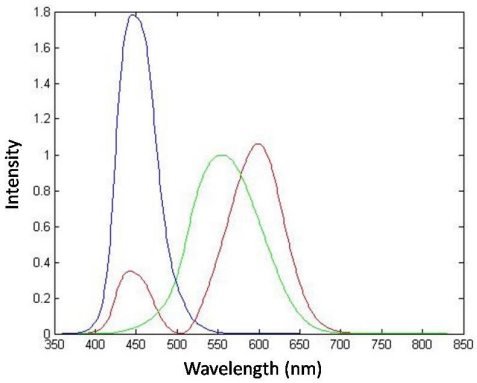
COLOR INSPECTION

In-process and Laboratory Color Monitoring

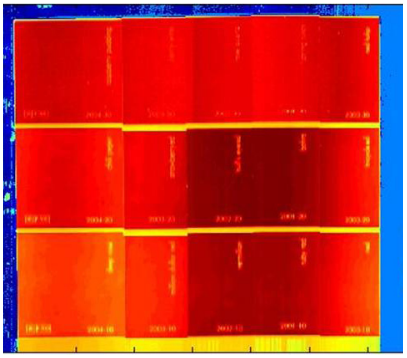
Color monitoring and sorting are key processes in numerous industries including textiles, cosmetics, food, printing, and building materials. In-process monitoring of these products during manufacturing is possible with push-broom hyperspectral imaging (HSI) cameras. In fact, if the samples are moving, such as roll-to-roll textiles or food products on a conveyor belt, push-broom imaging is the only way to obtain hyperspectral measurements without interrupting the continuous production process. Because hyperspectral cameras view the moving material one line at a time and cover the entire surface of the product stream, they are ideal for high-speed in-process quality control applications in manufacturing environments. Color inspection can also be performed on single objects and in the research lab, and includes a wide range of items such as art work, paint products, custom signs or posters, embroidery, quilts, and colorful antiques. Samples can be placed on a moving tray below the camera and full spectrum color measurements can be collected in only a few seconds without damaging the sample from high illumination and potential heat load.



Color Component Measurement

As shown in the images below, red paint color swatches were measured with a visible hyperspectral camera (model HS-V8E) and processed to compute CIE 1976 (L*, a*, b*) color space dimensions. The color coordinates were calculated based on all wavelength points to distinguish the similar colors. Shades of red towards the higher end of the visible wavelength spectrum are typically more difficult for the human eye to differentiate, as shown in the standard RGB camera image.

RGB image



Plot of b-color dimension

The three Lab components (L*, a*, and b*) can often display differences between colors that are indistinguishable to the human eye. For example, the "Bull's Eye Red" and "Vermilion" swatches (boxed in the RGB image) are almost indistinguishable to the naked eye, but in the measured and calculated b dimension, the swatches were clearly separated. Each color space dimension accentuates dissimilarities differently, so calculating all three can greatly improve upon the color differentiation observed by the human eye alone.

Counterfeit Credit Card Detection

Hyperspectral imaging color inspection technology can distinguish counterfeit credit cards from real credit cards. As counterfeiting technology improves, credit card companies are continually developing more complex and costly holograms to mitigate risk. As an alternative, hyperspectral imaging can be applied as a cost-effective, non-destructive way to verify the authenticity of a credit card hologram. Researchers at the National Electronics and Computer Technology Center in Pathumthanit, Thailand, used hyperspectral imaging technology to effectively identify whether the embossed hologram on a credit card was genuine. Although a hologram can be replicated to appear identical to a genuine hologram, hyperspectral imaging can detect differences in the microscopic detail and key color characteristics. (Sumriddetchkajorn, 2008)

Analysis of Historic Documents

Since aging and document damage is not always visible to the naked eye, HSI technology can be used to evaluate the condition of historic documents by assessing the amount of stain and chemical deterioration of the documents. Researchers at the University of Winnipeg, Canada, demonstrated that hyperspectral imaging improved their ability to evaluate the extent of damage to a historic treaty. By more accurately assessing the state of preservation of historic documents, researchers were able to improve their conservation methods. (Goltz, 2010)

Measuring True Color and Pattern

While there are many different devices to identify the precise color of an object, hyperspectral color imaging is the only technology capable of recognizing the color coordinates of many different sections of a pattern. This feature of hyperspectral imaging is important for the quality control of artifacts with complex patterns where the color of each part of the image is equally important, such as printed textiles or artwork.

References

Goltz, D., et al. (2010). Assessing stains on historical documents using hyperspectral imaging. *Journal of Cultural Heritage, 11* (2010), 19-26.

Sumriddetchkajorn, S., & Intaravanne, Y. (2008). Hyperspectral imaging-based credit card verifier structure with adaptive learning. *Applied Optics, 47* (35), 6594-6600.