



Naval Surface Warfare Center (NAVSEA) Crane Division

Two Band Imaging System
(US Patent No. 6,969,856)

Mini Market Study Report

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Sponsored by:



Integrated Technology Transfer Network, California State University San Bernardino

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MARKET STUDY REPORT

Technology Synopsis

The Two Band Imaging System uses a dual chrome component for radiometric measurement of objects. This system is designed to do two jobs in one: (1) Take the place of two cameras, (2) Solve the issue of spatial and temporal registration arrays. With the dual chrome, the end-user is able to see dim and bright objects in the same image, without distortion and in real-time (within nanoseconds).

This technology offers an improvement over the existing single band imaging systems, by allowing the end-user the opportunity to see simultaneous imaging of both radiance level (brightness of an object) and temperature (how hot or cold an object is), whereas the single band imagers only offer one or the other. In certain situations, for example for inspecting air panels separating on a hot aircraft engine; or for a sensor tasked to identify a target in a field of view, a dual band imaging system would be able to better detect this problem or identify the target.

This Two Band Imaging System will be especially beneficial to military systems equipped with thermal weapon sight or target acquisition, and it is a key technology for any imaging system offering real-time super-framing capabilities. By exchanging one or both of the imaging sensors, the imaging system can be used in a number of novel applications, such as inspecting a narrow band-width of light – this capability has the potential to revolutionize the current possible civil applications being served by single band imagers.

Potential Applications

Industry Segments	Uses	Market Size
A. Military*	<ol style="list-style-type: none">Soldiers: Target identification and Recognition (Weapon Sight)Soldiers: Missile Warning Systems	\$3.3B
B. Scientific**	Researchers: Research and Development Process	\$144.4B (2011)
C. Medical***	Physicians: Early Detection of abnormal health conditions	Millions of dollars per year
D. Manufacturing	Manufacturing companies: Spot/check for defects and issues within the manufacturing process	\$4.5T (2010)
E. Commercial	Thermographers: Diagnostics of engines including internal combustion, jet engines, and gas turbine	\$1.5B
F. Space	<ol style="list-style-type: none">Satellites/Telescopes: Infrared images and spectroscopic observations of stellar phenomenaMeteorologists: To study the Earth's weather during both the day and night	\$257B

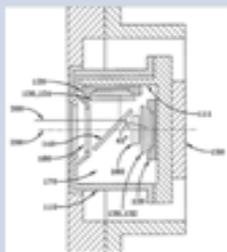
*Primary Market Focus

**Secondary Market (Great potential for solving critical problems in the research and development process)

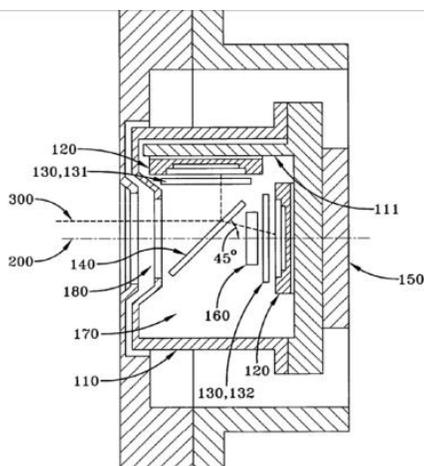
***Will require additional R&D

Competing Technologies

Company Name/Inventors	Product/Technology	Features
 Army Research Laboratory A. Goldberg, T. Fischer and S. Kennerly	Dual-Band Imaging of Military Targets Using a QWIP Focal Plane Array	<ul style="list-style-type: none"> Focal plane arrays (mid-wave & long wave) Quantum-well infrared photo detector Use to gather image data on military targets Image fusion techniques
Distant Focus Corporation The MITRE Corporation U. S. Army	Dual-Band Imaging System Based on a Compact Coaxial Folded Optic Architecture	<ul style="list-style-type: none"> Simultaneous acquisition of images from a common scene Basic folded lens Coaxial configuration
 NAVSEA Eric Hillenbrand	Two Band Imaging System	<ul style="list-style-type: none"> Real time radiance & thermography Compact & inexpensive Flexible Superframes Can be used in daylight & night Can withstand cold conditions (70K)



