Varifocal Illumination System Technology Explained

A Guide to Understanding the Benefits of this Unique Technology

NuOptic

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Introduction

The lighting products offered by NuOptic feature the patent pending Varifocal Illumination System (VIS) technology. This technology provides the user powerful advantages over competitors' more traditional products. All VIS illuminators incorporate continuously variable field of illumination angle over a very wide range and are motorized for both remote and local control. Further, the VIS optical design enables an unmatched product size benefit to NuOptic's hybrid products. This paper fully explains these features and contrasts them with competitive products.

Why Field of Illumination Matters

It is very important for the field of illumination of a light source to closely match the field of view of the camera it is servicing. To understand why this is the case, we will look at the scenarios where the field of illumination is both larger and smaller than the field of view of the camera.

In the first scenario where the illumination source's spot size is smaller than the camera's view angle, the camera's image will have a bright area centered in the image with much darker sides and corners. The camera will maintain a gain level that prevents the bright areas from becoming saturated. This means that the tones within the bright area will become "washed out", resulting in a significant loss of detail. It also means that the tones in the surrounding area will become dark or even black. In many cases, this could severely reduce the benefit of having the added illumination.

In the second scenario, the illumination source's spot size is larger than the camera's view angle. While this will result in a uniformly lit scene, the brightness will be significantly reduced. To understand this, it is important to know that for a given illumination power the brightness drops very quickly as the illumination angle is increased. For example, if the field of illumination is doubled for a given light source, the area that is being lit grows by a factor of 4. Therefore, if an illuminator is able to increase the brightness of a given scene by 40 lux with a 20 degree field of illumination, that same light source will only increase the brightness by 10 lux at 40 degrees. For a more detailed explanation of this relationship, please refer to the NuOptic white paper entitled *Illumination Distance*. This example demonstrates that even moderate mismatches in illumination angle result in significant drops in scene brightness. While the autoexposure system in the camera will adjust the gain level to compensate for the lower brightness, the resulting video image will suffer from added noise.

Continuously Variable Field of Illumination

Most traditional illuminators have a set angle of illumination (30 degrees, for example); the illumination angle of these products cannot be altered. Manufacturers typically offer a range of products to try to cover different camera installation scenarios: 10, 30, and 60 degrees being common. This means that installers must know at the time of purchase what fields of view will be used by the cameras at a given site. However, it is very common for installers to adjust cameras equipped with vari-focal lenses on-site to best meet the demands of the scene. This often results in a condition where the pre-selected illumination angle is no longer well matched to the

camera's view. If the illuminator is not replaced with a more appropriate model (which can be a costly and lengthy process), then the scene will suffer from the conditions described above.

Some manufacturers have attempted to address this problem by offering products with multiple "modules" with an adjustable mount, thereby allowing the modules to be pointed in separate directions and providing an adjustable illumination angle. However, this method has the serious drawback of creating an uneven illumination pattern. A simple experiment shows that slightly overlapping two flashlight patterns results in a bright area in the middle and slightly diverging two flashlight patterns results in a figure "8" pattern with a dark center.

Some competitive models offer replaceable plastic diffusers that can alter the illumination pattern of a single illuminator model. However, these products can still only offer discrete, pre-selected fields of illumination. For example, one plastic diffuser providing an illumination angle that is 35 degrees wide could be manually uninstalled and replaced with the next closest diffuser part that has an illumination angle of 60 degrees wide. This may provide good coverage for a few scenarios, but will leave many installations far from ideal.

In contrast, the VIS system provides a *continuously variable* field of illumination. With a simple turn of a knob, the illuminator responds with a real-time changing illumination angle. The installer simply adjusts the illuminator (either at the illuminator itself or via a remote serial connection) while viewing the camera image until the illumination pattern is perfectly matched. This method requires no before-hand knowledge of the installation scene, no compromise in overlapping light patterns, and no manual replacement of diffuser parts that still do not closely match the camera's view.

Wide Range Field of Illumination

The patent-pending optical design of the VIS system allows for a very wide range of illumination angles. Infrared units offer continuous adjustment from 7 degrees to 90 degrees, while White Light units offer continuous adjustment from 6 degrees to 70 degrees.

Competitive illuminators may require up to 4 separate models for every illuminator type in order to cover this same range. This situation forces installers to guess ahead of time which models will best suit an installation and forces distributors to stock many more models.

In contrast, the VIS system accommodates a very wide range, thus allowing installers to be confident that a NuOptic illuminator can be adjusted to exactly match the camera's view. This flexibility offered by the VIS technology greatly simplifies the process of adding an illuminator to any installation.

Motorized Control

The VIS system uses a stepper motor to position the optical component of the illuminator. The VIS system couples the reliability of stepper motor technology with the precision of modern, single-chip drive electronics to provide robust and repeatable motion. No other illuminator for the video security market offers motorized control.

Motorized control offers several benefits. For local adjustment, it offers low-force, high resolution tuning. An installer simply turns an electronic knob (similar to a volume knob) located on the back of the illuminator. The installer moves the knob in convenient amounts while the stepper motor simultaneously moves the optical component by very small increments. This allows for easy, precise tuning of the illuminator to exactly match the camera's view angle. Motorized control also allows for remote adjustment of the illumination angle – a benefit that no other manufacturer can offer. The system can be remotely controlled via a variety of common serial connections, or by Ethernet connectivity in upcoming models. The use of a stepper motor also provides the ability to use position presets. The illuminator can be added to zoom camera presets such that it changes to match that camera's view angle while toggling between preset numbers. For a further explanation of this preset capability, please refer to the NuOptic white paper entitled *Varifocal Illuminators for PTZs*.

Hybrid Advantage

The VIS system uses an advanced, patent pending optical design wherein the optical elements are movable to create a continuously adjustable field of illumination. By contrast, most competitors' products utilize stationary optical elements positioned over each separate LED. These optical elements are large compared to the size of the LEDs, and the overall product's dimensions are limited by the how close these elements can be packed together. Because the VIS optics are movable, they can simply be repositioned over separate LED sources. This benefit allows NuOptic to offer hybrid products using either white light or IR LEDs *in the same size housing* as single source products. In comparison, competitors are limited to offering hybrid products that are either twice as large or use half as many LEDs for each wavelength. This is a strong advantage for NuOptic's design, and an important factor for anyone considering purchase of a hybrid illuminator.

Conclusion

In summary, the VIS technology provides powerful, flexible, and truly exciting benefits that no other video security illuminator in the world can match.