8K Resolution: Making Hyperrealism a Reality

Is 8K worth it?

With the first 8K TV being released into consumer markets this year and the growth of 8K content creation and supporting technologies, it's not long before 8K display technology is projected to become mainstream.

The introduction of 4K technology significantly pushed the boundaries of digital displays performance, increasing the number of pixels on the screen four-fold. With the leap from FHD to 4K, we could easily see the difference in resolution between the two screens: even the entry-level UHD technology provides an incredibly sharp, clear, and vivid picture.

8K resolution is sixteen times that of FHD and four times more than 4K. As the next generation technologies advance so drastically and quickly, it becomes harder to objectively measure the differences in how we see ultra-high resolution imagery. So what does quadrupling the highest currently available resolution really translate to?

To be able to fully explain the effect of the increased resolution on how we perceive UHD content, let's begin with the fact that we cannot rely on retina's optical properties alone. A human eye does not function in the same way as a digital camera.

First of all, as we direct our attention to an object, we focus on it and exclude the surrounding details from our cognitive process. Secondly, as we examine the object, we scan it line by line, which in practice allows us to comprehend resolutions way beyond 8K.

Our visual system interprets light patterns to form notions about the objects we see and their properties. Based on how light interacts with an object's shape in 3D, we are able to infer information and form perceptions about the properties of the object. Luminance gradient helps describe objects' properties by supplying a range of variable data points, such as:

- Surface properties through curvature
- Non-surface properties through specular highlights and illumination
- Depth relationship through cast shadows and blur

At 8K high resolution, retina responses are intensified by luminance gradient configuration and how it contributes to our lightness and brightness perception—as the gradient is smoother due to substantially larger pixel quantity.

The non-gradient component of 8K performance also intensifies real world acuity as higher contrast increases perceived brightness and object's edges appear sharper. Visually, sharper edges help to separate the foreground and background of an image more.

When we are looking at an object in the real world, we are placing it in focus, while not concentrating deeply on the rest of the surroundings. However, when we are looking at the same object using the display, we can focus on every point of the screen, allowing us to perceive substantially more information about this object.

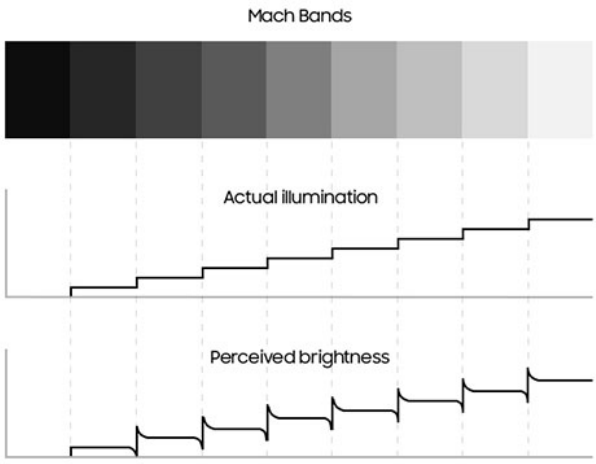
In addition to increased focus while looking at the screen, with four times more pixels, 8K displays are able to provide smoother gradient and improve sharpness to the point, where objects seem even more realistic than in real world. This phenomenon is referred to as **hyperrealism**. Hyperrealism is achieved when we are able to capture and comprehend even the subtlest lighting and shading effects and the display is able to transmit extreme glossy and shadow expressions, giving us abundant information about the object.

Such an unprecedented level of image perception and immersion make 8K technology totally worth the investment as it far exceeds visual performance that lower resolution screens are able to deliver. While objectively the real world is sharper and has more acuity than displays can provide at the moment, ultra-high resolution displays are evolving to approach the capacity of our vision.

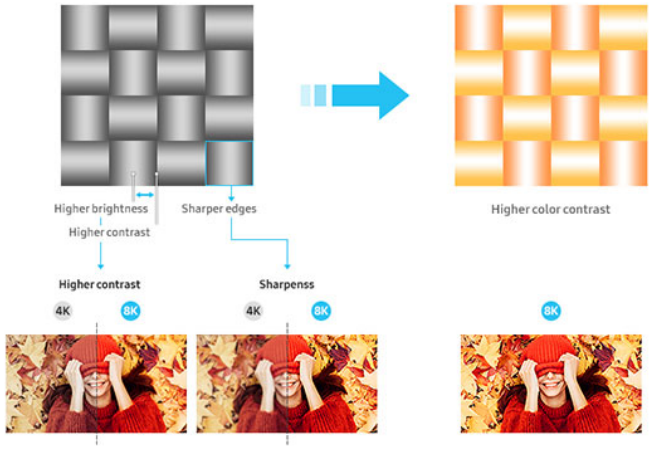
So what changes between 4K and 8K happened on the technology level? Let's dig deeper to understand what aspects of 8K technology make hyperrealism and increased perception possible.