Competitive Advantage



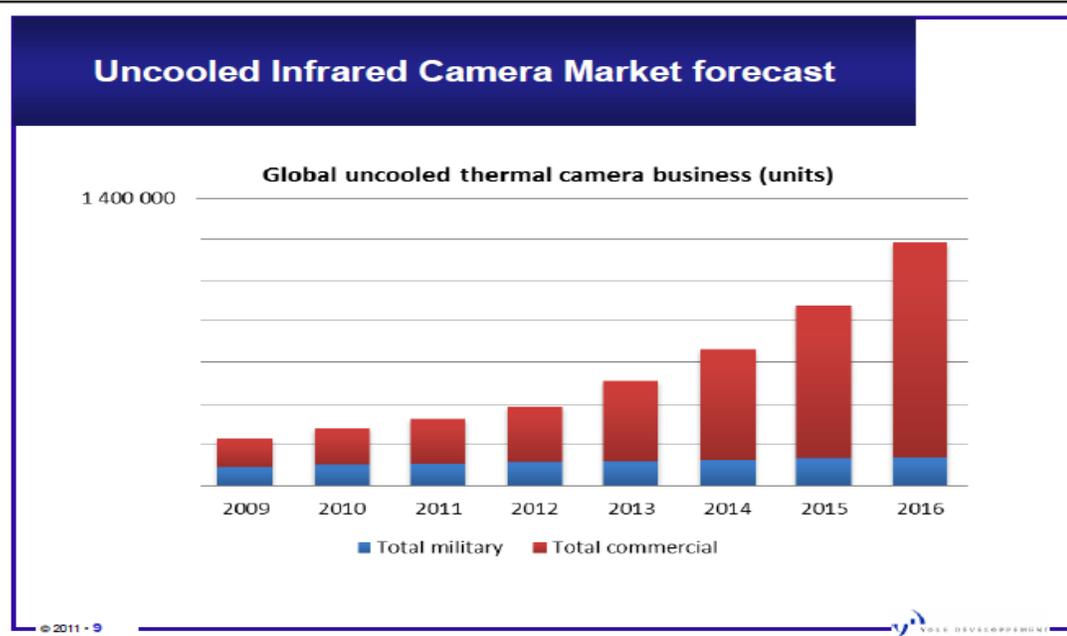
- Use any band, sensor or focal plane
- Able to transform different images into a single image
- Able to effectively repress temperatures
- Distinct processor can carry out operations from super framing capability to image correlation

Market Size

The market opportunities within the thermography market are large and growing. The uses for thermography have increased over the last ten years. The infrared (IR) night vision imaging and thermography market is estimated at \$4.8 billion annually, of which \$3.3B is derived from pure military applications and \$1.5B from commercial and dual-use applications.¹ According to the report "Uncooled IR Cameras & Detectors for

