

COMPACT MULTI-BAND ZOOM IMAGER

Bodkin Design & Engineering, LLC

P.O. Box 81368
Wellesley, MA 02481
Ph: (781) 235-6351

Contact: Havell Rodrigues

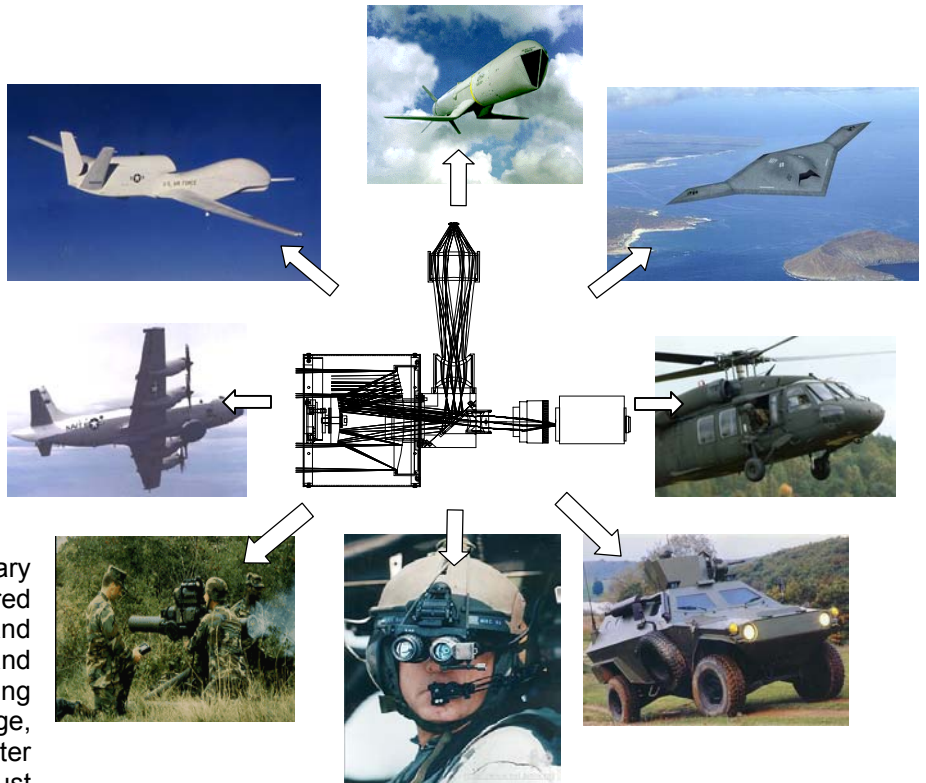
Ph: (781) 694-3251
Fax: (781) 283-9174
Email: sales@bodkindesign.com
Website: www.bodkindesign.com

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PROBLEM STATEMENT

An increasing number of military applications depend on visible and infrared imaging sensors. From surveillance and reconnaissance operations, to search and rescue missions, success lies in identifying targets hidden by foliage and camouflage, and discriminating those covert targets from clutter and decoys. These covert operations must be performed both day and night, under all weather conditions, from both airborne and portable platforms.



Vis/IR Imager for Multiple Applications and Platforms

In a multi-band system, the visible sensor provides high-resolution imagery for daylight operations, while the infrared sensor permits imaging under both day and night conditions, and penetrates camouflage, clutter and smoke. Because the infrared imager captures the thermal self-emission of the objects in the scene, it does not need a light source: starlight, daylight or spotlight.

For man-in-the-loop operations, it is often difficult for the human operator to interpret infrared images without the familiar cues of a full color picture. This leads to the risk of confusing enemy targets with allies and non-hostiles. Multi-band imaging systems mitigate this problem by adding high-resolution visible imagery to the infrared imagery, thereby improving accuracy of the human operator.

Military systems are becoming more dependent on autonomous target recognition (ATR) techniques to locate targets and guide weapons. For example, the SLAM-ER missile uses ATR algorithms trained on visible imagery, but it is terminally guided with infrared imagery. Dual-band (Visible/Infrared) imaging improves ATR results by terminally guiding missiles with both infrared and visible imagery. This allows these military systems to perform seamlessly during day and night and use the visible and the infrared bands in a synergistic manner to provide a cross-spectrum check on ATR correlations.

Current multi-band imagers use multiple apertures with large radar and aerodynamic cross-sections. This increases the risk of radar detection, requires greater airframe power and reduces maneuverability. They are also expensive, power hungry, heavy and bulky.



Thus, currently available multi-band imagers are limited in their usefulness for airborne and portable military applications. An ideal multi-band imaging system should have the following characteristics: 1) small size and weight; 2) low-cost; 3) reduced radar and aerodynamic cross-sections; 4) analog and digital output.