Mach bands effect and hyperrealism in 8K displays

In 8K displays, real-world luminance and acuity are aided by the mach bands formation—a phenomenon observed when a band of gradients will appear lighter or darker than they actually are. Mach bands affect our perception of color and brightness values—and essentially result in an optical illusion. That lateral inhibition in the retina visual system enhances the perceived sharpness of edges.



When mach bands are formed, color gradually appears darker or brighter at the boundary of the band when the contrast-reducing bands are adjacent to each other. It triggers edge-detection in our visual system when color shades of slightly different brightness border each other, enhancing the contrast between the edges of the areas with different brightness. Although it cannot be objectively measured, perceptually adjacent gradients seem to exhibit higher contrast.

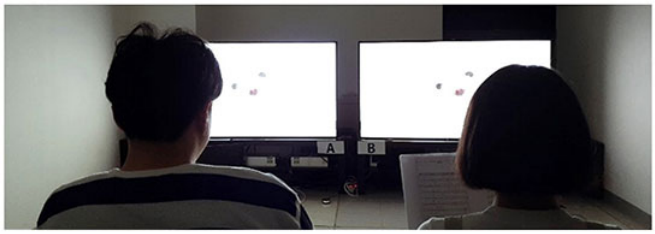


With a four-fold increase in resolution from 4K, 8K displays would have substantially more bands per the same screen length. Mach bands effect in 8K screens results in stronger brightness intensity. As resolution increases, the spacing of the mach bands narrows forming a continuous gradient. Hence, higher resolution results in higher brightness and contrast and improves color and clarity expressions.

As mach bands effect is essentially an optical illusion—while we can see it, it is not something we can measure—but it does have an impact on our visual experience of the display.

University research study: 4K vs. 8K

Looking to find out whether increasing the screen resolution from 4K to 8K made a significant difference in viewing experience, Samsung Display (SDC) partnered with Ewha University in Seoul. In the experiment led by Professor YungKyung Park—Department Chair, Color Design—who specializes in the color science field, researchers asked 120 participants to comment on differences observed between 4K and 8K displays.

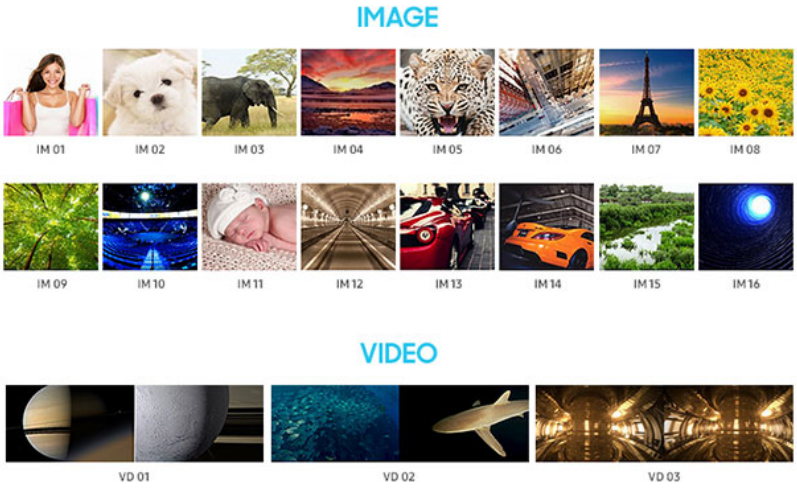


The experiment

The study used two 65-inch LCD screens—one with 4K and the other one with 8K resolution, with the same brightness level of 500 nit.

