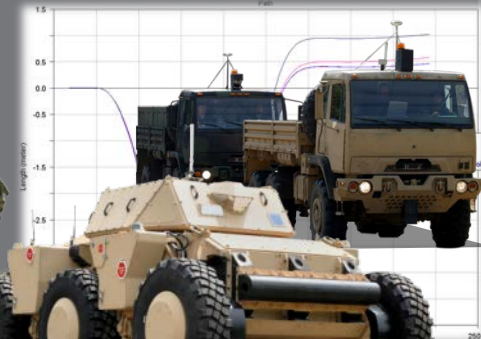
Shaping Requirements



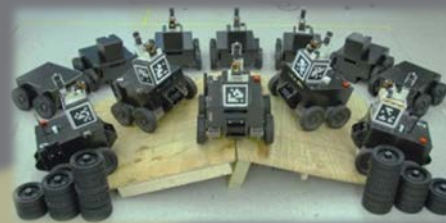
Automotive OEMs and Suppliers



System Analysis & Prototypes



International



Building M&S Capability



Component Development



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GVR Facilities

Robust – Unique

Laboratory Capabilities

- Robotics VSIL / Modeling and Simulation

Autonomous Behaviors
Safety System Virtual Test
Perception Algorithms
Localization Algorithms
Active Safety Algorithms
HMI Algorithms
Hardware/Software in-Loop

- GVR Robotic Development Laboratories

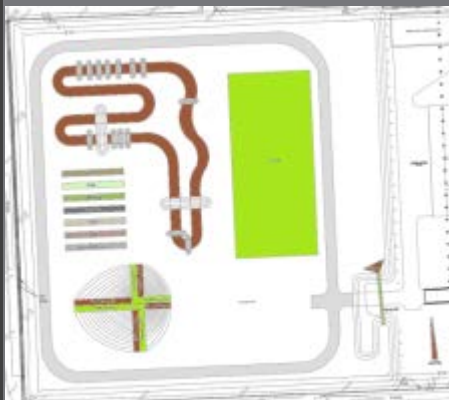
360 Situational Awareness Lab
Crewstation Laboratory
Robotics Applique Development
Small Robot Integration
Large Robotic Platform Integration

- Robotics Development Environment

Obstacle Course
- Culvert, Rubble Pile, Switchbacks
- Gap Crossing Pit (Water optional)
- Multiple terrain strips
- 15%, 20%, 25%, & 30% Grade Hill

- Future Test Facilities at Grayling

Robotic Autonomous Test Track



Robotics Laboratories and Prototype Integration



Small Robotic
Development and
Integration
Laboratory



Large Robotics
Development and
Integration
Laboratory



Sensor / Display / HRI
Development



Software and Algorithm
Development

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Enabling Capabilities



Pedestrian/Vehicle Detection, Classification, & Tracking



Dynamics of Distributed Role Allocation in Teams



Autonomous Moving Object/Complex Terrain



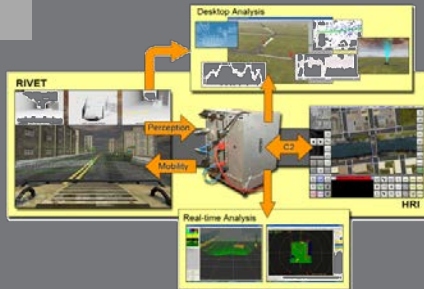
Collaborating Socially, Organizationally & Culturally



