2011-07

A-MATS: Autonomous Mobile Adversarial Target System, USMC Sniper Live-Fire Training

Becker, Bill; Davis, Duane

https://hdl.handle.net/10945/44368

A-MATS: Autonomous Mobile Adversarial Target System

USMC Sniper Live-Fire Training

Bill Becker, Ph.D.
CDR Duane Davis, Ph.D.

MOVES Research and Education Summit 2011

Session 6
13 July 2011

Ph: 831-656-7980
Email: dtdavi1@nps.edu
http://movesinstitute.org

Outline

- Project overview and objectives
- Currently available options
- Proposed system
  - Physical components
  - Software
  - Capability milestones
- The bigger picture
  - Formal testing
  - Related projects

A-MATS Objectives

- Research objectives
  - Advance the fundamental science and engineering in implementing autonomous target systems for use in live-fire infantry training
  - Demonstrate the utility of generalized training robotic system that links performance monitoring to customized training interventions with predictable training transfer
- Military relevance / operational impact
  - Reduce instructor workload, improve throughput
  - Increase training for complex scenarios
  - Reuse current training ranges without costly reconstruction

Sniper Training Requirements

- Moving targets
- Limited exposure time
- Live fire
- Realtime feedback
- Realistic behavior
- Individual & team tactics
- Flexible scenarios

Currently Available Options

- Simulators
  - Varying degrees of realism and complexity
  - Realtime feedback
- Laser-based systems
  - Human-based scenarios
  - Portable & scalable
  - Realtime feedback
- Robotic systems
  - Tailorable scenarios
  - Potential for live fire training
  - Realtime feedback
  - Limited live-fire options
  - Evaluation limited by underlying models

