SPECIM
SPECTRAL IMAGING

HYPERSPECTRAL TECHNOLOGY VS. RGB

Machine vision manufacturers widely use Red-Green-Blue (RGB) cameras. These cameras are suitable for characterizing objects based on their shape and color. However, since only three visible bands are available, their identification capability is minimal.

Hyperspectral cameras may be used for more demanding applications to measure objects or scenes by recording hundreds of bands across a wide spectral bandpass. Those bands are contiguous and are not limited to the visible part of the spectrum.

Hyperspectral Imaging (HSI) provides the users with a large amount of information, allowing identifying the screened materials based on their chemical composition rather than only their size, shape, and visible color. Each material has its unique composition and therefore reacts singularly to the electromagnetic spectrum. HSI cameras extract this singular reaction and, in turn, use it as a signature for identification, just as one uses a fingerprint to identify an individual.

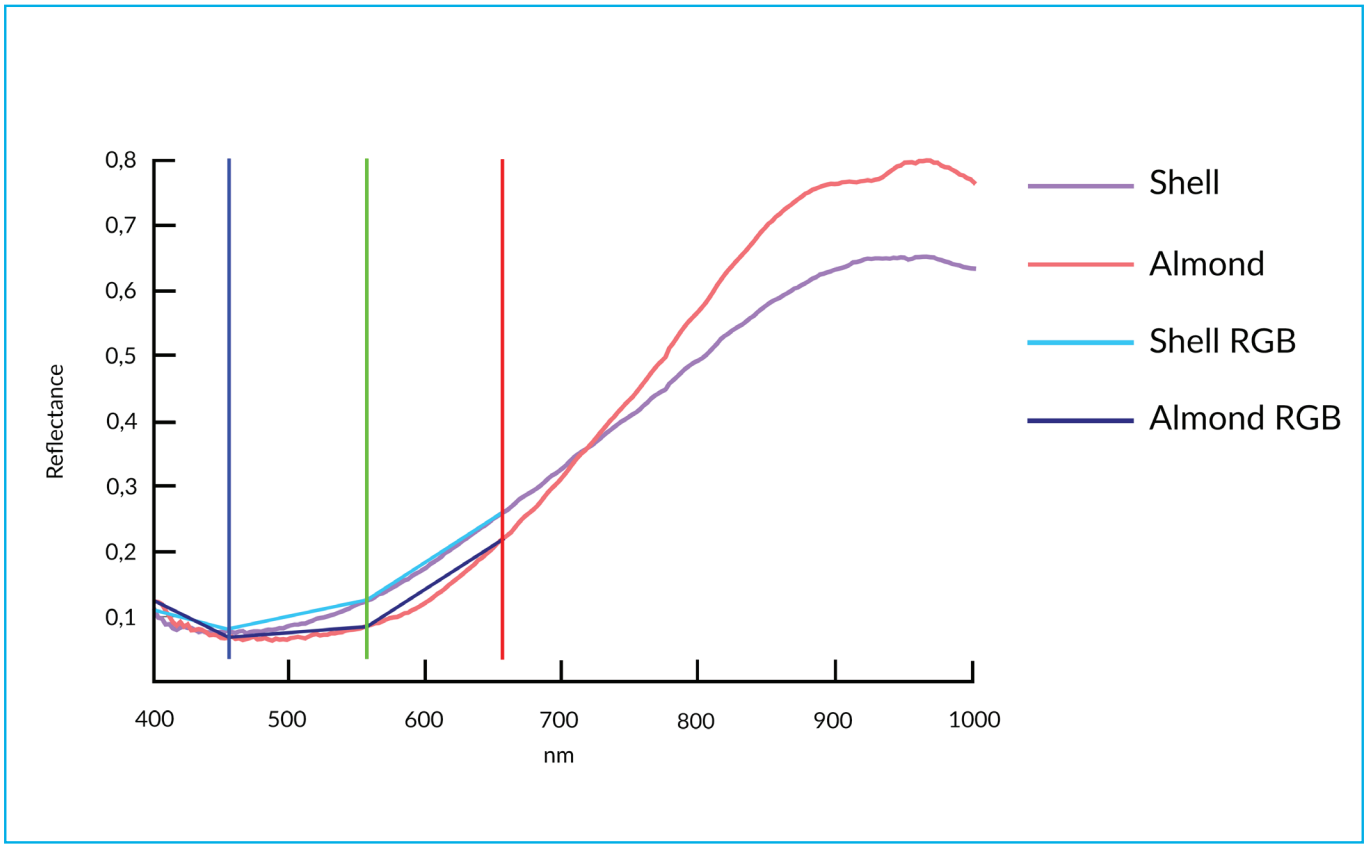

Figure 1: VNIR spectrum of an almond (FX10; Red) and shell (FX10; Magenta). RGB components of almond (dark blue) and shell (cyan). Measurable RGB camera bands are represented by respective vertical lines.

