VISUALANT™

Technical White Paper

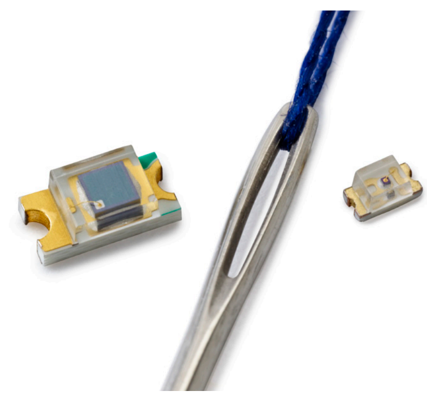
Visualant's ChromaID™ Technology

THE HANDHELD ChromaID Scanner can detect light between 350 and 1450 nm.

Everything in the world has a unique machine-readable chromatic identifier. The Visualant Spectral Pattern Matching™ technology captures this 'fingerprint' as a ChromaID Profile. The ChromaID profile is a type of spectral signature created through Rayleigh scattering of light as it is reflected off a sample.

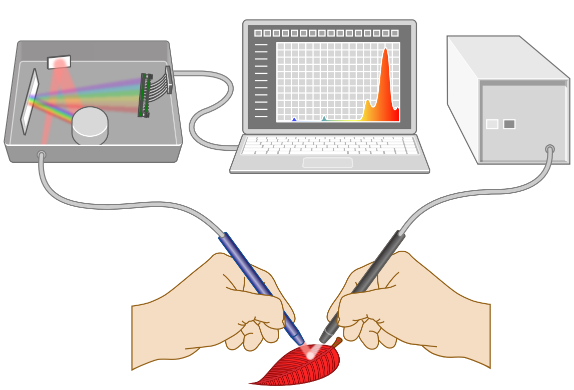
Spectral signatures are typically captured by a spectrophotometer, which uses a broadband light source to illuminate a sample, and then passes the light reflected from the sample through a collimator and diffraction grating or prism to split the light into different wavelengths. This light is then measured with a linear CCD array. These devices are bulky, and the parts can be delicate and expensive.

The Visualant ChromaID approach is simpler than a traditional spectrophotometer and can be implemented in a lower cost package and more diverse form factors. ChromaID technology makes use of simple emitters (light emitting diodes) and detectors (photodiodes). The emitters are fired in a sequence to paint a structured pattern of light, based on the spectral-emissive characteristics of each LED, onto the surface of a sample being measured. The scattered light reflected by the surface of the sample excites the detector, which provides a measure of the amount of reflected light at the emitter's frequency. Emitters are selected to output light at the wavelengths most suited to a particular application and can include ultra-violet and infra-red wavelengths.

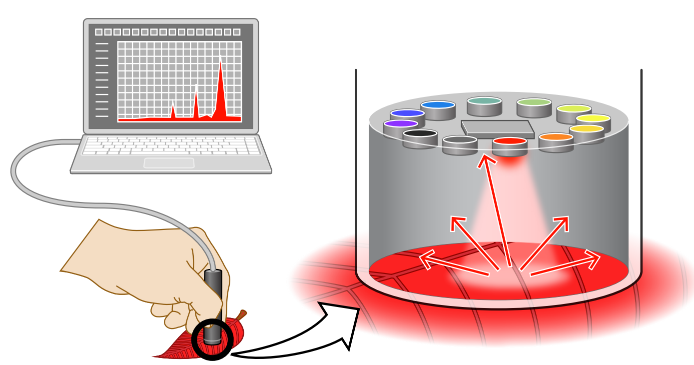


COMPARED TO a needle and thread, the tiny size of photodiode (left) and LED (right) components makes it possible to build ChromaID technology into a small robust form factor.

