Dual Use Opportunities for EO Sensors - How to Afford Military Sensing

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ABSTRACT

There are many dual use opportunities for Electro-optical sensors. A number of EO sensors have already been transitioned from military development to commercial applications. Many more need to be transitioned for the military to be able to afford the sensing technology that it needs. The old paradigm was that the military developed what it needed and then produced it. Companies then exploited that development for commercial markets. The new paradigm will be that the military asks for participation from companies with commercial interests even in the development phase. In addition, the military will plan its developments to promote a volume manufacturing market as a method of getting production costs down to affordable values. This has to be carefully planned to preserve a military edge over potential adversaries. With rapid technical progress the military edge occurs simply because we are " first to market" with the military hardware. In a slower technical development this edge is not enough.

INTRODUCTION

A number of potential areas for cooperation between military and commercial interests in the Electro-optic sensing arena will be considered. These include:

Table 1. Military and Commercial Applications Pairings

Military	Commercial
Wind Sensing	Wind Sensing
Global Wind Sensing	Global Wind Sensing
High Bandwidth Communications	High Bandwidth Communications
Chem. / Bio detection	Environment Monitoring & Chem. / bio detection
Imaging through Clouds	Noninvasive Imaging in the body
Material ID / Hyperspectral	Crop reports/ mineral detection
IRCM	Inexpensive IRCM
2D & 3D imaging	Robotic Vision
Underground Tunnel detection	Oil / gas exploration
"	Archeology
Missile Seekers	Obstacle Avoidance

Many of these will be briefly discussed. The above pairings are drawn from a larger grouping of commercial and military applications. While not a complete list, I have included a larger list of military and commercial requirements in tables 2 and 3.

Table 2. Military Applications of laser radar or laser radar like hardware

Hard Target Detection
Hard Target Identification
Chem. / bio cloud identification
Effluent Detection
Wind sensing
Cloud mapping
Obstacle Avoidance
Laser Communication
Laser Designation
Foliage / camouflage penetration

Underground bunker detection
Flir Navigation & targeting
Infrared Search and Track
Missile Warning
IR countermeasures vs. missile threats

Table 3. Commercial Applications of Laser Radar or Laser Radar like Hardware

Non evasive imaging inside the body
Obstacle avoidance for automobiles and trucks
Wind sensing for microburst avoidance and aircraft spacing (vortex problem)
Environmental monitoring
Heat detection for insulation monitoring & other applications
Vibration mode analysis & removal
Automobile Flir for night vision
IRCM in some areas
High Bandwidth Lasercom
Crop reports
Mineral location
Global Wind Sensing
Robotic Vision
Global Cloud Mapping

Lastly I have included a partial list of paramilitary laser radar or laser radar like hardware applications

Table 4. Paramilitary Applications of Laser Radar or Laser Radar like Hardware

Night Vision
Drug factory detection
Chem. / bio detection
Target ID in an urban environment
Wind Sensing for accurate long range fire

In the following sections I will provide a brief discussion of some of the most promising areas for commercial and military EO sensor dual use.

WIND SENSING

Wind sensing is one of the applications where commercial and military applications are very similar. There are many different wind sensing applications for both the military and commercial applications. For the military we have target aimpoint selection, bomb drop, and cargo drop as one set of applications. We also have very short-range laser radar that can replace the pito tube for aircraft velocity and angle of attack measurement through the air. In addition the military is interested in global wind measurement such as could occur from a satellite. Lastly wind shear and vortex detection can also have military application, since military aircraft are not immune to those hazards. Figure 1 shows a military application of wind sensing.

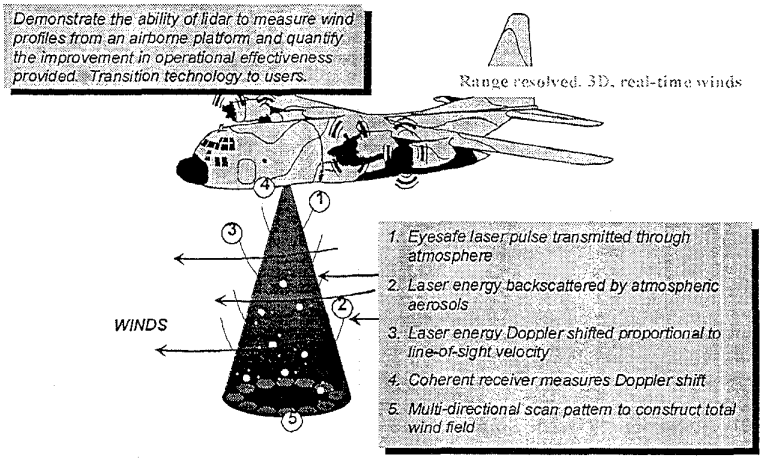

Figure 1. Ballistic Winds Implementation.

The commercial applications start with wind shear detection for commercial aircraft. Laser radar can provide a method of detecting this hazard miles in front of the aircraft, so the aircraft can approach the changing wind area with the correct velocity. The same sensor can detect clear air turbulence, saving potential injuries onboard an aircraft, as well as potentially

increasing the lifetime of the aircraft wings if the advance turbulence warning is used to smooth the aircraft flight through the turbulence. This increase in aircraft wing lifetime is certainly also of interest to the military. The other big commercial application is in the global winds measurement area for increased weather forecast accuracy. Again, the military has a strong interest in increased weather forecast accuracy as well.