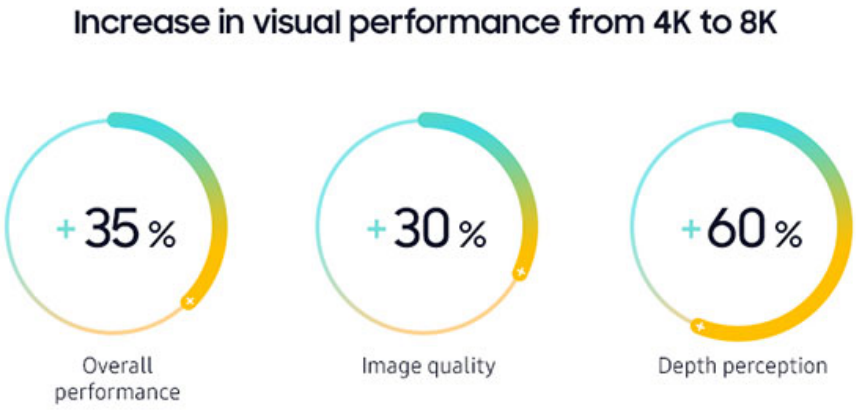
All 120 participants were tested to confirm 20/20 normal color vision (with or without glasses or contacts) to qualify for admission. In a side-by-side comparison of both static imagery and video content, the participants were asked to point out differences between the two.

For objective evaluation, researchers used a Likert-type 7-point scale, and the same viewing distance of 9 feet and lighting conditions (dark room). All participants were shown the same 16 images and 3 videos representing a diverse range of visuals.



Key findings

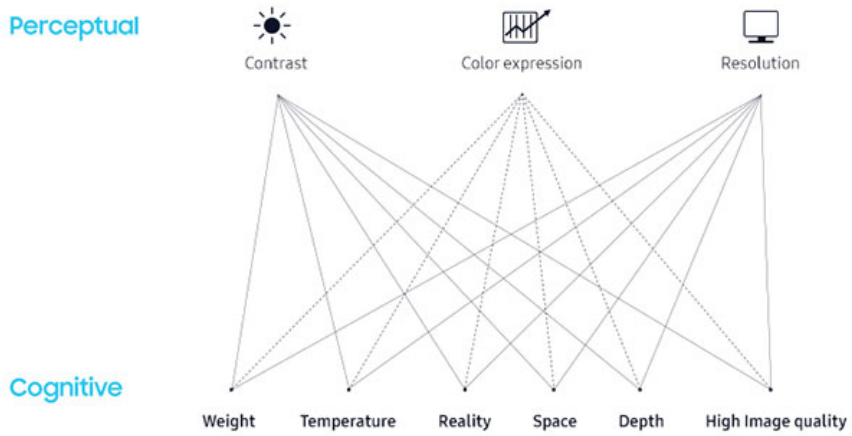
The participants were not provided any specific instructions or context as to what to look for or informed of the screen resolutions of the display technology involved. As a result of the study, 8K displays performance was rated 35% higher—with perceived image quality increasing by 30% and depth perception increasing 60% from 4K to 8K.



What's most fascinating is that rather than pointing out the increased sharpness or contrast of the image associated with higher resolution, participants highlighted the main differences to be those related to sensory perceptions. They described images depicted on 8K screen as evoking higher sense and perception—for example, noting that objects look cooler, warmer, more delicious, heavier.

The researchers then studied the effect of perceptual evaluation factors on cognitive factors using regression analysis. For perceptual factors—i.e. parameters highly relatable to the display technology itself—they selected contrast, color expression, and resolution attributes. Cognitive evaluation criteria—attributes of how well the participants understood the object—included weight, temperature, sense of reality, space, depth, and perceived image quality.

The study found that perceptual qualities are positively related to cognitive factors across all selected criteria. Display-dependent qualities, such as much higher 8K resolution increases contrast and how vivid the image seems. This increased contrast and vividness help us understand the object depicted more—perceiving it as more 3D-like and real. Because of all this additional information about the object, on the cognitive level, it appears like it has an even higher resolution—which is the perceptual rather than measured quality—which makes us feel like the image is more real and has higher senses.



This two-way relationship explains the hyperrealism effect:

> Because of perceptual qualities and technical display characteristics are actually increasing cognitive perception of the image
>
> Because of the higher cognitive qualities, perceptual parameters also seem higher

Conclusion

With the arrival of 8K displays, increased resolution has enhanced the ability to deliver on hyperrealistic images by providing more information about the object and its optical properties.

8K allows for stronger cognitive perception which helps us have a higher perception of the image's contrast, color expression, and resolution. 8K boosts these perceptual values because of the luminance gradient, shading effect, and highlights. These features improve how we understand the objects depicted. We believe that 8K displays deliver substantial value over the best of currently available 4K displays. As consumers experience this more immersive displays the demand will grow rapidly in the coming years.

To learn more about 8K technology, content, and devices, as well as the market adoption projections, read the first part of our 8K series here.

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