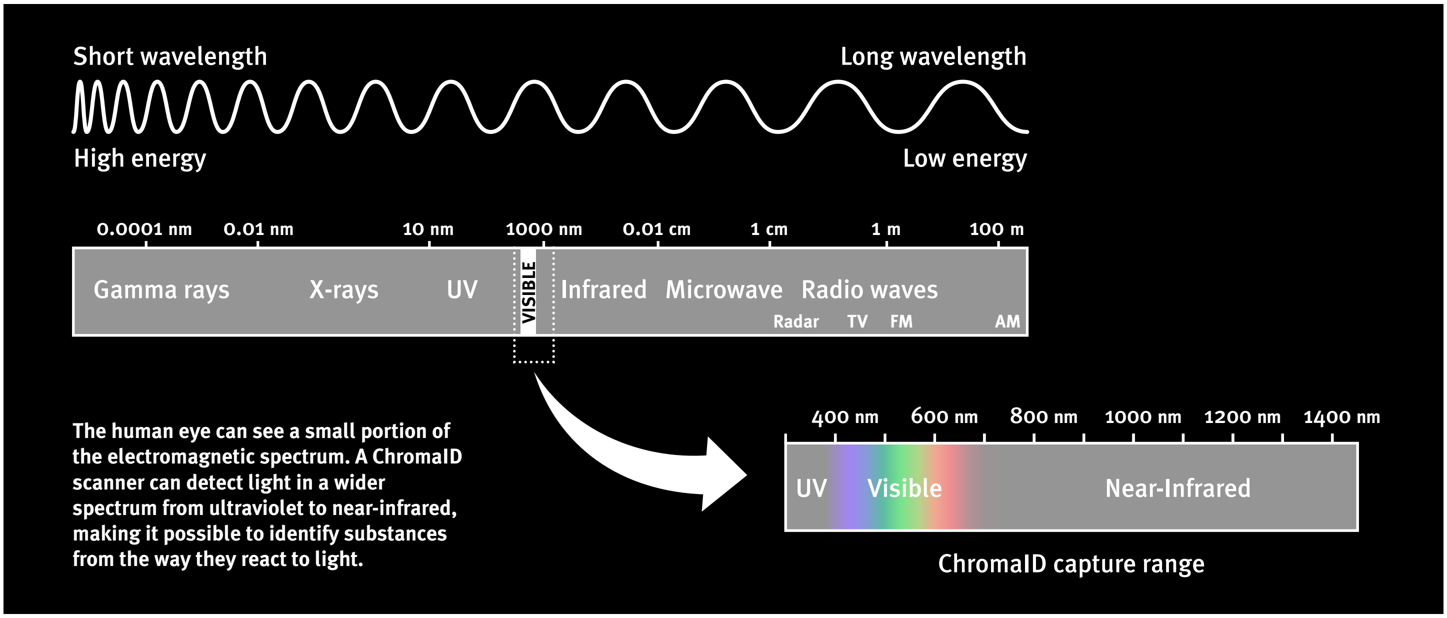
A unique aspect of Visualant's approach (which is protected by several patents) is that the current supplied to the LEDs is varied through a range of steps. This allows Visualant to vary the spectrum of the light produced by the emitter – effectively creating a 'virtual LED'. The virtual LED technique allows Visualant to cover a wider light spectrum using a limited number of LEDs. For example, one of Visualant's ChromaID scanner prototypes incorporates 32 emitters with each LED fired through 25 current steps, plus the entire sequence is repeated four times. In a single scan the emitters



IN A TRADITIONAL SPECTROPHOTOMETER, broadband white light is shone onto a red leaf. The scattered light is captured with a fiberoptic rod and reflected off a collimating mirror onto a diffraction grating. The diffraction grating separates the light into different frequencies onto a focusing mirror. The separated light falls onto a linear CCD array which measures the amount of light at each frequency. The computer shows a spike of red light in the 600 to 700 nm range.



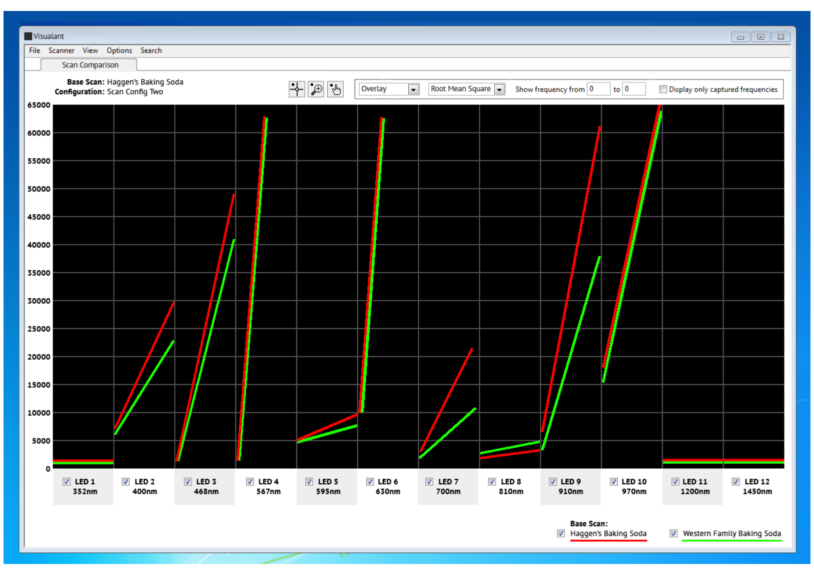
IN THE ChromaID SCANNER, LEDs shine light of different frequencies onto the leaf. The scattered light is reflected onto a photodiode, which reads the intensity of the light. The computer shows the unique spectral pattern of the red light from the leaf.



