



FLIR

APPLICATION STORY

Emerging applications for miniature thermal imaging cameras

The use of thermal imaging technology and the public's awareness of its capabilities has increased dramatically in the last decade. Thermal imaging used to be a very expensive technology for military users only. Today, more and more people are discovering the technology and the benefits it has to offer. Thermal imaging cameras produce a clear image in the darkest of nights, in light fog and smoke and in the most diverse weather conditions.

The Photon can be used for the most demanding applications.

Through television shows like "Rescue 911" and other reality programs that are reporting about the activities of firefighters, policemen and other rescue workers, more and more people are aware of thermal imaging cameras and their capabilities. Many of us have seen on television how thermal imaging can help policemen to locate and follow suspects in total darkness.

There has also been an increased interest in thermal imaging for all kinds of security applications, from long-range surveillance at border crossings, truck and shipping container inspection, to the monitoring of high-security installations such as nuclear power stations, airports, and dams. But thermal imaging has a lot more to offer than just a night vision solution for security applications.

Thermal imaging: a technology that saves lives

Thermal imaging has a multitude of uses, but none are more important than the ones that save lives, whether it is locating people in a fire, finding suspects in total darkness, or helping drivers and captains to navigate at night. It might just be a matter of time before every policeman, firefighter, rescue worker and security guard will have a personal thermal imaging camera in a compact, battery-powered package.

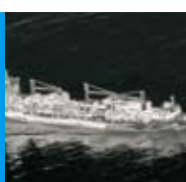
At the same time, consumers are gaining access to thermal imaging technology. Car manufacturers are integrating night vision modules for driver vision enhancement into cars. By helping drivers to see at night, accidents can be avoided. Boats and yachts are being equipped with thermal imaging cameras for nighttime navigation and other maritime applications like man overboard searches. The increasing worldwide demand for thermal imaging cameras has resulted in the ability for manufacturers to bring down production costs considerably. As prices come down and interest in the technology rises, more and more manufacturers across many diverse product areas are seeing the added value of thermal imaging and are willing to integrate a thermal imager in their products. Often the thermal imager is just a small part of the complete product, so it needs to be as small, light and inexpensive as possible.

Photon: miniature thermal imaging camera developed by FLIR Systems

Recent advances in miniaturizing thermal imaging technology have led to the production of the FLIR Systems Photon thermal imaging camera. The Photon is a high sensitivity, high reliability, uncooled, longwave thermal imaging camera. The compact design of the Photon and its low weight and low power consumption make it the ideal thermal imaging camera for numerous thermal infrared imaging applications, particularly those involving battery-powered operation.







14.25 mm lens

19 mm lens

35 mm lens

50 mm lens

A wide range of lenses is available to adapt the Photon to virtually any application.

With an IR sensor based on vanadium oxide microbolometer technology that produces images from a 320 x 256 array, the Photon is intended to be a commodity infrared camera, made in large quantities as a standard product, yet with a diverse variety of optional features that make it attractive to a wide market space. A wide range of lenses is available to adapt the Photon to virtually any application.

The key to achieving low price is the ability to manufacture the infrared sensors in mass quantity with high yield. FLIR Systems has implemented a highly automated microbolometer production line, based on the commercial silicon foundry process model. This production line has the highest production capacity in the world by far. It uses cassette-to-cassette wafer handling technology to speed up production, as well as metrology integrated into the line to ensure continuous process feedback.

Small and lightweight but producing crisp thermal images

The Photon fits in the palm of one's hand, is extremely lightweight (only 130 grams with 19 mm lens), and consumes less than 1.6 watts. It is very similar in form to compact CMOS cameras for visible-light imaging.

The Photon infrared sensor is a 320 by 256 pixel focal plane array (FPA) that images in the 7.5-13.5 micron, or longwave infrared waveband. The longwave infrared band is particularly useful for seeing people in the dark, even through smoke. The Photon is a fully integrated camera that has both analog video and 14-bit digital data outputs as well as an RS-232 serial communications port, all three of which are brought out to a single 15-pin high density connector that also contains the power input pins.

