Starlight Info

The Dahua paper(Starlight, color at night):

Low-Light-White-Paper_2021_09_FINAL-1.pdf

Color at night & Starlight use Sony Starvis tech

Sony Starvis

Overview

STARVIS Technology STARVIS STARVIS2

STARVIS technology is characterized by ultra-high sensitivity, pushing the boundary of mechanical recognition to enrich society and bring safety, security, and convenience to people. With sensitivity superior to that of the human eye, it enables object shape and color recognition even in dark locations and obtains the required information with accuracy, contributing to greater safety and security in society.

STARVIS 2, evolved from STARVIS, is the latest technology with wider dynamic range. Technical Features Super-high sensitivity beyond the human eye

Image sensors capture light and convert it to electrical signals in order to create images and other data. It is a significant advantage for image sensors to capture images accurately in dark locations. To achieve this, it is crucial to sense the faintest light in darkness and convert this to electrical signals efficiently without allowing noise contamination.

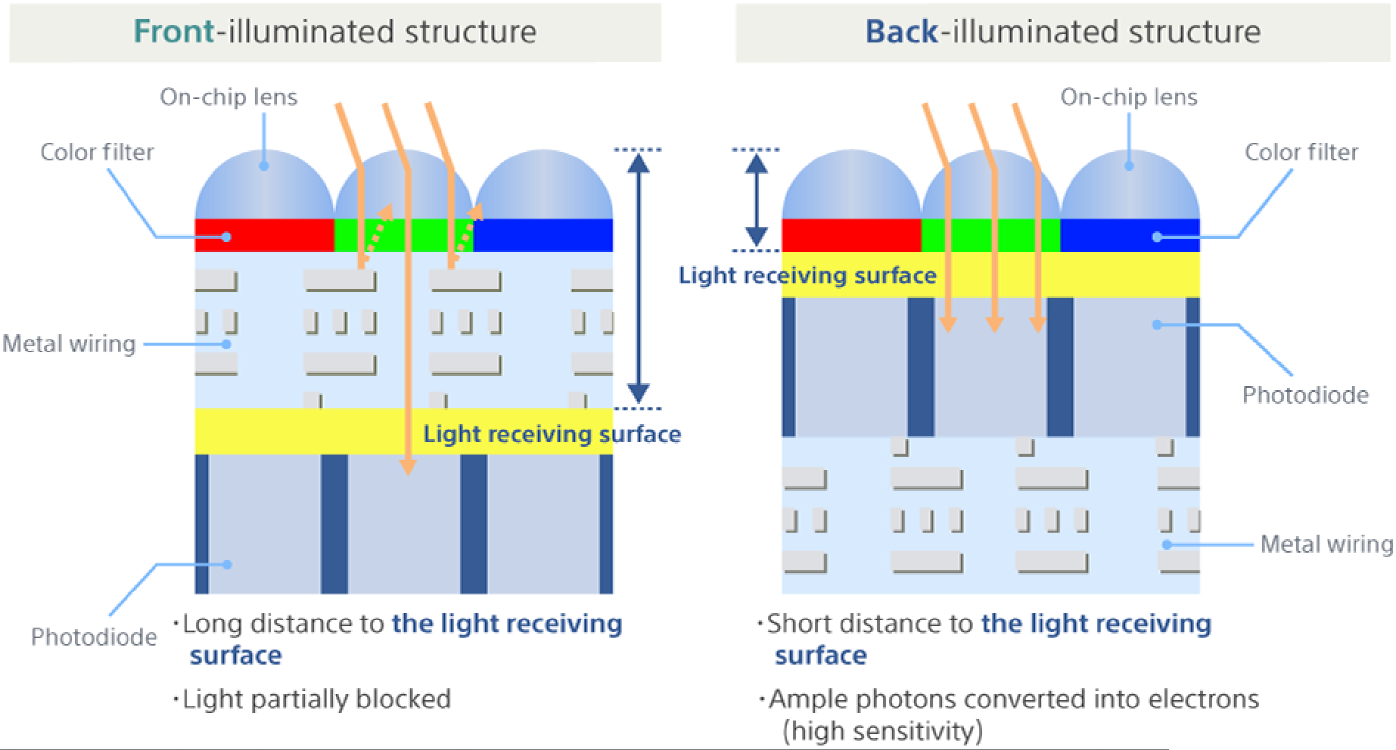
STARVIS technology is designed to capture the faintest light in a dark place, such as a small alleyway without street lights, convert this light into noise-less electrical signals, and deliver an image of the target object through the realistic rendition of its shapes and colors.