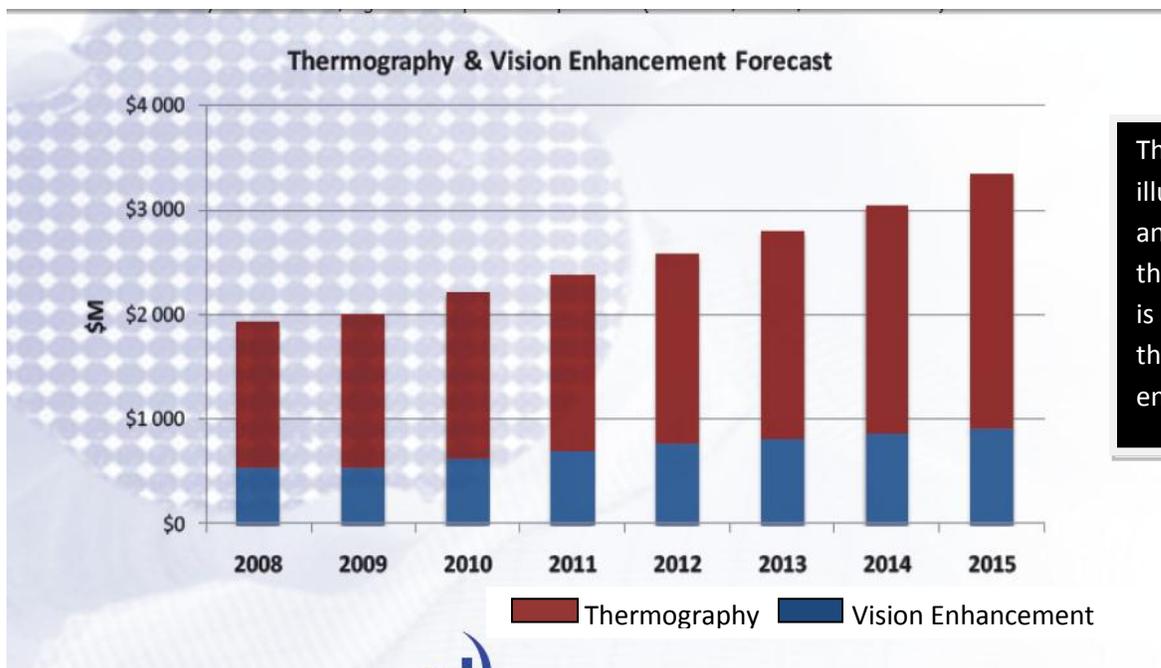
¹ <http://www.sirica.com/market.asp>

Thermography and Vision 2010” driven by dramatic cost reduction of detectors, the market volume for thermography and infrared vision will triple by 2015 from more than 200,000 cameras today to more than 700,000 units, meaning +23 % annual growth rate. The revenue growth will be about + 9% as market prices for the cameras decrease.²



The diagram to the left illustrates the continuous demand for uncooled cameras within the military industry.

Source: http://www.i-micronews.com/upload/Rapports/Yole_Uncooled_Infrared_Cameras_&_Detectors_for_Commercial_Military_2011_report_Sample.pdf



This diagram illustrates how large and growing the thermography market is in comparison to the vision enhancement market.

Source: <http://www.sensorsmag.com/sensors-mag/sharply-lower-costs-uncooled-ir-sensors-may-spur-growth-7260>

²http://www.i-micronews.com/upload/Rapports/Uncooled%20IR%20Cameras%20&%20Detectors%20for%20Thermography%20and%20Vision_w eb.pdf

Previous Uses of Thermography

Uses of Thermography (2006)	Percentage (%)
Detection of overheating electrical components	73
Measurement of transformer temperatures	53
Identification of heat loss areas	43.7
Repair of electrical components	36.7
Identification of material wear	35.9
Monitoring outdoor wiring	28.9
Building inspections	27.8
Management of maintenance inventory levels	23.3
Roof asset management	12.6

Source: http://ecmweb.com/mag/electric_thermography_market_heats/

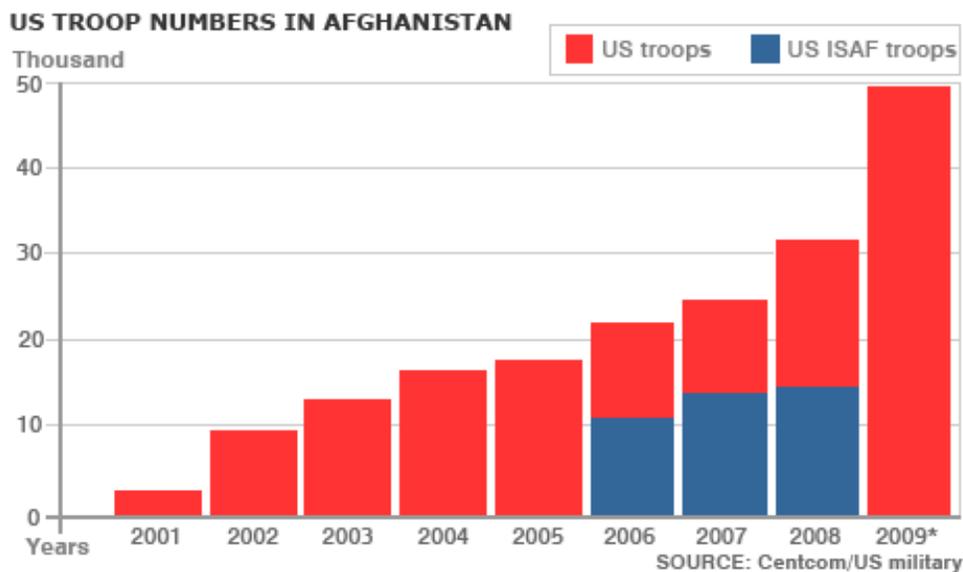
Current Uses of Thermography

In the military industry, thermography is currently used extensively by the United States armed forces for night vision optics and has been incorporated into aircrafts, sea and land vehicles. Ground forces use a hand held infrared cameras for general theatre scanning and a **thermal imaging scope for target acquisition**.³