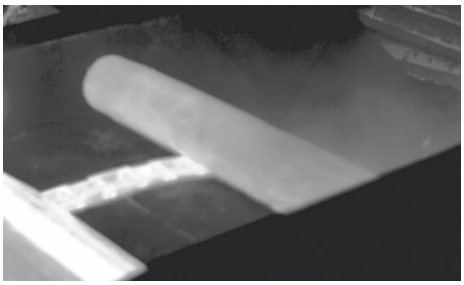
No thermoelectric cooler

The Photon's FPA does not require temperature stabilization, thus eliminating the thermoelectric cooler (TEC) found in other microbolometer cameras. Although there are other TEC-less cameras, they do not have the wide operating temperature range (-40°C to +80°C) of a FLIR TEC-less camera. Making a camera that operates without a TEC was made possible by FLIR's development of proprietary read-out circuitry and novel non-uniformity correction algorithms. This design feature leads to a number of major advantages over thermal infrared cameras with TECs:

- The Photon can produce an image in about 2 seconds from power up, because it does not require that the FPA be at a particular temperature for operation, as is the case with TE-stabilized cameras. This is a big advantage in firefighting applications, since cameras are turned on and off to conserve battery power and any delays in producing an image can be potentially dangerous.
- There is reduced power consumption, crucial in applications where the camera operates on battery power. This power consumption does increase as the difference between the camera case temperature and the FPA temperature grows, a situation often encountered in applications such as firefighting where ambient air temperatures can be several hundred degrees C.
- There is greatly reduced heat buildup within the camera package, especially important in applications where the camera is enclosed in insulation and self-heats. TECs draw substantial current and therefore generate plenty of waste heat.
- The Photon's scene dynamic range can be extended considerably over TE-stabilized cameras, due to the reduction of the effects of stray radiation from the optics and FPA enclosure. An extended dynamic range allows the thermal imaging camera to see a wide range of temperatures in the scene without saturating the image, a situation often found in firefighting applications.

Photon: an excellent thermal imaging camera to include in a wide variety of products and applications

For an infrared camera to be successful in the commercial marketplace, it has to be adaptable to a wide variety of applications. The number of applications for infrared cameras is growing at a tremendous rate as the price decreases. The Photon's advanced signal processing is highly versatile and can be programmed in a variety of different ways that allow for specialty features for diverse applications. For example, the firefighting market drove the development of a coarse spot radiometer that indicates temperature within a 2 by 2 pixel region of interest. Another firefighting feature implemented in software is the false coloring of pixels within the image. The color of these pixels correspond to temperatures over adjustable thresholds for rapid identification of hot areas in the scene.



The Photon can be used for a wide variety of commercial applications.

Driver Vision enhancement

Nighttime driving presents serious risks to drivers of cars, trucks, buses and other vehicles. Many serious accidents occur at night, in fog, and in light rain because the driver could not see an object in time to prevent the collision. Each year, thousands of nighttime accidents occur with large vehicles, many due to adverse weather conditions. Drivers may lack the ability to quickly reduce speed, fatigue can negatively affect reaction time, and vision gets severely impaired in the dark.

Thermal imaging is a powerful driver's vision enhancement tool which significantly reduces the risks of nighttime driving and allows the driver to see up to 5 times farther than with headlights. It needs no illumination to operate. Thanks to thermal imaging, drivers can more quickly detect and recognize potential hazards and avoid deadly accidents. Thermal imaging also helps drivers to see road edges better, see approaching curves earlier, overcome momentary blindness from oncoming headlight glare and see through smoke, dust, light fog and light rain.

The PathfindIR™ installed in a truck

BMW has started using this technology on its 7-, 6- and 5-series passenger cars to facilitate night time driving. Buses and trucks are used much more intensely than passenger cars and can greatly benefit from this technology.

FLIR Systems markets the PathFindIR as a specific thermal imaging camera solution tailored to the demanding needs of the transportation industry. Essentially, the core of the PathFindIR is a Photon camera, which is packaged in an extremely rugged housing that withstands harsh driving conditions.

Aviation – making flying safer

The Photon is also the core of the FLIR Systems EVS3. It is a low-cost thermal imager for use as a pilot's night vision enhancement. It helps pilots by enhancing the ability to see terrain and other aircraft at long ranges, even in total darkness, light fog, dust and smoke.

The EVS3 is designed for integration with existing multi-function displays, with a simple "power in and standard video out" interface. The FLIR's patented Digital Detail Enhancement (DDE); which is included in the Photon, assures excellent image quality regardless of scene dynamics, revealing scene detail missed by more expensive competitive systems. A choice of lens options is available to accommodate various flight profiles with wide, medium and narrow fields of view.