Technology that delivers high sensitivity

Light travels into an image sensor through a lens and reaches a photodiode, which converts the light into electrical signals. It is this photodiode that holds the key to higher sensitivity—how efficiently it collects light.

The arrangements of photodiodes are a determining factor in an image sensor’s sensitivity. In a structure known as front-illuminated, photodiodes are placed behind a wiring layer. In this structure, the problem is that incident light is deflected or absorbed on the wiring layer before reaching the photodiodes, compromising the image sensor’s sensitivity. By contrast, with STARVIS the photodiodes are positioned on top of the wiring layer in the back-illuminated structure. This configuration resolves the light loss that was caused by the wiring layer, significantly increasing the amount of light that reaches the photodiodes. As a result, this structure has improved the sensitivity by over 4.6 times*1.

The closer proximity between the on-chip lens and each photodiode means that the photodiodes can receive rays at larger angles of incidence, which helps to improve the imaging performance of the image sensor when combined with a low f-number lens.



Technology that achieves low noise

Image sensors capture light with photodiodes, convert it into electrical signals, and then output an image as digital values. A dark image can be brightened by amplifying the signals (setting a higher gain level). However, higher gain levels cause noise in the electrical signals to be equally amplified, resulting in a grainy image.

Sony's Super High Conversion Gain technology is designed to amplify electrical signals immediately after the conversion from photons, when the noise levels are relatively low. In this way, it reduces the overall noise after amplification. As a result, lower-noise images, compared to conventional technology, can be captured even in a low-illuminance environment. Lower noise levels in images also help to enhance the accuracy in visual or AI-assisted image recognition.

Capturing light ranges invisible to the human eye

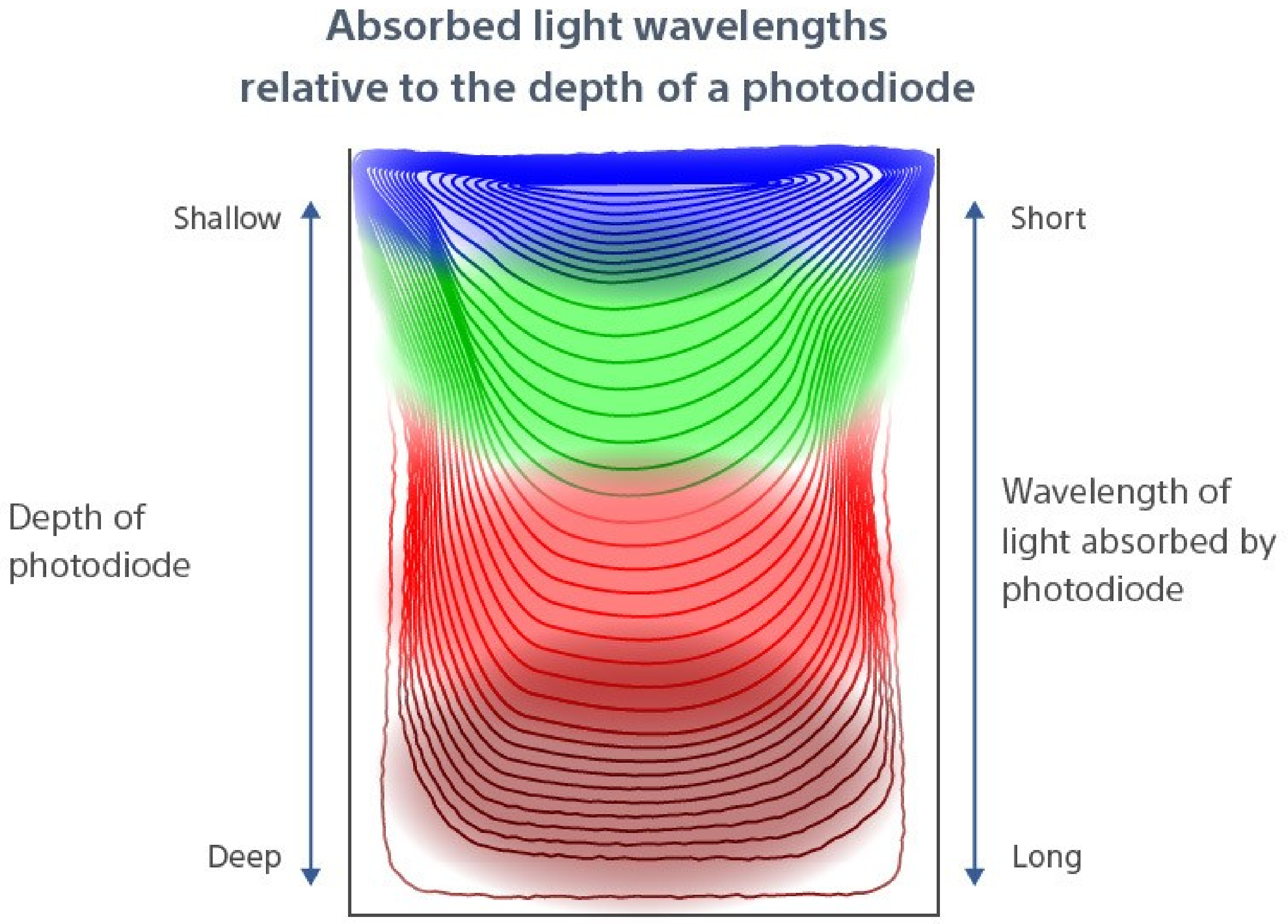
The image sensors used in standard cameras, such as smartphone cameras and mirrorless cameras, are designed to reproduce images as we see them in the light (visible light). Some image sensors for special applications, such as security cameras, are designed to work in the near-infrared (NIR) region, where is not visible to human eye.