The human eye can see a small portion of the electromagnetic spectrum. A ChromaID scanner can detect light in a wider spectrum from ultraviolet to near-infrared, making it possible to identify substances from the way they react to light.

in this device paint 32 x 25 x 4 = 3,200 flashes of light onto the sample. The reflected light from the sample due to each of these flashes is measured by the detector. This entire 'scan' is completed in less than one second and the data is captured as a ChromaID, providing a unique chromatic profile of the scanned object.

The ChromaID can be plotted on a chart showing the intensity of the reflected light at each wavelength and level that was fired. The pattern of this chart can be compared to a database of patterns from known substances. This makes it possible to identify a substance based on its ChromaID. Visualant has patents relating to aspects of how these comparisons are made.

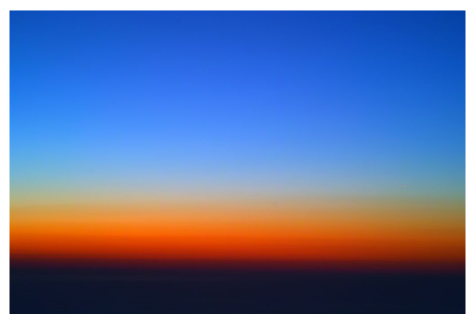


HOST SOFTWARE in our ChromaID Development Kit displays the ChromaID Profile from a scanhead with 12 LEDs. Reflected light intensity is captured for each of 25 current steps the LED has been fired at. The red and green lines are for ChromaID Profiles of Baking Soda samples from two different manufacturers.

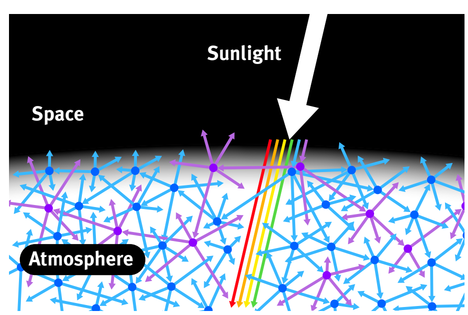
Key advantages of the Visualant ChromaID approach include:

- Uses inexpensive LEDs and photodiodes. These components are manufactured in enormous quantities for the consumer electronics market, which keeps the cost low and quality high. These components are also very small, allowing

Rayleigh, a 19th Century physicist, discovered that the electric polarization of particles in solids, liquids, and gases could cause electromagnetic radiation (light) to be scattered if the particles are smaller than the wavelength of the light. Rayleigh used his theory to explain why the sky is blue during the day, but red at sunset. The core of Rayleigh's discovery is that when light is shone onto a substance, light at different frequencies will be scattered according to the particles in the substance. The unique pattern of scattered light frequencies can be used to identify the substance. This is a key aspect of the science of spectrophotometry.



THE SKY IS BLUE and sunsets are red because of Rayleigh scattering of light.



TINY PARTICLES in the upper atmosphere cause blue light to scatter.

Visualant's scanhead component to have a small form factor.

- Does not require prisms or diffraction optical elements, which can be bulky, expensive, and fragile.
- Scanheads can be designed for specific applications, requiring only those emitters needed to provide the wavelength of light needed to characterize the types of samples that will be measured. Prototypes were developed with up to 34 emitters, but in many situations only four or six emitters might be required.
- The emitter and detector elements could be miniaturized and integrated into a custom silicon device, which could be built into everyday consumer products like a Smartphone.

Visualant's ChromaID technology was developed by University of Washington Professor Tom Furness and Dr. Brian Showengerdt over a seven year period. The technology is being transferred into products and a scanhead component. Visualant has partnered with Sumitomo Precision Products to manufacture the scanhead and reduce the technology to a very reliable and cost effective form. The first demonstration of this is the Cyclops6, which can be used to evaluate the technology for flat surface applications. This unit has sensitivity from 350 nm to 1450 nm.

THE DEVELOPMENT of Visualant's technology has been progressively refined from tethered prototypes to integrated handheld devices in a variety of form factors.

ChromaID SCANNING TECHNOLOGY can be built into a wide range of form-factors. These concepts demonstrate potential ChromaID devices and help us define the requirements for a ChromaID Scanhead component.

Visualant is soon making available ChromaID Development Kits which will include a scanner, PC host software application, Scanhead API, and C sample code. This will enable potential partners to try our technology and determine its suitability for their applications.

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