VHF/UHF Radar Signatures of Foliage-Obscured Threat Military Vehicles

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STL website: http://stl.uml.edu/stlweb/index.html
Physical Scale Modeling Radar Measurements

Radar wavelength: 1 m
Scaled radar wavelength: 1 inch (X-band)

Advantages of Scale Modeling Radar Measurements:
- Rapidly generate calibrated signature libraries
- Controlled, covert environment
- Models built from intelligence data
- Rough ground planes, clutter, trees

200 MHz - 400 MHz
7 GHz - 14 GHz
Microwave Radar Range

- Based on HP vector network analyzer
- 8.2 - 12.4 GHz models 234 - 354 MHz at 1/35th scale
- Automated calibration and target positioning hardware
1/35th Scale Vehicles, Terrain, Trees
Signature Validation with 1/16\textsuperscript{th} Scale Slicy
VHF TRCS of Slicy Compared with CARLOS at 285.7 MHz and 15° elevation

VV data

HH data
M-1 Tank in Tree Clutter Scene

- Scene incorporates dielectrically scaled wood and soil
- Models coated with 4000-Å-thick sputtered Cu film
### VHF/UHF RCS of Slicy, M-47, M-1, and Trees at 45° elevation

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<thead>
<tr>
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<th>Median RCS in dBsm</th>
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<tr>
<td></td>
<td>free-space</td>
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<tr>
<td>Slicy</td>
<td></td>
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<tr>
<td>VV</td>
<td>15.5</td>
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<tr>
<td>HH</td>
<td>15.1</td>
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<td>M-47</td>
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<td>VV</td>
<td>8.8</td>
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<td>HH</td>
<td>7.7</td>
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<td>VV</td>
<td>10.2</td>
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<td>HH</td>
<td>10.0</td>
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<td>Trees on ground plane</td>
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Materials Issues

- VHF/UHF dielectric constant of wood ranges from $\varepsilon = 13 + i\ 3$ to $68 + i\ 20$
  
  Scale model wood (aluminum-loaded epoxy): $\varepsilon = 69 + i\ 10$

- VHF/UHF dielectric constant of soil ranges from $\varepsilon = 3 + i\ 0.5$ to $24 + i\ 5$
  
  Scale model soil (carbon-loaded polyurethane): $\varepsilon = 14.7 + i\ 1.1$

Reflectivity of 1/35th Scale M-1 Coating

- 4000 Å sputtered Cu coating on M-1 model
- Skin depth of Cu film at 10 GHz = 8000 Å

Reflectivity of Scaled Model Soil

- Brewster angle of soil = 15° elev.
VHF/UHF TRCS of M-1 Tank

Free-space

On smooth ground plane
VHF/UHF TRCS of M-1 Tank

On ground plane with trees

Trees only

VHF/UHF Radar Cross Section of M-1 Tank on Ground Plane with Trees

VHF/UHF Radar Cross Section of 8 Trees on Ground Plane

medians
VV - 18.5 dBsm
HH - 18.5 dBsm

medians
VV - 19.4 dBsm
HH - 18.1 dBsm

aspect angle

aspect angle
VV-pol VHF/UHF ISAR Imagery of an M-1 Tank

Range res. = 1.3 m, Cross range res. = 0.9 m, 90° aspect
HH-pol VHF/UHF ISAR Imagery of an M-1 Tank

Range res. = 1.3 m, Cross range res. = 0.9 m, 90° aspect
Program Accomplishments

• Established Radar Range to Acquire Calibrated VHF/UHF Signatures of Vehicles
• Demonstrated Signature Validation with Method of Moments Code (CARLOS)
• Developed Signal Processing Techniques for FOPEN ISAR Imaging
• Developed Dielectrically Scaled Materials to Model Various Types of Soil & Wood
• Fabricated Ground Planes Modeling Smooth, Moist Soil Surface
• Demonstrated Ability to Construct Scale Model Tree Structures