Terrain Classification Technologies



Autonomous Complex Dexterous Manipulation



Modeling & Simulation



Interactively Understanding Situations, Contexts, and Activities

Faster movement and terrain feature mapping through real-time adaptive learning



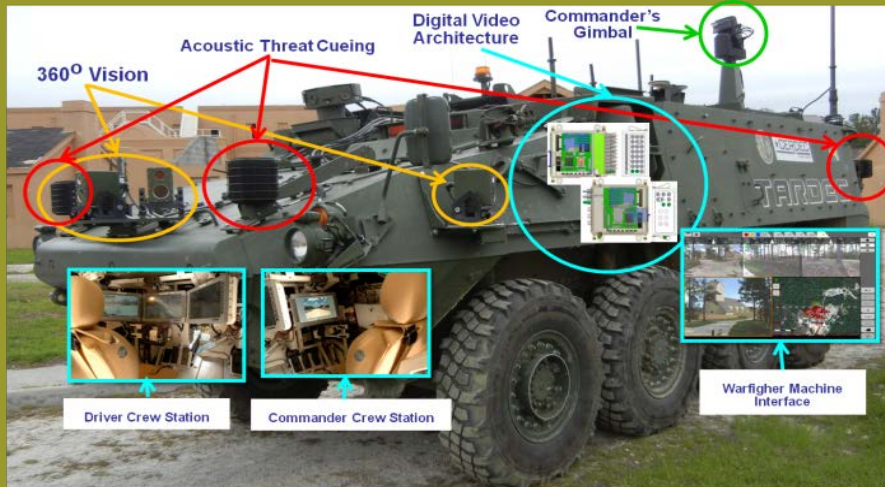
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Enabling Technology Programs

Increased Mobility and Operational Performance through Autonomous Technologies (IMOPAT)



Provide visual local situational awareness (LSA) thru electro-optic indirect vision (EOIV) technologies during manned and unmanned platform operations

Safe Ops of Unmanned Systems for Reconnaissance in Complex Environments (SOURCE)



Autonomous Mobility Appliqué System (AMAS) - JCTD

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Safe Operations & Autonomous Platform Demonstrator (APD)



Safe Ops

'Rules of the Road', structured environments

APD

Off-road mobility, unstructured environments



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Robotic Convoy Operations

Convoy Active Safety Technologies (CAST) *Driverless technology for military trucks*



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The Robot is a Member of the Unit

Understand the mission

- Receive and correctly interpret orders
- React to changing situations

Understand the environment

- Recognize “rubble pile by lamppost”
- Observe person fleeing checkpoint
- Spot suspicious activity near intersection

Move in a tactically correct way

- Move downrange to IED – and return
- Check intersection before manned units pass through it
- Maintain tactical integrity moving through urban environment

Communicate clearly & efficiently

- Ask for assistance when needed
- Report salient activity – e.g., insurgent entering building, fleeing checkpoint

Perform missions

- Monitor activity at checkpoint
- Navigate autonomously to combat outpost
- Inspect and neutralize IED
- Perform ISR in urban setting



Able to function in a world designed for humans, to grasp small objects, to open doors, to carry the wounded, etc.

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Optionally Manned Vehicles



X-by-wire kit

Autonomy kit

Electronic
Architecture

Driving functions only

2 modalities

Human in vehicle

(i.e. shared driving)

Human NOT in vehicle

(i.e. remotely operated)

invariant across all missions for OMV

Mission
Payloads

OMV can be driven by a soldier;
OMV can drive a soldier;
OMV can be remotely operated;
OMV can be autonomous



Manned Vehicles

Optionally Manned Vehicles



Unmanned Vehicles

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Ground Robotics Opportunities

Robotics benefits...

- Robots can extend the reach of the soldier
- Robots can reduce the load of the soldier
- Robots can go into some dangerous places
- Robots are better at doing some tasks

Moving beyond current **'fielded'** mobile ground robotics...

- Mission effective capabilities beyond remotely controlled or tele-operated
- Ease of control; language/hand signals instead of laptops and game controllers
- Robots that maintain operational tempo in almost all environments
- Robots that are inexpensive and have reliability levels approaching automotive standards
- Intelligent robots that communicate their intention to testers and users
- **Showing soldiers that robots and unmanned systems are safe, reliable, and can ease their burden and can save their lives!**

