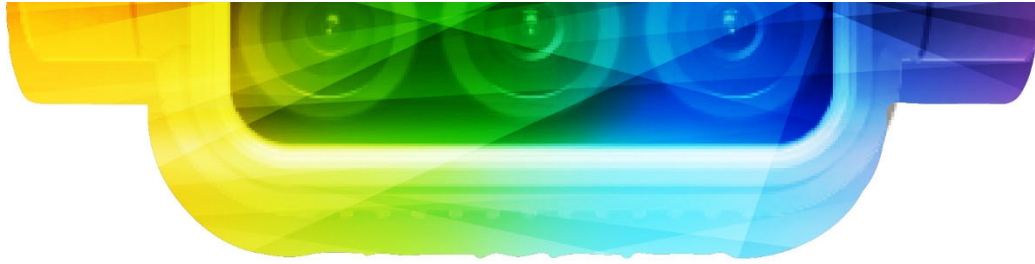




# **Multispectral Imaging**

What it is and what it's used for





**You may be surprised to learn that there's a kind of photography that captures images of things that you can't see. It's called multispectral imaging.**

Multispectral imaging captures light from a narrow range of wavelengths across the electromagnetic spectrum. Multispectral images are captured either with special cameras that separate these wavelengths using filters, or with instruments that are sensitive to particular wavelengths, including light from frequencies that are invisible to the human eye (infrared and ultra-violet, for example).

Your traditional digital camera captures the light that falls onto the sensor. The sensor captures images in the same way that your eye perceives color. To do this, your camera uses wideband filters to divide the light into three channels: red, green and blue (RGB). A multispectral camera, on the other hand, captures information that is neither available to the human observer, nor to a typical RGB camera.

Multispectral imaging was developed by NASA for space-based imaging, but is now used in a wide variety of applications. So, what is multispectral imaging used for? Let's see.

## Space-Based Imaging

If you've ever seen an infrared image of the earth taken from space, you have likely seen an image captured with a multispectral imaging camera or instrument. Earth observation satellites carry a number of instruments for measuring infrared and ultraviolet radiation. Multispectral imaging combines between two and five spectral imaging bands into a single optical system.

Multispectral imaging instruments installed on NASA's Terra and Digital Globe's Worldview-2 have given researchers a new way of observing the earth, especially for agricultural research and mapping of man-made and natural disasters.

## Remote Sensing

Landsat satellites use multispectral sensors help analysts study land use and land cover change, vegetation and agricultural production trends and cycles, water and environmental quality, soils, geology, and other earth resource and science problems. In fact, Landsat has been one of the most important sources of mid resolution multispectral data globally.

## Military Target Tracking

Many of the threats facing today's military are unconventional. Enemies typically have an advantage on their local terrain, an advantage that must be monitored from a distance. Multispectral imaging has a wide variety of military applications, including locating improvised explosives, discovering enemy movements at night time, and measuring the depth of hidden bunkers.

Multispectral imaging is used to detect and track military targets because it measures mid-wave infrared and long-wave infrared. Multispectral imaging measures radiation that's inherent to an object, regardless of the presence of any external light source. This type of detection is also known as thermal imaging.

## Land Mine Detection

Multispectral imaging is also used to detect land mines and underground missiles by analyzing the emissivity of ground surfaces. Drones flown over former battlefields use a camera that acquires registered images in six spectral bands. These images are then analyzed using software that identifies metal and plastic land mines.



Soil on the surface and soil beneath the surface possess different physical and chemical properties that can be detected with multispectral analysis. Disturbed soil features increased emissivity in a specific wavelength, and analyzing images of this soil helps military commanders to identify likely locations of land mines. Detection of recently buried land-mines and improvised explosive devices using multispectral imaging is a growing field.

## Ballistic Missile Detection

The most important component in ballistic missile defence isn't the surface-to-air missiles that intercept the ballistic missiles, but the multispectral sensors that detect the ballistic missiles.