CHEMICAL & BIOLOGICAL SENSING / ENVIRONMENTAL MONITORING

The problem of chemical and biological agents is both the same for the military and commercial applications, and it is different. Commercial agencies have an interest in detecting hazardous chemical and biological agents due to the hazard associated with these agents. The reason commercial interests want to detect these agents may simply be because of the cost of clean up of any spill, or the costs associated with any lawsuites or medical bills associated with a chemical or biological agent leak. In addition there will be times when a government agency requires compliance with environment emission laws, and a company will be required to prove compliance. Also, there will be times when the personnel from a company may be at risk to exposure, and other times when one company is monitoring compliance of an industry on behalf of a government agency. Commercial detection and identification of chemical and biological agents has to include all types of hazardous materials that are shipped and used legally, as well as potential hazards from terrorists.

The military issue with respect to detecting chemical or biological agents is both a manufacturing issue and a field use issue. There is a substantial terrorist potential risk, which brings the paramilitary application into alignment with the military field detection problem. We have an obvious interest in detecting the manufacture of any weapon of mass destruction, plus we need to know about threats to our troops.

IMAGING THROUGH HIGHLY SCATTERING MEDIA

The military has a substantial interest in the ability to image through highly scattering media called clouds. The major drawback to electro-optic sensors is the fact they do not work very well in " bad weather". Recent interest in flying at mid altitude has made this problem much worse because clouds are often between the aircraft and its intended target. When the envisioned tactics were mostly low altitude flight electro-optic sensors would usually have clear line of sight to the target. With the move to mid altidude clear line of sight may occur less than 50 % of the time in some seasons and areas of the world.

The medical community has been very interested in noninvasive imaging of areas within the body. [1] To do this the community has considered both ballistic imaging, in which the first photons through are used for imaging, and also more sophisticated algorithm approaches with higher signal to noise.

MATERIAL ID / CROP REPORTING

Material identification can be accomplished using spectral discrimination. This done can be done both for aerosol targets such as chemical an Biological agents, or for hard targets. Figure 2 gives a chart of material reflectiviites for some common materials. [2] Figure 3 shows some of the uses for multispectral / hyperspectral.

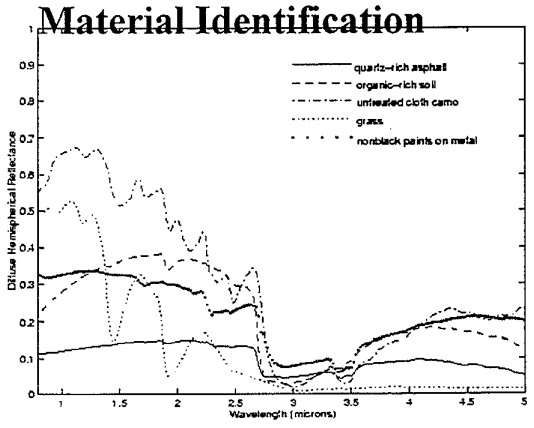

Figure 2. Material Reflectivities

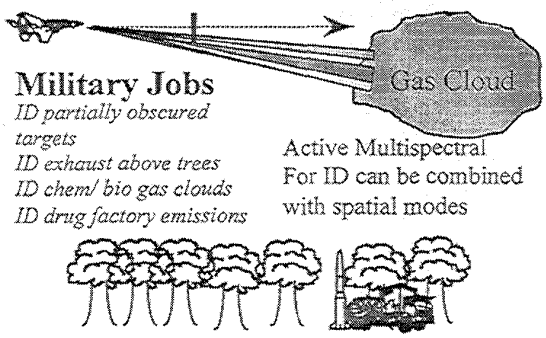

Figure 3. Examples of multispectral Material ID

Oil / mineral detection is one of the main commercial applications. In addition things like crop forecasts can be done commercially using multispectral/ hyperspectral techniques.

UNDERGROUND TUNNEL DETECTION / ACHEOLOGY / MINERAL EXPLORATION

This is a difficult area that can use seismic exploration. It has been pioneered by the oil companies, but can be applied to both archeology and military applications, where locating underground instellations has become important. Another more exotoc implementation of this technology that could be pioneered by the military and fed back to the oil exploration companies or the archeologists is the idea of using laser radar vibration detection to replace the seismic sensors. The advantage of this is the logisitcs tail reduction. No longer would it be necessary to have a large number of seismic sensors on the ground. This is however a difficult development. Figure 4 shows the concept.

Detecting / Mapping Underground Bunkers

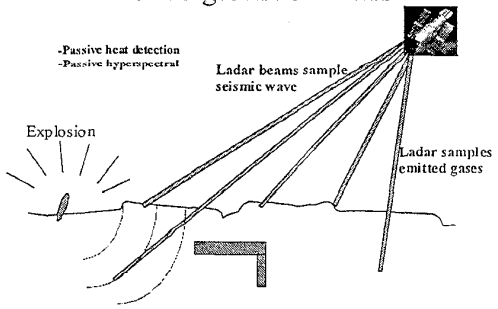

Figure 4. Detecting/ Mapping Underground structures

CONCLUSIONS

EO sensors for military, paramilitary, and commercial applications are continuing to evolve new applications. Economics has more closely linked these applications. In many cases the commercial application will now enable the military to afford both the development of the technology and the force modernization.

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[1] Medical Optical Tomography: Functional Imaging and Monitoring, R.F. Potter, ed., SPIE Optical Engineering Press IS11 (1993)

[2] M. Vaidyanathan, T. P. Grayson[2], R.C. Hardie*, L.E. Myers[1] and P.F. McManamon , "Multispectral Laser Radar Development and Target Characterization, SPIE AeroSense Conferecne, April, 1997.