In machine vision applications, cameras are used to obtain an image to inspect for visible characteristics. The camera then communicates with a computer through machine vision software to process the data, analyze results, record findings, and make decisions based on the information. The result is increased automation, consistency, and efficiency. So how can machine vision be used beyond what is visible?

Infrared (IR) or thermal vision is capable of detecting infrared radiation through infrared or thermal imaging. Infrared emissions can be thought of as being related to temperature. Infrared machine vision uses an infrared camera working at wavelengths beyond the visible spectrum (in other words, invisible to the human eye) to capture radiation emitted by an object. Practical working IR wavelengths are typically in the range of 7.5 to 14µm (micrometers). Typical applications for IR machine vision could include industrial inspections, detecting exothermic chemical changes in samples over time, or absolute measurements against an established threshold.

Some examples where infrared machine vision is currently being used include food inspection (for both temperature and bruising of produce – as illustrated in Figure 1) and manufacturing inspection (for impurities, leaks or gaps in the solder in microelectronics, and other “invisible” quality control issues).

Figure 1. An example of a bruised apple: visible image (top) vs IR image (bottom), demonstrates the advantage of using Non-Visible spectrum for image analysis. Source: http://archives.sensorsmag.com/articles/1004/19/main.shtml

The same computer driven analysis techniques used in Infrared Machine Vision applications can also be applied to spectroscopic analysis. Much of the spectroscopic analysis of organic and biological compounds is based around the fact that vibrational and rotational modes between atoms can absorb energy resonantly in the IR. By looking at areas of strong absorption from a broadband source and noting the wavelength at which the absorption occurs, the compounds structure can be determined. In Figure 2, each trough represents a resonant absorption of IR radiation related to either a specific inter-atomic transition or change in potential of some form between the various elements that make up the compound.
Since the development of the first commercial infrared camera in the late 1960s, the availability of new generation infrared cameras coupled with growing computer power has provided new applications for using infrared or thermal imaging, including component maintenance, defect detection and characterization, and medical and veterinary thermal imaging. Now that infrared cameras are more accessible and affordable, combining imaging with the benefits of machine vision enables a user to conduct machine vision beyond visible light, where temperature or chemical composition is a factor.

The use of Infrared spectroscopy in a variety of clinical chemistry and biomedical applications has increased given better instrumentation and sample processing. Studies have been conducted that involve the transcutaneous determination of important metabolites, such as blood glucose. Samples from a variety of bio-fluids, including blood, urine or tissue, can be measured spectroscopically by identifying the infrared absorption peaks when light is in a resonance through the shift it creates in the spectrum.

Infrared spectroscopy can also deliver reagent-free multicomponent assays and identify the structure of organic or inorganic compounds. It can be used to monitor oxygen metabolism by observing changes in absorbance between 760 and 950 nm (where hemoglobin shows significant absorption in both reduced and oxygenated states), measurement of myoglobin in muscle tissue, or cytochrome aa3 in cell mitochondrial membrane (based on spectral absorption features around 840 nm). The infrared imaging combined with machine vision could be used to develop custom software to drive spectroscopic analysis.

Many medical diagnostic tools take advantage of the optical window that defines the range of wavelengths between 700 and 900 nm -- the sum where the oxygenated hemoglobin (HbO2), deoxygenated hemoglobin (Hb), and water (H2O) is at a minimum, making the window ideal for medical spectroscopy. This is the dispersion of the light in relative intensities across an energy scale (see Near Infrared or NIR window Figure 3 below), where the spectroscopic components of the light are either given off or absorbed.
JADAK’s machine vision software can be utilized in image analysis solutions for the spectroscopic market or to perform analysis between two individual spectra with the difference used to identify a “presence or absence” type scheme.

Now imagine all of the other potential infrared machine vision applications that are possible – from exothermic chemical reactions to any water-based solution, where infrared light can be absorbed. Infrared machine vision can be used to monitor the temperature of products, people, reactions, samples and even rooms.

To discuss your machine vision needs, contact the experts at JADAK at info@jadaktech.com or 315.701.0678.

SOURCE:


2 http://www.vision-systems.com/articles/print/volume-17/issue-10/features/infrared-cameras-enhance-diagnostic-medical-imaging.html