According to FLIR as the cost of infrared technology has declined, the demand in large untapped markets has grown rapidly. Thermography is used currently in the untapped markets and areas including **manufacturing process control and research and development**.⁴

Market Opportunity

The military inability to effectively identify intended targets on the battlefield has resulted in a copious amount of civilian casualties. Every year since 2001, the number of troops in Afghanistan has increased. And every year the number of Afghan civilian casualties increases as well. In 2009 there was a 24% year-on-year jump in the number of civilian deaths.⁵



³ <http://www.x26.com/uses.html>

⁴ <http://files.shareholder.com/downloads/FLIR/0x0xS1193125-11-51695/354908/filing.pdf>

⁵ <http://www.newshoggers.com/blog/2009/07/more-troops-more-civilian-casualties.html>

Due to this fact there is a need in the thermography market and within the military industry for a technology that effectively differentiates and identifies more accurately the intended target.

Potential targets for licensing

To effectively license this technology, a variety of major players should be considered, specifically, main infrared military systems market players that specialize in weapon sight (target acquisition and identification). These companies include **DRS Technologies** and **BAE Systems**. Based on the primary market research conducted, infrared military systems companies such as BAE Systems and DRS Technologies would be the best candidates to seek interest in licensing opportunities. **DRS Technologies** is the leading supplier of integrated products for military forces. DRS has been recognized as one of the fastest growing defense technology companies in the world and holds the leading market position in thermal imaging devices. **BAE Systems** is the second largest global defense and security company that deliver a full range of products and services for the military, air, land, and naval forces. Both companies are leaders in military systems, thermal imaging devices and provide state of the art products that assist military forces in carrying out critical missions.



Source: http://www.imicronews.com/upload/Rapports/Yole_Uncooled_Infrared_Cameras_&_Detectors_for_Commercial_Military_2011_report_Sample.pdf

Keys to Commercialization

To commercialize the Two Band Imaging System technology, the Naval Surface Warfare Center is recommended to do the following:

1. Contact the **main infrared military systems players:**

- **BAE Systems** for military application, specifically target acquisition (Thermo Weapon sight) application
 - **Contact Infrared Imaging Systems' Mike Lewis** to initiate conversation about current infrared products. Determine the need for the technology within BAE Systems and discuss product integration process.
 - **Phone:** 781-863-3687
 - **Email:** michael.l.lewis@baesystems.com
- **DRS Technologies** for military application (identification and recognition of targets)
 - **Contact Terence J. Murphy, President, RSTA Group** to discuss DRS's current military products, possible integration of the Two Band Imaging System and potential applications for this technology within DRS Technologies Inc.
 - **Phone:** 973-898-1500
 - **Email:** terence.murphy@drs.com
- 2. Use prototype to conduct performance test against competitors' technologies to quantify competitive advantage
- 3. **To build awareness for technology: Showcase technology at tradeshow and infrared imaging conferences**
- **Attend the SPIE Defense, Security, and Sensing Conference** as a presenter in the IR Sensors and Systems conference program track.
 - **Paper submission:**
http://spie.org/app/program/index.cfm?fuseaction=conferencedetail&export_id=x12502&ID=x6770&redir=x6770.xml&conference_id=967003&event_id=957483&programtrack_id=966996
 - April 23-27, 2012 at the Baltimore Convention Center in Baltimore, Maryland, USA
- **Attend the Night Vision 2011 Conference as an exhibitor.**
 - Focuses on military applications of Night Vision and Thermal Imaging
 - November 9-11, 2011 at the Bristol Marriott Hotel City Centre, United Kingdom
- 4. **Consider exploring the commercial industry, market data indicates great potential.**

Appendices

Interview with FLIR SYSTEMS validated the need for the Two Band Imaging System in the military for target acquisition and in the scientific industry for research and development. (Primary and Secondary Markets)

[FLIR SYSTEMS INC.]