Bodkin Design and Engineering, LLC (BD&E) has developed a compact, lightweight, high-resolution, multi-band sensor system to satisfy these requirements.

The “Omni Spotter” offers the following unique advantages:

1. Single Aperture
 - reduced radar and aerodynamic cross-sections
 - reduced size and weight
2. Uncooled Infrared Sensor
 - lower cost
 - higher reliability
3. Optical/IR Zoom
 - diffraction limited imagery
 - high sensitivity F/1 system
4. Interchangeable Fore-Optics
 - variable range of operations
 - 4 to 16-inch diameter aperture
5. Interchangeable Modules
 - VNIR
 - MWIR
 - LWIR
 - Hyperspectral
 - Laser Ranger/Designator
6. Analog and Digital Output
 - man-in-the-loop
 - computer assisted targeting
 - sensor fusion and ATR/ATC
7. Common Modules
 - interchangeable between platforms
 - reduced logistics tail

The Omni Spotter multi-band imager satisfies a variety of military needs, and lends itself to a broad range of military applications and platforms.

WHO CAN BENEFIT?

The Surveillance, Reconnaissance, Targeting and Guidance communities can all benefit from the Omni Spotter technology.

The Omni Spotter, originally designed for integration with the SLAM-ER missile system, is now available to meet the needs of a broad range of applications. The system is lightweight enough to be portable for a forward observer and is robust enough to be vehicle-mounted or pole-mounted for perimeter security.

Military applications and platforms that can benefit from this technology include:

- UAV, TUAV, UCAV, UTUAV, MAV, UCAR, UGV, micro/mini UAV
- Missile systems: JASM, JDAM, JSOW, SLAM-ER, Harpoon
- FLIR systems: helicopters, fighters
- Gun mounted platforms
- Vehicle mounted imagers
- Pole mounted platforms for perimeter security
- Portable platforms for Special Operations

The technology is not limited to Navy specific requirements and can be used on platforms across DoD programs including: Naval Air Systems Command, Space and Naval Warfare Systems Center (SPAWAR), Navy Unmanned Air Vehicles (UAV) Program, Maritime Patrol Aircraft Program, Naval Air Warfare Center Aircraft Division (NAWCAD), Maritime UAV Development and Operations, Naval Surface Warfare Center, Naval Research Laboratory, Marine Corps System Command, Air Force Reconnaissance Systems, Air Force Aeronautical Systems Center, Army’s Night Vision and Electronic Sensors Directorate, Contingency Airborne Reconnaissance System (CARS) group, Aviation Weapons System Requirement Branch, Special Operations Command (SOCOM), Department of Homeland Security. Initial discussions with these agencies have been positive.

The low-cost modular design of the Omni Spotter lends itself to further applications in commercial markets. These applications include: civilian security, remote surveillance, law enforcement, fire fighting, navigation, process control, non-destructive testing, power distribution inspection, pollution monitoring, astronomy and medical imaging.

BASELINE TECHNOLOGY

Several products available that provide multi-band imaging capability, but none can match the capability of the Omni Spotter. Table 1 shows a comparison between the Omni Spotter and competitive products.

Product Name	Detector	Field of View Degrees	Zoom Feature	Dimensions Inches	Weight	Format	Cost
Omni Spotter	LWIR microbolometer 320 x 240	4.5-1.5	3x	8 x 12 x 18	< 10 lbs	RS170/ DIGITAL	\$45k
	VIS 1000 x 1000	4.5-1.5	3x			RS170/ DIGITAL	
DI-7000	LWIR microbolometer 320 x 240	DUAL 6.2 & 18.5	N/A	30 x 12 x 25	25 lbs	RS170	\$40k
	VIS	zoom	47.5-2.16			RS170	
Night Guard 3000	LWIR BST 320 x 240	12	N/A	8.5 x 17 x 20	32 lbs	RS170	\$61k
	I2 Gen 3	12	N/A			RS170	
SC5500	LWIR BST 320 x 240	12	N/A	15 x 28 x 23	26.5 lbs	RS170	\$195k
	I2 + color CCD	12	N/A			RS170	

Table 1: Comparison with commercially available multi-band imaging systems. The Omni Spotter design results in an average cost savings of 50% and a weight and volume reduction of 60%.

The above competitive systems use two separate apertures for visible and infrared imaging, requiring greater size and weight. At best, the competing systems offer only digital zoom in the infrared spectrum and provide only analog video output, which results in less accuracy with low-resolution imagery. Because these systems rely on refractive elements, they contain many pounds of optics, and do not offer the high-quality magnification possible with a reflective system.

BD&E, using its extensive experience with infrared technology and miniature UAV cameras, has developed a superior, cost-effective multi-band imaging system to uniquely satisfy these requirements.

