Diverse Sensing for Synergistic Protection in Urban Threat Environments

Demonstration Results

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29 April, 2010

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**2010Diverse Sensing for Synergistic Protection in Urban Threat Environments Demonstration Results**

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Sponsoring Agency:
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Distribution/Availability:
Approved for public release, distribution unlimited

Supplementary Notes:
The original document contains color images.
Objective

- Show reasonable time, automated algorithm performance of pre-shot cueing algorithm on live, blind test collected data
Automated Detection Algorithm Flow Diagram

**Processed RADAR Data**
- Automatic detection and location of walls *
  - front wall
  - back wall (if poss.)

**Auxiliary Information** *
- Target ensemble
- Building practices

**Nonparametric Detection Algorithm**
- Derived from training data
- Weighted classification trees
- Estimate a posteriori probs for each target
- Decision logic/thresholding for final target/no target decision *

**Spectral processing of range profiles**
- Filtering
- Normalizing energy
- Spectral estimation *

**Determine processing window**
- offsets for front wall
- offsets for back wall or using building practices

**Compute principal components (PC)**
- Derived from training data
- Done for each target
- Sliding window
- Range of stretch factors *
- Utilize best match (for each target)

**Declare:** “Target” vs. “No – Target”

Target Classification

* Corresponds to a significantly new component for this program
Demonstration Location

- Ft. Pickett MOUT site
- Deployment at ‘Warehouse building’ (T9)
- Processing/display at ‘Schoolhouse’ building (T2)
MTRIs Rotating Antenna Stage

- Antenna head mounted on adapter for servo-controlled rotation stage
  - provides estimates of antenna azimuth

  Collection used continuous rotation rate of 0.2 °/s with frequency sweep rate of 2 Hz
  - emulates a rotating antenna at 200 °/s with 2 kHz frequency sweep rate
Demonstration Structure

- Azimuth scan on single building
  - Set up time too long to move, re-align instrumentation system

- Confusers/targets need to remain ‘still’ during illumination
  - Long sweep time of instrumentation radar (100 msec) and short wavelength (3mm, W band) make data susceptible to scintilation and smear
  - Field operational Radars have much faster sweep times (<100usec) which will effectively ‘freeze’ signatures

- Targets will be > 1 foot behind plane of walls
  - EO system will see threat if exposed at opening

- Radar and target will have direct line of site and have weapon pointed at Radar
  - Threat is defined as weapon pointed at vicinity of Radar
Measures to Mitigate Scene Motion

- Long chirp time (100ms) and non-uniform filter transition time coupled with small wavelength (W band) creates phase anomalies in moving targets.

- Used monopods in Demo to mitigate PRF spoilage due to range-relative target motion.
• Scan set #1
  – False alarm testing
    • Scan #1: building with confuser targets
      – Empty rooms, people, people with implements
        » Positioning of people determined on site with government
    • Scan #2: completely empty building, shutters open
    • Scan #3: empty building with shutters closed

• Inspection of processing results

• Scan set #2
  – Detection testing
    • 3 Scans
    • 4 Weapons
      – RPG-7, Dragunov, AK-47, AR-10
    • Positioning of target determined on site with government
    • Confusers added as resources permit
Demo April 2010
Detection Results

- Demo performed under TARDEC supervision
  - TARDEC chose deployment scenarios in real time

- Deployment of weapons and confusers under control of TARDEC
  - Weapons: RPG, Dragunov, AK-47, AR-10
  - Confusers: Person, person with tripod, person with broom
  - 6 building scans: 2 empty building, 4 with weapons/confusers

- Automated detection system
  - Data moved from collection system to detection system via data stick
  - All parts of detection system were automated

- Demo handled as a blind test
  - Truth was not used during testing, only for display purposes
Demo April 2010
Detection Results – tp9037

Scenario
Empty building, shutters open

Munitions
• None

Confusers
• None

Results
• No false alarms

Building
Front Wall
Inner Back Wall
Outer Back Wall

RADAR Data

Sweep Number →

Declarations

Target

Clutter

Sweep Number →
Scenario

Empty building, people as confusers

Munitions
- None

Confusers
- Person

Results
- No false alarms
Deployed Persons
Demo April 2010
Detection Results – tp9039

Scenario
Empty building, shutters closed

Munitions
• None

Confusers
• None

Results
• No false alarms

RADAR Data

Sweep Number

Target

Clutter

Sweep Number
Scenario

Munitions
• Dragunov
• RPG
• AK47
• AR10

Confusers
• Person with Tripod

Results
• RPG, AK47, AR10 detected as weapons
• Dragunov was missed
• Person+Tripod was not a false alarm

Notes
• Dragunov was in back room, outside search area
Deployed Persons

Confuser targets aimed at RADAR

AR-10 in prone position aimed through kill hole
Scenario

Munitions
• RPG
• AK47
• AR10
• Dragunov

Confusers
• Person with Tripod

Results
• RPG, AK47, AR10, and Dragunov detected as weapons
• Person+Tripod declared as clutter
Deployed Persons

Confuser targets aimed at RADAR
Scenario

Munitions
- Dragunov
- AK47
- RPG
- AR10

Confusers
- Person with Tripod
- Person with Broom

Results
- Dragunov, AK47, RPG, and AR10 detected as weapons
- Person+Tripod declared as clutter
- Person+Broom declared as clutter

Notes
- AK47 and Dragunov in same room

Demo April 2010
Detection Results – tp9042

RADAR Data

AK47 + Dragunov
RPG
Person + Tripod
Person + Broom
AR10

Declarations
Deployed Persons

Window 1 had 2 weapons (AK-47 and Dragunov)

Dragunov in prone position aimed through kill hole
### Summary: Algorithm Declarations

#### Clutter Test, Windows Open

<table>
<thead>
<tr>
<th>Window 1</th>
<th>Window 2</th>
<th>Window 3</th>
<th>Window 4</th>
<th>Window 5</th>
<th>Window 6</th>
<th>Window 7</th>
<th>Window 8</th>
<th>Window 9</th>
<th>Window 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clutter Test, Windows Open</td>
<td>Person</td>
<td>Person</td>
<td>Person</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Person</td>
<td>Person</td>
</tr>
</tbody>
</table>

#### Clutter Test, Windows Closed

- Detect Test 1
  - Dragunov
  - RPG
  - Person + Tripod
  - AK47
  - AR10

- Detect Test 2
  - RPG
  - Person + Tripod
  - AK47
  - AR10
  - Dragunov

- Detect Test 3
  - AK47 + Dragunov
  - RPG
  - Person + Tripod
  - Person + Broom
  - AR10

#### Detection

- All weapons within search range of system were detected
- No false alarms
- Automated algorithm used 4 minutes for declarations (non-real time code)

#### Missed Detection/Outside Search Area

- Correct Declaration
- Incorrect Declaration

#### False Alarm

- Confuser