Visual image

Thermal image

Firefighting – seeing through smoke

Firefighters have been using thermal imaging cameras for years in order to see in absolute darkness or through smoke, as well as to detect hot spots in floors, walls and ceilings. Smoke has a large component of micron-sized carbon soot particles in it, making it very absorbing to visible light. However, when the particle size is significantly smaller than the wavelength of light used by a sensor, the scattering is greatly reduced, making it possible to see through smoke. Longwave infrared light has a wavelength that is about 20 times longer than visible light wavelengths, making longwave thermal imaging cameras ideal for this application.

The ability to detect temperature differences of objects is vitally important to firefighters, who must often open doors that lead to fires, or who must identify the seat and extension of a fire quickly and reliably.

Reducing the size, weight and cost of fire service thermal imaging cameras while improving performance has been of paramount importance to the industry, as some earlier fire services cameras were heavy and awkward to use, lacked sufficient dynamic range to be useful in some situations, and were too expensive for many fire departments.

Mine Safety Appliances Co. (MSA) (Pittsburgh, PA) has integrated a version of the Photon camera into their Evolution® 5200, Evolution 5200HD[2] and the new Evolution 5600 for the fire service. It is also used in the ThermalTrac™ camera for law enforcement. The fire service requires a camera with a very wide scene dynamic range, such that the camera can be pointed in the direction of a very

hot fire, yet still produce a useable image of the colder surroundings or personnel without saturation. The Photon has a 14-bit scene dynamic range, and uses a non-linear histogram AGC algorithm to map the 14-bit range to an 8-bit analog video display. The camera also has two gain states which are automatically selected according to the percentage of pixels in the image that go above or below a threshold value. This enables the camera to be used in both extremes of environments that firefighters regularly encounter, such as a dark wet basement and a burning room.

Unmanned Aerial Vehicles (UAV)

Unmanned aerial vehicles are becoming more and more common in military and civilian operations, especially miniature aircraft designed to fly at low altitude. These radio-controlled planes can be equipped with video cameras that are downlinked to a ground station. Thermal imaging allows the aircraft to fly in total darkness and detect targets through smoke. The same aircraft can also be used to detect such things as forest fires. Areas which are hotter than the surroundings can indicate the start of a fire and can clearly be seen on a thermal image.

AeroVironment (AVAV) (Simi Valley, CA), a leader in unmanned aircraft systems, has integrated the Photon into several of their products, including the hand-launched Raven B. Since the Raven B is a lightweight UAV powered by batteries, minimizing the weight and size of any on-board instrument is crucial. Typically, the Photon is mounted inside the aircraft's nose cone, pointing forward and angled down for reconnaissance and navigation. This capability enables the Raven B to provide true day and night operation, resulting in a formidable tool for acquiring real-time situational awareness in a wide variety of environments and applications.

Thermal surveillance

Qioptiq based in the UK is a designer and manufacturer of infrared and image intensified night vision equipment. The company has integrated the Photon in one of their handheld thermal surveillance sight products called "VIPIR2-S" and in the weapon mounted "VIPIR-2".

Since the equipment needs to be small and lightweight so that it can easily be carried in the field, the Photon was the perfect instrument to integrate in the VIPIR. Moreover, the low power consumption of the Photon allows the VIPIR to be operated on only 4 commercial AA batteries for over 6 hours. The absence of a Thermoelectric cooler in the Photon allows the operator of the VIPIR to switch on the device and get a clear image immediately.

Infrared everywhere

The FLIR Systems Photon thermal imaging camera is a major step to the arrival of miniature, low-cost thermal imaging cameras in the technology marketplace. As volumes are increasing and prices continue to fall, we will see the Photon and similar products incorporated into a host of OEM applications and packages.

Thermal imaging will, in the not-too-distant future, be as ubiquitous as technologies like GPS and Radar that had their origins in military laboratories but are today widely spread and accepted by consumers worldwide.

Ackowledgement to Dr. Austin Richards Ph. D. to authoring the article and to Mr. B. Terre and to Mr. S. Laband for valuable input and advice.

For more information about thermal imaging cameras or about this application, please contact:

FLIR Commercial Vision Systems B.V.
Charles Petitweg 21
4847 NW Teteringen - Breda - Netherlands
Phone : +31 (0) 765 79 41 94
Fax : +31 (0) 765 79 41 99
e-mail : flir@flir.com
www.flir.com

AS_0109_0013_EN