TECHNOLOGY DESCRIPTION

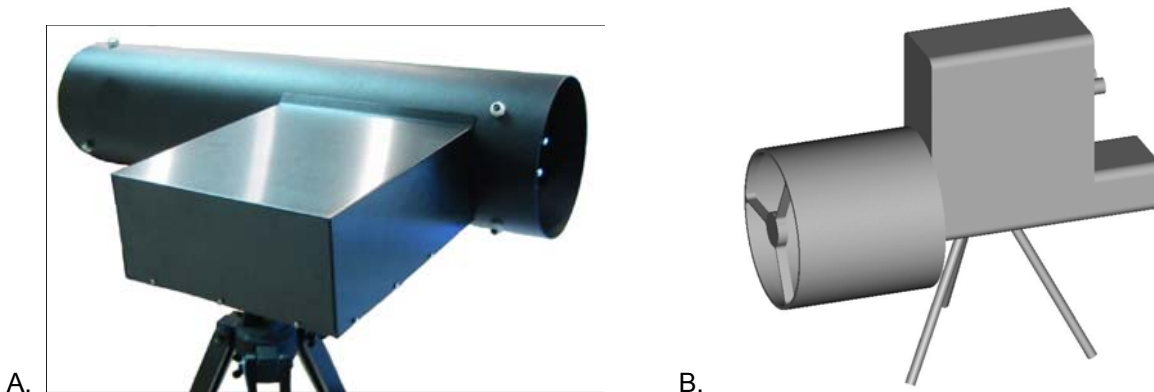


Figure A) The Omni Spotter Phase I System. B) The Phase II system is ¼ the size and weight with 4 times the resolution.

Key to the Omni Spotter's performance are several unique, patent-pending innovations.

The Omni Spotter uses a single aperture for both visible and infrared imaging, thus reducing the aerodynamic and radar cross-sections. The interchangeable fore-optics can vary from a 4-inch to a 16-inch diameter aperture. This provides for moderate to extremely long-range reconnaissance. The unique optical zoom module allows for continuous 1x to 3x magnification, with any of these fore-optics, and without the data loss associated with digital zoom.

The Omni Spotter provides high-resolution, co-registered imaging of the visible and infrared with analog and digital outputs. Its use of the latest microbolometer detector array technology for long wave infrared imaging greatly reduces its cost and increases its reliability. This micro-machined detector array technology is becoming the future standard for long wave imaging. The compact, lightweight system is designed to work with on-board stabilization gimbals for airborne and vehicular applications.

Table 2: Omni Spotter's unique features make it a powerful VIS/IR imager.

FEATURE	ADVANTAGE	BENEFIT
Single Aperture	<ul style="list-style-type: none"> • Compact design • Reduced Parts 	<ul style="list-style-type: none"> • Reduced cross-section (radar and aerodynamic) • Increased Stealth
VIS/IR ZOOM	<ul style="list-style-type: none"> • Wide field scanning • High-magnification targeting 	<ul style="list-style-type: none"> • Superior Resolution • More accurate and faster target identification
Modular Design	<ul style="list-style-type: none"> • Interchangeable lenses • Interchangeable focal planes • Module interchangeable across platform 	<ul style="list-style-type: none"> • Easily upgradeable • Lower system integration cost • Single design for multiple platforms • Reduced logistics tail
Microbolometer Technology	<ul style="list-style-type: none"> • Lower power • Lower cost • No moving parts 	<ul style="list-style-type: none"> • Higher resolution • Reduced cost and weight • Increased reliability

CURRENT STATE OF DEVELOPMENT

The Omni Spotter is in its second year of Phase II SBIR funding from NAVAIR. The common VIS/LWIR module has been successfully demonstrated (TRL 4) during Phase I. The Phase II design makes the system compact, offers higher resolution in the visible and infrared, has an all optical 3x zoom capability, and digital and analog outputs. Future developments include MWIR, hyperspectral and laser ranger/designator modules.

TECHNOLOGY AVAILABILITY

The Phase II prototype will be complete and ready for on-site testing in the third quarter of CY-2004 (TRL 5). BD&E is seeking DoD partners and prime contractors interested in this technology for specific applications. We are prepared to support demonstration activities with selected partners. Following operational development and testing (TRL 6, 7 & 8), the system will be production ready.

ABOUT THE COMPANY

Bodkin Design & Engineering, LLC, founded in 1992, provides electro-optical and mechanical design services to address military and commercial needs. The company's products are manufactured and marketed through a combination of in-house efforts and strategic relationships. The company holds several patents and has extensive experience building ultra-light cameras. Previous instrumentation development includes miniature UAV cameras, air-droppable sensors, land mine detection sensors, and spectrographs. The company is currently working on developing a novel hyperspectral imaging system for the Air Force. Under a previous Navy-funded SBIR contract, the company developed the world's first uncooled microbolometer based miniature camera for the Pointer UAV. The resulting technology is now found as part of BAE systems product line.