NIR lighting is used to capture images where visible light might disturb people or cause an accident, for example at nighttime in residential areas and on multilane highways.

STARVIS enables image sensors to deliver clear images in a near-infrared light environment. If the image sensor’s NIR sensitivity is sufficiently high, NIR lighting can be lowered, helping to reduce heat generation and power consumption.

Improved sensitivity in near-infrared (NIR) region

Near-infrared light is longer than visible light in wavelength. In an Si (silicon) photodiode, short-wavelength light, such as blue light, is absorbed in the region closer to the surface of the photodiode while longer-wavelength light, such as green and red light, is absorbed in deeper regions. The absorption of near-infrared light is enhanced by increasing the depth of the photodiode.



Absorbed light wavelengths relative to the depth of a photodiode

Absorbed light wavelengths relative to the depth of a photodiode

STARVIS 2 also adopts photodiodes with uneven surfaces, which enhance NIR light absorption by refracting incident light. These structural features have led to significant improvement in NIR sensitivity.

Feature to eliminate blowouts

Image sensors can adjust the length of time to take in light (exposure time) to output images, optimized according to the brightness of the scene. A short exposure time in a bright environment avoids oversaturation of the photodiode and a long exposure time in a dark environment ensures the collection of a sufficient amount of light.

In contexts where both extremely bright and dark areas are in view, such as a strong light source next to a tunnel exit, these areas of the image may be over- or under-exposed and details could be lost. When we can see details in both bright and dark areas of an image, it is said to have a high dynamic range, and the attribute for realizing this is called a high dynamic range (HDR) feature.

DOL HDR

When the digital-overlap (DOL) HDR feature is on, the image sensor captures two images in succession:one with a short exposure according to the bright region and the other with a long exposure adjusted to the dark region. HDR is realized by synthesizing these two images to complement one another.

However, this method involves a slight time lapse between the two shots and this can cause some artifacts, such as a blurred outline and chromatic aberration, if the target is in fast motion.

Clear HDR

When the Clear HDR feature is on, the image sensor captures two images simultaneously, one with a low gain level set to the bright region and the other with a high gain level adjusted to the dark region*2. The images are then synthesized.