Name: Scott Way

Position: Sr. Director of Advanced Development

Phone: 503- 498- 3118 (office)

503- 880- 4958 (cell)

Email: scott.way@flir.com

**** Key information is highlighted in blue.**

Background information: FLIR Systems, Inc., is a world leader in the design, qualification, and manufacture of thermal imaging and stabilized EO/IR systems for a wide variety of airborne, maritime, land based and man-portable applications including intelligence, combat search and rescue, border control and drug interdiction, navigation safety, maritime patrol, force protection and facility security, forward observation, training, targeting, and fire control, and laser weapons designation. FLIR Systems is headquartered in Portland Oregon, with service and manufacturing facilities worldwide. FLIR Systems is the leading thermography company in the commercial sector.

The primary contact at FLIR is Scott Way.

Key questions and answers:

Q: What would be the typical process in your company for integrating a new technology?

A: Typically marketing identifies the need for new technology based on either definite customer requirements or market surveys. Engineering assesses the validity of the technology and provides an estimate of the cost and schedule to insert this technology into a product or to develop a new product. Management determines if the product will meet ROI guidelines and if sufficient resources are available to develop the product. Once this process is completed and assuming it meets the ROI requirements, it gets a go ahead.

Q. Is the initial screening for a technology driven by the R&D department/team or by a product manager? Who conducts the rest of the screening to ensure that the new technology can be beneficial not only to the company, but also the customer?

A: Usually R&D does the initial screening to determine if the technology can meet requirements. Product management and Marketing provide the “customer interface” to be sure that what is developed is useful.

Q. To your knowledge has FLIR ever licensed a technology to help improve existing products or as an addition to the product line?

A: Yes

Q: If FLIR were to license a technology such as the Two Band Imaging System, how would you go about doing so? Who is the contact person for licensing?

A: The advanced technology group usually does the initial evaluation.

Q. Do you think this technology has military application (specifically identifying and recognizing targets)?

A: In looking at the patent for the dual band imaging system it appears that this technique is most suitable for cryogenically cooled detectors. FLIR is divided into two primary divisions, Government systems and commercial systems. In commercial systems we have high end scientific cameras such as the SC series that would be more suitable for this technology. In government systems, the US Army is considering making dual band technology a requirement in many of their systems but they have already invested a lot of money in a stacked detector technique that they want to deploy. The detectors are very expensive however so the technology is limited to very high end systems. One alternative for us might be to insert this type of technology into a lower end product such as our RECON series hand held imagers.

Q: There are many products at FLIR that are similar to the Two Band Imaging System. What is the competitive advantage of your technology in comparison to other infrared cameras on the market?

A: Price, performance, user interface.

Q: Can your technology be used in the daylight and at night? Is it flexible enough to use any array, band, or focal plane?

A: Infrared can be used 24/7. The camera designs have to be tailored to the spectral band and the detector being used because different optical materials have to be used for different wavebands.

Q: Do you see a need for the Two Band Imaging system in your company? If so where is the need?

A: At the high end if we want to compete with some of the new army programs we will need dual band. At the low end we will need an affordable solution to be able to market a viable product.

Q: What are some potential applications do you see for the Two Band Imaging System?

A: Scientific applications, better target discrimination and acquisition, industrial applications such as pollution detection, energy surveys.

Q: Are there any other technologies in your company that use multi-focal planes/sensors and functions in merging images?

A: Most of our high end gimbal systems are multispectral that is they have an IR camera, an EO camera, perhaps a SWIR camera.

Q: How do you foresee improving your current E-Series line to better fit the needs of your customers?

A: higher performance, longer battery life, more user interface features.

Q: What role can we expect FLIR to play in shaping the future of the infrared camera market?

A: We try to be the price performance leader for the infrared marketplace, we strive to continue to make IR products more affordable to open up the market space. This benefits not only our commercial customers but also our military customers because they can afford to provide this technology to a wider spectrum of the force.

Q: Is there any other insight or information that you could provide on the infrared camera market and/or equipment that would be beneficial to this market study?

A: None that I can think of.

