

BAE SYSTEMS	Unclassified	Approved for Public Release; Distribution Unlimited
GENERAL DYNAMICS Robotic Systems	Survivability on the ART Robotics Vehicle	
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Outline	BAE SYSTEMS	 TARDEC
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▪ ART Program ▪ Sensor Configuration ▪ Anti-Tamper ▪ Intent Analysis (Visual and IDS system) ▪ Countermeasures (Tactical Behaviors)		
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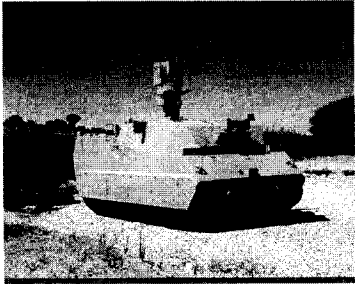
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Armed Robotic Technology (ART) Platform





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Purpose:
Advance the state of the art in unmanned platform technologies to achieve FCS ORD Objective capabilities of UGV systems.

Product:

- Enhanced Semi-Autonomous Mobility Suite
- Integrated Tactical/Mission Behavior System
- Increased Platform Maneuverability
- Survivability Technology/Devices/Payload

Payoff:

- Reduced soldier burden/interaction
- Improved semi-autonomous operation in adverse weather and urban/complex terrain.
- Tactical behavior incorporated into semi-autonomous maneuver.
- Increased mobility over rough terrain.
- Increased soldier survivability using unmanned systems.
- Reduced risk to FCS ARV and MULE

Schedule

MILESTONE (FY)	05	06	07	08	09
• Develop ARV Technologies	████████████████████				
• Develop UGV Mobility M&S Suite	████████████████████				
• Analyze UGV Vulnerabilities and develop countermeasures	████████████████████				
• System Integration and Test		██████	██████	██████	██████
• Conduct Warfighter Experiments and Evaluations			◆	◆	

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ART Sensors





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- Intrusion Detection System (IDS) Radar
 - FM/CW
 - FOR: 100m X 360deg H X ±30deg V
- RSTA
 - Visible, NIR, IR, LRF
 - FOR: 360deg H X 30deg V
 - ATD/AiTR
- Autonomous Mobility System (AMS)
 - Visible, NIR, IR, LADAR
 - FOR: 100m X 360deg H

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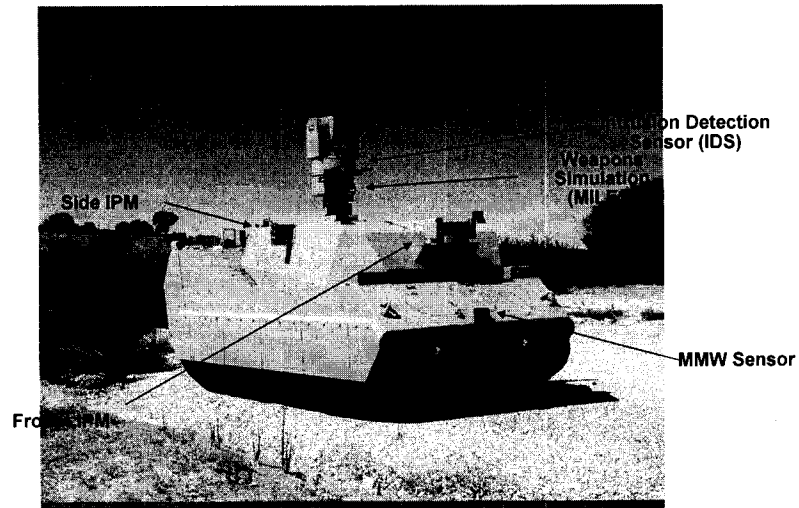
ART Sensor Configuration

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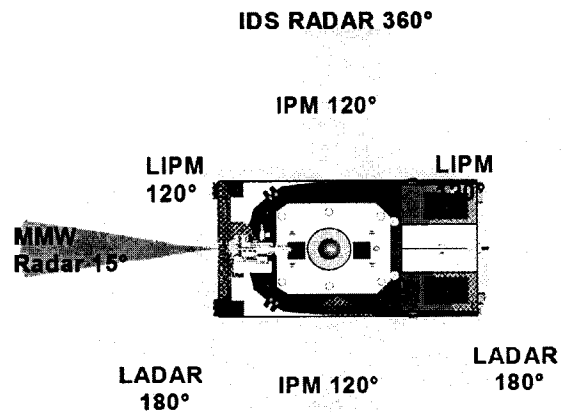
ART Sensor Coverage

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Anti-Tamper

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- **What is “Anti-tamper” protection?**

For ART: Anti-tamper refers to a system that determines the threat of an approaching person and actions to avoid the threat. It does NOT imply the ability of systems to be rendered useless (as traditionally defined).