Ballistic missile defence systems detect, track and intercept enemy ballistic missiles. The system consists of a ballistic-missile warning system, a target discrimination system, an anti-ballistic-missile guidance system, and a command-control communication system. Multispectral imaging is used in the detection stage. Intercontinental ballistic missiles emit invisible radiation during their boost phase. Multispectral imaging detects the body of the missile body (mid-wave infrared) as well as the rocket plumes (long-wave infrared).

## Document and Painting Analysis

Multispectral imaging is also used to interpret ancient papyri and other documents from antiquity by imaging the documents in the infrared range. Typically, writing on ancient documents appears to the naked eye as black ink on black paper. But when viewed with a multispectral imaging camera, the difference between ink and paper is more distinct because of how differently ink and paper reflect infrared light.





## Farming

Multispectral imaging is being used in agriculture to manage crops, soil, fertilizing and irrigation more effectively. Multispectral cameras mounted under agricultural drones detect green, red, red and near infrared wavebands to capture visible and invisible images of crops and vegetation. Multispectral imaging helps farmers minimize the use of sprays, fertilizers and irrigation, while increasing the yield from their fields.

Farmers integrate their multispectral images with specialized agriculture software that translates the images into meaningful data. This data includes information about land telemetry, soil condition and crop progress, and helps the farmer to monitor, plan and manage the farm more effectively, which saves time and money, and reduces the use of pesticides.

## Healthcare

The earliest and most successful uses of multispectral imaging were in diagnostic medicine. Multispectral imaging lets healthcare providers pinpoint the presence of diseases that are hard to identify with other means. Eventually, multispectral imaging was combined with nanotechnology to diagnose health issues at the level of individual cells.

Light interacts with biological tissue in different ways, depending on the wavelength of the light. This makes spectral multispectral imaging a powerful tool for biomedical and chemical applications. For example, images captured in the near infrared wavelength help doctors take depth measurements in tissue and blood chromophores such as oxy-hemoglobin, deoxy-hemoglobin and bilirubin. Spectral imaging has the added benefit of being non-invasive, which makes it useful in assessing burns and skin inflammation.

## Forensics

Multispectral imaging is also being used to analyse forensic evidence at crime scenes and also in the laboratory. conditions or directly at the crime scene. Multispectral imaging is valuable to forensic teams because it is a non-contact, non-destructive way to analyse evidence. Also, it requires no sample preparation, which ensures the integrity of evidence. Multispectral imaging is used for forensic analysis of fingerprints, bloodstains, inks, powder residues and documents.

## Environmental Monitoring

Multispectral imaging is used to collect data from dangerous and inaccessible areas. Remote sensing applications include monitoring **deforestation** in areas such as the **Amazon Basin**, **glacial** features in Arctic and Antarctic regions, and **depth sounding** of coastal and ocean depths.

## Detecting Algal Blooms

Multispectral imaging is being used from space to map and monitor algal blooms in coastal waters. Algal blooms are a rapid growth of microscopic algae or cyanobacteria in water, often resulting in a colored scum on the surface. The science of detecting algal blooms with multispectral imaging is in its infancy because of the presence of suspended sediments and dissolved organic matter, which interfere with the images.

## Surveying & Mapping

Traditional single-wavelength systems are good at revealing where things are on the ground, they are less capable of determining what those things are.

Multispectral imaging allows surveyors to compare a target's unique reflectance response for each wavelength emitted, providing more detailed analysis and enhanced target discrimination.

## Multispectral Imaging Cameras

A number of multispectral cameras can be purchased on the open market. These include hand-held units and ones that can be attached to a drone. Prices range from \$2,400 at the low end for drone cameras all the way up to \$44,000 for specialized hand-held units.



### About Benton & Sotheby

Benton & Sotheby provides scientific imaging solutions for a vast array of applications. From solar cells to live cells, our fast and integrated hyperspectral imaging systems provide solutions to industrial challenges, and give researchers access to the latest innovations in optical and photonic instrumentation. In addition to our recognized hyperspectral microscopy and wide-field systems, we have developed unique near infrared cameras specifically adapted to industrial applications. If you cannot find what you are looking for in our standard products, let us know, our innovative team is always ready to transform ideas into solutions.