A-MATS Component Overview

<u>Mobility System</u>

Multi-vehicle

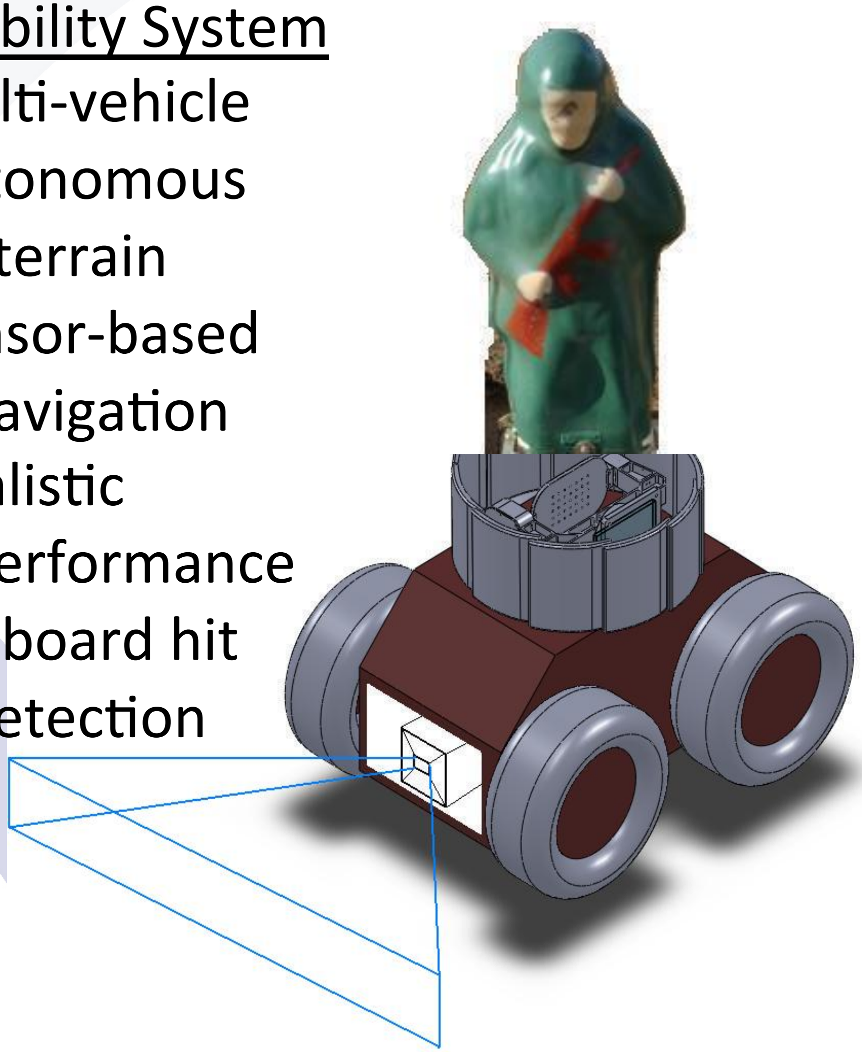
Autonomous

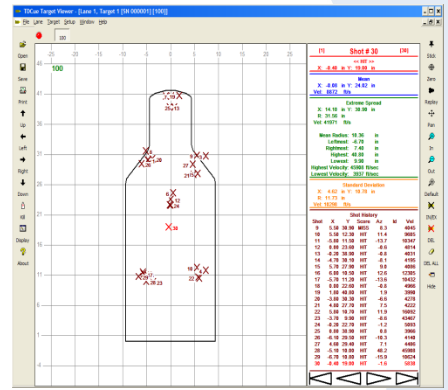
All terrain

Sensor-based navigation

Realistic performance

On board hit detection





<u>Runtime Support</u>

Training scenario development

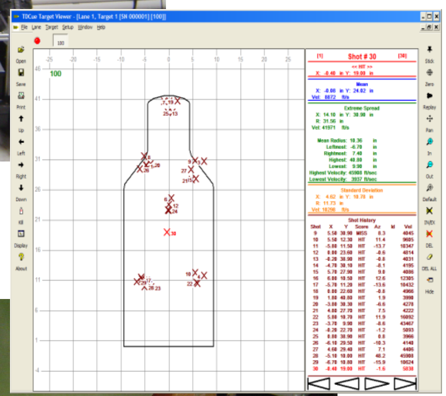
Realtime feedback and evaluation

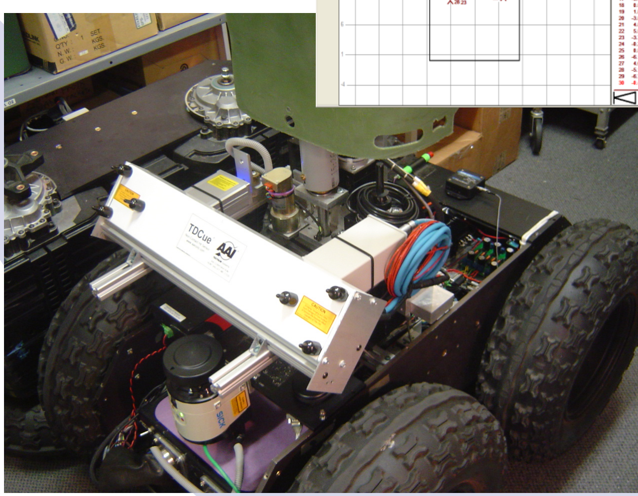
Logging and playback

The RMP400 Platform

- Characteristics
  - 0-18 mph
  - 400 lb payload
  - All terrain
- Onboard systems
  - PC-104 computer
  - SICK LMS-111 LIDAR
  - Garmin GPS
  - Microstrain 3DM IMU
  - 802.11g communications

Mission Systems





- 3-DOF gyro-stabilized target
- TDCue Fire Point non-contact target scoring system
- GUI-based mission-support software
- Category IV armor

System Characteristics

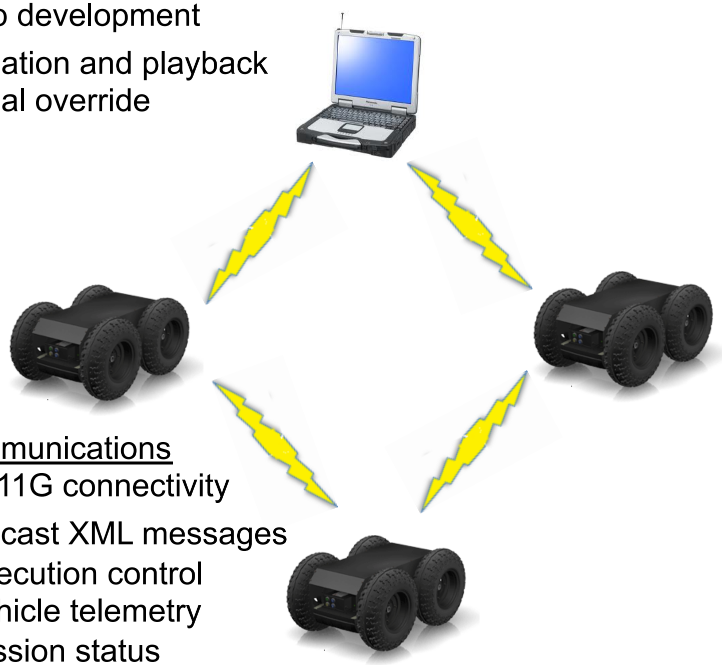
Mission Control

Mission Definition
- Static script
- Coordinated waypoints
- Team goals
- Map development

Evaluation and playback

Manual override

Mission execution
- Mission / map push to vehicles
- Monitor Progress
- Results pull from vehicles



Autonomous Vehicle Execution

Sensor-based navigation
- Two-layer EKF
- GPS, odometry, laser, map

Run-Time Mission Control
- Waypoint sequencing
- Goal decomposition / planning
- Collaboration and coordination
- Path planning
- Obstacle detection/avoidance

Mission system
- Hit detection
- Event reporting / logging
- Target gimbal control