- **Anti-tamper for the ART platform uses Visual Intent Analysis and IDS Radar.**

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Intent Analysis - Visual System

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- **Visual Intent Analysis framework**

- Uses pedestrian detection/tracking to determine and track people as differentiated from other objects.
- Classifies the intent of the people based on movements.
- Hostile intentions trigger countermeasures (tactical behaviors).

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Visual Intent Analysis - Pedestrian Detection/Tracking

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- Uses stereo infrared and color cameras to identify people and track them using disparity mappings, color blob analysis, and body positions.
- Tracks people through occlusions.

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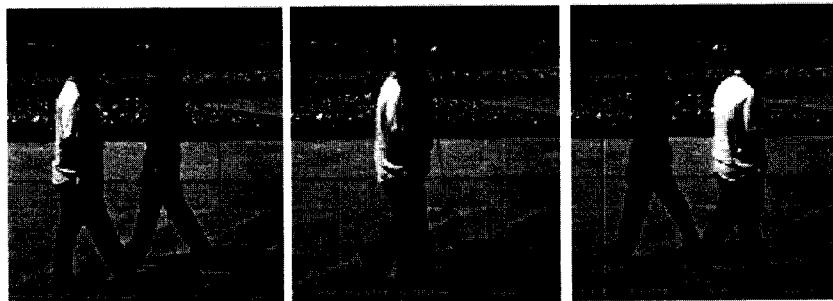
Visual Intent Analysis - Pedestrian Detection/Tracking

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Visual Intent Analysis - Determining Intent Visually

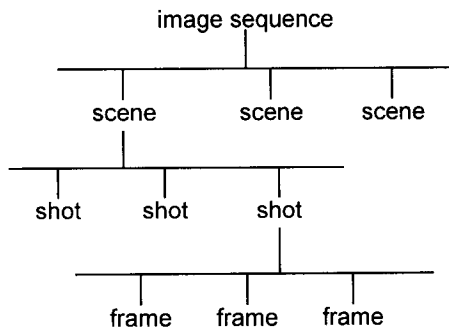
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Video data hierarchy



Scenes: Global content and Intent.

Shot: Objects and object relations, motion, and locations of objects

Frames: Low level – color, texture, and shape.

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Visual Intent Analysis - Identify the Scene

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- Identifying the scenes (and shots) requires a well defined feature space.
- Usually requires color and motion.
- Basically, we are trying to find major changes in the image sequence.

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Visual Intent Analysis - Identify the Scene

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Modeling Scene into Simple Verbs

- From identifying and tracking the objects in the scene, we can determine their actions and their relationship with each other.
- Examples of simple verbs are: pickup, putdown, move, touch, etc.

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Visual Intent Analysis - Identify Intent of the Scene

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- Once each object is modeled, thus the scene is modeled, we can identify the intent based on prior information.
- Example: The intent of a person (O1) picking up an object (O2) and moving it to another location would be observed as: *O1 moves. O1 touches O2. O1 moves. O2 moves. O1 un-touches O2. O1 exits.*

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Intent Analysis -IDS Radar

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- Determine intruder motion
 - Range, range rate, bearing
 - Crawling, walking, running
 - Intruder tracks
- Used by the AMS to identify potential threats
- Future UGV systems may use this in conjunction with the FCS Common Operating Picture (COP).

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Countermeasures (Tactical Behaviors)

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- Layered Response
 - Dependent upon threat level as determined by intent analysis
- Responses
 - Aural warning/High-intensity spotlight
 - Start/Rev engine
 - Move away
 - Move toward
 - Point gun
 - Shoot (MILES)

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Conclusion

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- ART Survivability utilizes several key sensors to protect itself from hostile intentions by people – called Anti-tamper.
- Anti-tamper uses both visual (Visual Intent Analysis) and radar (IDS Radar) to determine intentions of possible hostiles.
- Anti-tamper will be demonstrated in two user experiments (Jun-07, and Feb-09).

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Questions ???

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