Holographic radar brings a new dimension to sensing and instrumentation on T&E ranges

Collision avoidance, wind farms and scoring
<table>
<thead>
<tr>
<th></th>
<th>Short introduction to Cambridge Consultants</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>What is holographic radar?</td>
</tr>
<tr>
<td>3</td>
<td>Applications of holographic radar</td>
</tr>
<tr>
<td>4</td>
<td>Questions</td>
</tr>
</tbody>
</table>
A world leader in technology and product development

- Established in 1960
- 300 engineers and scientists based in Cambridge UK and Cambridge MA.
- We serve a wide range of industries – defence, wireless, transport, consumer, industrial, medtech
- We design, develop and manufacture innovative products, processes and systems using multi-skilled teams
- We have a long track record of technology based spin-out companies
- We manufacture and supply specialist radar systems
<table>
<thead>
<tr>
<th></th>
<th>1. Short introduction to Cambridge Consultants</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2. What is holographic radar?</td>
</tr>
<tr>
<td></td>
<td>3. Applications of holographic radar</td>
</tr>
<tr>
<td></td>
<td>4. Questions</td>
</tr>
</tbody>
</table>
What is Holographic radar?

Holographic radar implements Skolnik’s vision of Ubiquitous Radar

- Holographic Radar looks continuously at a whole volume of space (rather than scanning).
- It acquires fully sampled amplitude and phase information from every object within the volume.
- It provides range, azimuth, elevation and Doppler information for every detected object.
- Tracking algorithms discriminate moving targets and clutter.
- Clutter is removed without loss of sensitivity.
- Practical holographic radar is possible in the modern day due to the availability of high-power processor devices at reasonable cost.
Holographic radar

Doppler frequency

Range

Doppler frequency

z

y

x
1 Short introduction to Cambridge Consultants
2 What is holographic radar?
3 Applications of holographic radar
4 Questions
5-channel array for automotive pre-crash sensing – a minimum holographic array
Collision warning radar
Many wind farm planning applications are stalled

Absence of vertical discrimination combined with scan aliasing makes it impossible for a PSR to separate the track from the clutter.

Holographic radar provides the solution.
CH-InFill is a holographic radar located at or near a wind farm to generate local, high-resolution, 3D infill data

- The sensor is located in or near the wind farm
- It sees through and around the turbines without disruption
- Nothing else has been shown to do this

- Range up to 13km / 43,000ft
- Reporting rate 3-10Hz
Remote-controlled helicopter with 2.2m² radar reflector
Land and Surface Target Scorer (LSTS) system – in development

- The Land and Surface Target Scorer is a real-time vector scoring system for highly mobile targets operating in very cluttered environments.
- LSTS application of the CH radar is funded by the OSD Target Management Initiative program, sponsored and managed by NAWC-WD, Point Mugu, Target Systems Division, 5.3.1
Two views of how LSTS will perform:

**Accuracy and throughput**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Range (5” Shell)</td>
<td>50ft - 1000ft</td>
</tr>
<tr>
<td>Firing rate</td>
<td>Up to 20 rounds / minute</td>
</tr>
<tr>
<td>Along-track position accuracy</td>
<td>13ft / 5% at longer range</td>
</tr>
<tr>
<td>Target speed</td>
<td>Up to 46kts (at SS3)</td>
</tr>
<tr>
<td></td>
<td>Up to 100mph (land)</td>
</tr>
<tr>
<td>Sea state</td>
<td>Up to sea state 3</td>
</tr>
<tr>
<td>Trajectory reporting</td>
<td>Within 3 seconds of projectile arrival</td>
</tr>
</tbody>
</table>

Migration process rejects clutter
Performance measured to date:

- Cricket ball
  - RCS: 0.004m²
- Cricket bowling machine – 100mph
Performance measured to date:

- SNR at 80m 35dB (25W Tx)

Proof of concept trajectory processing takes 15 minutes

Beta Prototype trajectory output will be continuous and real-time

Detection, tracking and best-fit 3D trajectory
LSTS program

**Proof of Concept Phase** (system design and single face build)

- Start date: Jan 2010
- System Requirements Review: April 2010
- Preliminary Design Review: June 2010
- Critical Design Review: September 2010
- Test Readiness review: February 2011
- Proof of Concept System trials with 5” shell: March 2011 (in progress)

**Beta-prototype phase** (complete system build and test)

- Start date: April 2011
- Trials with 50 cal rounds: June 2011
- Sea trials on HSMST: December 2011
Holographic radar is the best you can do in very cluttered environments

- **Target and clutter separation**
  - Continuously gather signals from a large volume of space
  - Fully sampled amplitude and phase data from every target
  - Separate targets of interest from clutter through tracking processes

- **Applications** in collision avoidance, PSR infill, scoring, through-wall, asset protection, border monitoring, other…

- **LSTS system** under development
  - 5” and 50 cal projectiles
  - Land and sea surface targets
  - Proof of Concept sea trials underway
<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>Short introduction to Cambridge Consultants</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2</td>
<td>What is holographic radar?</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Applications of holographic radar</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Questions</td>
</tr>
</tbody>
</table>