The above figure (Fig. 1) illustrates the limitation of RGB cameras with respect to hyperspectral cameras. The hyperspectral camera (FX10) measures the complete spectral signatures, so it can accurately measure the differences between almonds and their shells regardless of the color of the shell or the almonds.

In this example, the spectral feature at 930 nm related to the nut's oil provides a precise and selective signature for accurate sorting. The RGB camera is limited to three color bands, missing the most relevant sorting criterion completely.

In addition to extended sensitivity into the Near Infra-red (NIR) spectral region, the hundreds of bands measured by the FX10 produce a much more accurate depiction of color images than one represented by just three bands of the RGB camera (Fig. 2). Hyperspectral cameras beyond the visible spectral range, like the FX17, cover the NIR from 900 – 1700 nm. These cameras offer extended spectral data suitable for more robust models (depending on the application requirements). As in Fig.2, the FX17 camera would be the best instrument for sorting almonds and pistachios from their shell and foreign contaminants – outperforming an RGB-based model. It is important to note that other applications may require hyperspectral cameras with sensitivity in the Short-Wave IR (SWIR, 1700 – 2500 nm), Mid-Wave IR (MWIR, 2.7 – 5.3 um), and or Long-Wave IR (LWIR, 8 – 12 um) spectral regions.

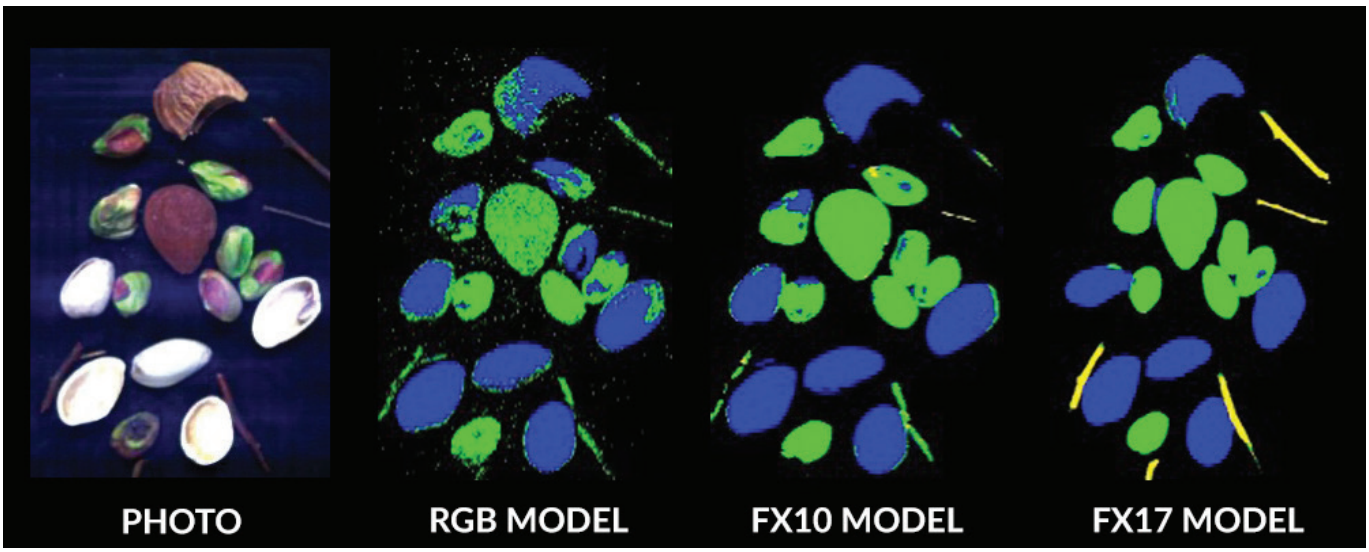

Figure 2: Photo and model predictions based on RGB camera, FX10 and FX17 data.
Pistachios and nuts are classified in green, shells in blue and wood in yellow.

Machine vision systems usually combine several sensors, which are complementary to each other. The table below highlights the advantages of hyperspectral technology over other typically employed sensors.

	HSI	X-Ray	Barcode Reader	RGB	Monochromatic	Multispectral
Speed						
Color Interference						
Material ID						
Contactless						
Versatile						
Quantitative						
Qualitative						

Table 1: Green = Good, Orange = Poor, Red = Not Relevant