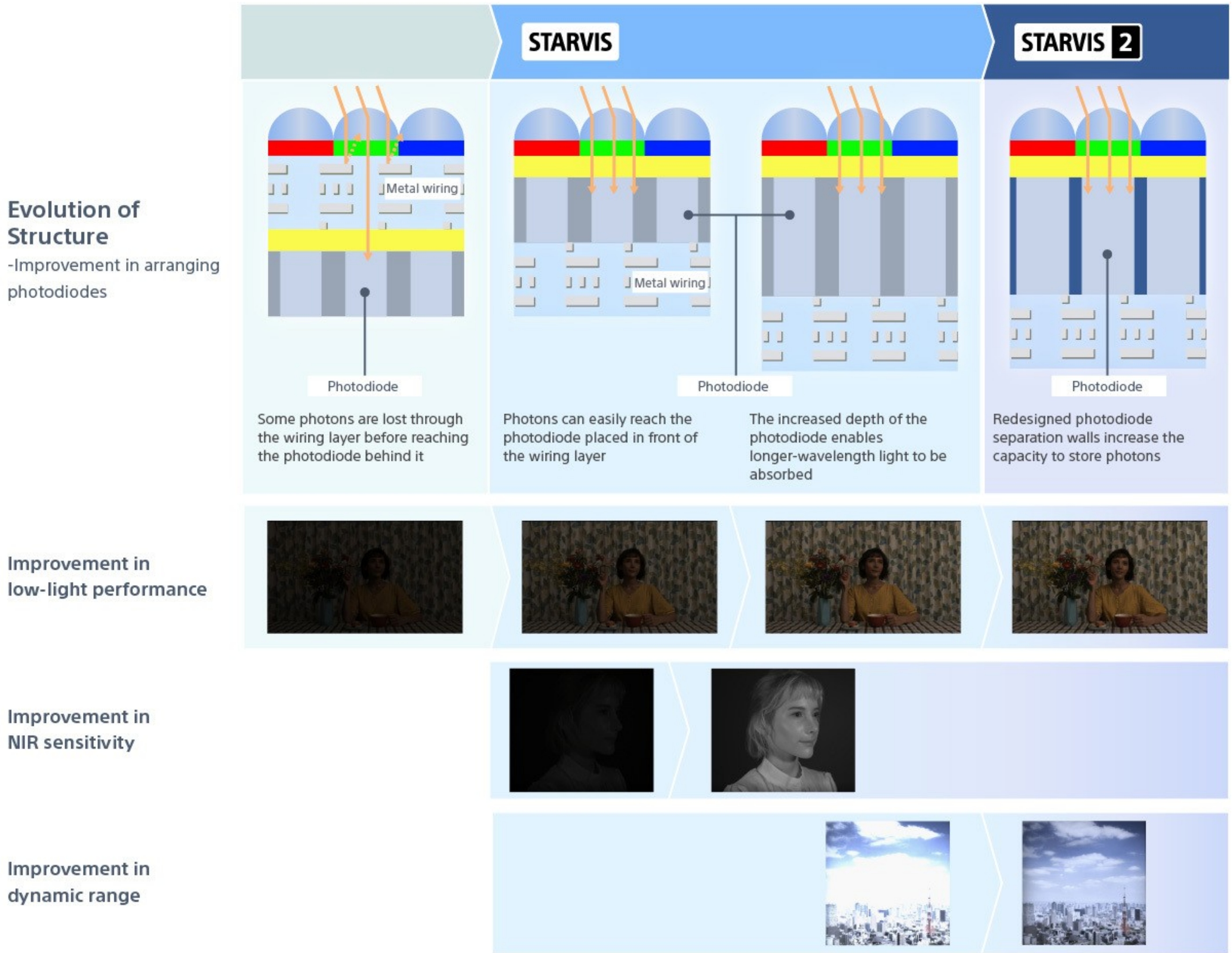
This method has the advantage of delivering images of a moving target without chromatic aberration and other artifacts because the two images are captured at the same time. The Clear HDR feature is suitable not only for security cameras but also for applications to capture moving targets, such as traffic monitoring systems and dashboard cameras.


Evolving STARVIS technology

Poor visibility is an obstacle to ensuring security in everyday life. STARVIS has been pushing the technical boundaries and surpassing human sensitivity of human visual perception. The technology continues its evolution to expand its capacity to capture images in the infrared region, high-contrast settings and other situations that are beyond discernible by the human eye.

Evolving structure and improving performance

The change from a front-illuminated to back-illuminated structure has enabled super-high sensitivity, from which came STARVIS technology. (See Technology that delivers high sensitivity) The sensitivity and HDR feature have been improved further by increasing the amount of light to be captured, enabled by increasing the depth of a photodiode and modifying the structures and materials of the walls between photodiodes. These are not the only improvements made. The on-chip lens has improved light concentration and transmittance, the color filter has higher transmittance, the photoelectric conversion efficiency has improved, and much more. As we explore, research, and develop optimal materials and continue the pursuit of nanometer-level precision in manufacturing processes, our technology progresses on its path of evolution.



Both STARVIS and STARVIS 2 are back-illuminated pixel technology specifically developed for image sensors for security camera applications. They feature a minimum sensitivity of 2,000 mV/µm2 (color product, when imaging with a light source of 706 cd/m2, F5.6 in 1s accumulation equivalent) and deliver high image quality in the visible light as well as near infrared light regions. STARVIS 2 further offers the wide dynamic range (AD 12bit) of more than 8 dB in a single exposure, wider than the STARVIS pixel of the same size.

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