Characterization of the Optical Computer Aided Training (OCAT) system: Novel application of a training aid for small arms human performance research and development

Frank Morelli¹, Thomas C. Fry¹, William D. Ludwig² & Douglas J. Struve¹
U.S. Army Research Laboratory (ARL), Human Research and Engineering Directorate (HRED), Dismounted Warrior Branch (DWB)¹
and
Sensors and Electron Devices Directorate (SEDD), Acoustic, E-field and Electromagnetic Sensing Branch²
ARL HRED Dismounted Warrior Branch (DWB)

- Basic/applied research and development
- Human performance and human factors assessment
  - small arms weapons systems
  - target engagement, marksmanship
  - biomechanics, Soldier worn/carried equipment

Characterization of the Optical Computer Aided Training (OCAT) system

- Purpose
  - Target engagement scoring during small arms assessments and experimental trials
- Metrics
  - Location of miss and hit (LOMAH) vs. hit/miss only
  - Performance comparison with alternate methods
  - Subsonic, high rate of fire applications
Optical Computer Aided Training System (OCAT)

- Training aid for civilian shooting sports market
  - Adapted for experimental data collection

- Components
  - Laptop
  - Web camera and spotting scope
  - Automated scoring algorithm

- User interface
  - Experimental condition assignment
  - File organization and storage
  - Rapid calibration

- Data Acquisition Procedure
  - Set up target
  - Designate area of interest
  - Assign point of aim (origin) based on physical target characteristics, and fire
ACOUSTIC Scoring

• Pros
  - rapid data acquisition
  - large data sets
  - high measurement precision within weapon effective range
  - scoring of target misses

• Cons
  - measurement precision degrades as projectile approaches weapon effective range
  - supersonic projectiles only
  - high maintenance costs
  - potentially cumbersome to program/operate
MANUAL Scoring

• Pros
  - risk of data loss is low

• Cons
  - very slow
  - low measurement precision
  - logistically cumbersome
DIGITAL Scoring

- Negative
  - very slow
  - potential image capture requirement
  - logistically cumbersome

- Positive
  - high measurement precision
Does the physical span of the hole (i.e., perforation diameter) affect scoring accuracy?

- Four (4) ammunition types (and corresponding weapon systems) to vary diameter of hole for the hit

Does the distance between the camera/scope and target affect scoring accuracy?

- Five (5) camera/scope-target distances: 10-25-50-75-100 meters

How well does optical scoring accuracy correlate with digital scoring accuracy?

- Paper target on plywood backer/frame
- 30-round groups, spread evenly across target quadrants
- Paper target image capture, Cartesian coordinate (x,y) hit locations digitally scored

How reliable is hit/miss capture rate across targets?

- Proportion of shots fired to shots captured
Results: Accuracy

Pearson’s Product Moment Correlation Coefficient \((r)\) for Optical vs. Digital Scoring across Targets

Scope/Camera to Target Distance

<table>
<thead>
<tr>
<th>Perforation Diameter</th>
<th>10 M</th>
<th>25 M</th>
<th>50 M</th>
<th>75 M</th>
<th>100 M</th>
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</thead>
<tbody>
<tr>
<td>5.56 mm</td>
<td>0.960</td>
<td>0.990</td>
<td>0.980</td>
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<td>0.960</td>
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<td>0.963</td>
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<td>0.960</td>
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<tr>
<td>9 mm</td>
<td>0.966</td>
<td>0.963</td>
<td>0.963</td>
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</tbody>
</table>

Variability for scoring accuracy as a function of ammunition type (i.e., perforation diameter) or camera/scope-to-target distance?

- Pearson’s \(r\): strong across target sessions, irrespective of ammunition type used or placement of camera/scope relative to target
Results: Accuracy

Target 03 - 7.62 mm, 10 M

Target 16 - 5.56 mm, 100 M

Target 09 - 5.56 mm, 50 M

Target 15 - 7.62 mm, 75 M

Optical  Digital

N  Mean  SD

7  0.12  0.06

20  0.17  0.12

28  4.69  3.46

27  3.86  3.62
Error Sources

• Scope movement due to wind, vibration
• Interference from sunlight (ambient IR) – shadowing
• Splintering of backer creating tears, hole deformation

Mitigation

• Dampened movement on the spotting scope/camera by suspending a weight
• Shrouded the target to maintain consistent ambient lighting, resulting in higher hit capture rates
• Used Coroplast backer to prevent wood splintering

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<tbody>
<tr>
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Conclusions

- Potentially viable technology for data collection during human performance, weapon system experimental trials (accurate)

- Mitigation of camera/scope movement and protection from ambient light variability a requirement during data collection, otherwise scoring reliability, accuracy variability is unacceptable

- Optical Scoring
  - faster than manual scoring
  - potential accuracy on par with digital, acoustic scoring

- No projectile velocity-dependent loss of fidelity due to shooter-target range or subsonic ammunition selection (such as when employing an acoustic system)
  - both subsonic and supersonic munitions are viable options when using optical targetry
Future Efforts

- **Assessment of reliability with refined movement mitigation**
- **Data capture for rapid fire, burst and near-synchronous (e.g., shotgun) shooting sequences**
- **Data capture for multiple targets engaged in close temporal contiguity (e.g., multiple shooters engaging distinct targets)**
- **Examine the effect of scope/camera-to-target eccentricity on scoring accuracy**
- **Examine near-keyhole target hit fidelity (since patterns were intentionally spread across target quadrants)**

POC: Frank Morelli, U.S. Army Research Laboratory-HRED, Dismounted Warrior Branch; frank.morelli.civ@mail.mil