Communications

802.11G connectivity

Multicast XML messages
- Execution control
- Vehicle telemetry
- Mission status
- Training events

TCP/IP
- Mission and map push to vehicle
- Mission results pull from vehicle
- Manual control override

Development Milestones

Hardware

- Robot platform *Complete*
- Navigation systems *Complete*
- Comms systems *Complete*
- Hit detection *Complete, in Testing*
- Gimbal system *In Development*
- Armor *In Development*
- Swappable sensor and instrument packages *Future Work*

Software

- Mission control *In Development*
- Control and navigation *Complete*
- Communications *Complete*
- Path planning *Complete*
- Goal decomposition *Partially Complete*
- Coordinated control *Partially Complete*
- Team behaviors *Future Work*
- Tactical response *Future Work*
- SLAM *Future Work*

Formal field experiment scheduled for August 2011

Field Testing

- USMC Sniper School
- Pre and post training test
  - Two robots, two shooters
  - Multiple firing lane passes
  - Targets hidden between passes
  - Various ranges
  - Same test for all participants

Collaborators

- A-MATS contributors
  - ONR and the Marine Corps Warfighting Laboratory
  - Synbotics
  - Cal Poly, San Luis Obispo
- Related projects
  - Marine Corps Small Arms and Marksmanship Training (NPS)
  - Smart Tutoring System Supporting Skill Acquisition and Retention: Moving Target Tutor (Penn State)

Small Arms & Marksmanship Training

OBJECTIVES:

- Improve marksmanship skills acquisition/sustainment by developing automated assistance capability for coaches and students.
- Demonstrate the utility of a generalized training system model that links performance monitoring to customized training interventions with predictable training transfer

MILITARY RELEVANCE/OPERATIONAL IMPACT

- Reduce workload on instructor/coach, improve throughput
- Increase cognitive shooting training capability
- Improve marksmanship scores, decrease time to qualify
- Decrease live fire re-shoots (save ammunition)
- Increase training for complex environments (moving targets)

NAVAL S&T FOCUS AREAS ADDRESSED:

- Naval Warfighter Performance
- Affordability, Maintainability and Reliability
- Distributed Operations

TECHNICAL APPROACH We will show that:

A. Marksmanship is a decomposable task
B. Task components can be identified via a task analytic approach
C. Task components map to sensor packages
D. Sensor packages can be aggregated into individualized training systems that will impact skill acquisition and sustainment.

To accomplish this, we will follow this approach:

1. Task analysis based on common practices and training methods will identify elements of the task used in coaching (trigger pull, breath control, sight picture, etc.)
2. Map coaching elements to sensors (e.g. cameras, pressure sensors)
3. Develop "swappable" sensor packages leveraging prior work (CRESST instructional model funded by DARPA)
4. Lab study and field testing to verify results and instructional model
5. Generalize methodology and instructional model to new domains

PERFORMERS: MOVES/NPS, NAWCTSD, UCLA/CRESST

SCHEDULE:

TASKS	FY10	FY11	FY12	FY13
Concept exploration, TA, System design				
System integration w/ Coaching Tool				
Experimentation and field test				
Report and documentation				
Transition to PMTRASYS				

TTA: PMTRASYS (preliminary)
Tech Transition Path: WTBn, TECOM (Requirement), PMTRASYS (Acquisition)

A Smart Tutoring System for Moving Target Marksmanship

OBJECTIVE

- Understand knowledge acquisition and its decay to make skills more robust against forgetting
- Application of theory to a fundamental Marine Corps task -- shooting moving targets

MILITARY RELEVANCE/OPERATIONAL IMPACT

- A fundamental theory-based understanding of skill retention that can be applied to design and implementation of all Navy training (e.g., real-time procedural skill training), leading to
  - Better predictions of warfighters' performance and future performance
  - Optimization of training resources (e.g., determination of when to train/retrain and how to train)

NAVAL S&T FOCUS AREAS ADDRESSED

- Warfighter Performance & Protection

HYPOTHESIS

Does using a task analysis and a 3-phase learning theory lead to a better Moving Target Tutor based on live fire testing at Quantico?

TECHNICAL APPROACH

- Develop and test a learning theory (3 phases—declarative, mixed decl. & procedural, and primarily proc.)
- Suggest factors to mitigate skill decay based on the model
- Create a Moving Targets Tutor (not fully resourced, 41/299)
- Test tutor at Quantico with live fire study (2011)
- Modify tutor to adapt to learners based on theory (2011-2012)

PERFORMERS

The Pennsylvania State University

SCHEDULE:

Tasks	FY10	FY11	FY12
Refine model			
Implement. Embody, and test a cognitive model of learning			
Create tutor(s) based on model			
Test, deploy tutors			

TTA: Frank Ritter, frank.ritter@psu.edu

TECH TRANSITION PATH: Into a tutor(s)

Questions?