

Overview of Higher “Resolution” Imaging Systems

SD, HD, FHD, QHD/WQHD, qHD, 2K, 4K And 8K

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Abstract: To transfer the super high definition images, the high speed optical networks are used in digital cinema projection.. The TV market is moving rapidly towards high-definition television, HDTV. HDTV provides up to five times higher resolution and twice the linear resolution compared with traditional, analog TV. In digital cinema projection, the terms 2K and 4K indicate the image resolution that is projected onto the screen. 4K indicates that there are close to 4000 pixel columns that can be projected onto the screen. The total pixel count is actually 4 times higher than that in 2K

After 4K, 8K UHD resolution can be considered the new challenge for film, visualization and television. Present day transfer services recommend high-definition (HD) quality video, live-streaming applications will soon shift to providing cinema quality 8K content to both business and movie theaters user. 8K ultra-high definition imaging technology is a 16-fold higher resolution than the current 2K high-definition technology This paper describes the various resolution imaging system such as HD, FHD, 2K, 4K and 8K used for image transmission in digital cinema and related application fields.

Keywords: FHD, HD, HDTV, 8K, Super Hi-vision

I. Introduction

This paper describes the Higher resolution imaging system and continued development of higher resolution imaging system, and explains some background and what is currently happening in bringing 8K. Resolution is the number of the total pixels or individual dots that a one frame of a video or a single photo is created with. When this numeral turn into higher, quality of the video becomes high and it creates a very sharp picture. So all the terms like 4K, UHD, QFHD are assigned for different number of total pixels or resolutions. Usually these resolutions are inscribed in a format of multiplication of the number of Horizontal pixels and Vertical pixels (Horizontal pixels x Vertical pixels). To get the actual number of pixels you need to multiply those two numbers.[1]

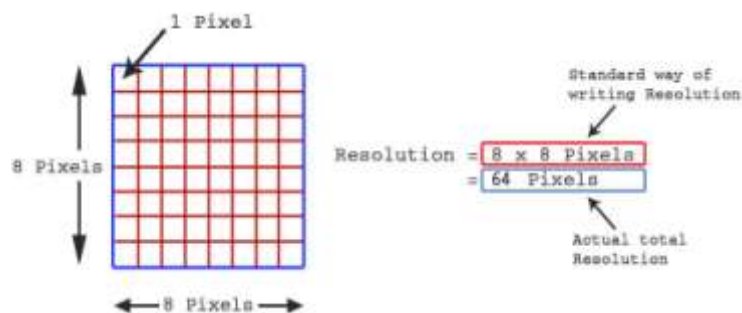


Fig 1. Resolution [1]

Image resolution relates directly to the amount of detail in an image. Higher resolution means greater image detail and more detail brings us nearer to visual sensitivity. The number of pixels does associate to the amount of information within the image.[2]

The primary difference between Super Hi-Vision and former TV formats is the pixel count. Other parameters are also important because they are influenced by the change in pixel count and visual angle. These parameters need to be set to produce image quality and performance proper for the increased pixel count of Super Hi-Vision.

Super Hi-Vision are planned to determine the next-generation television system to succeed HDTV at some point in the future, and it consists of ultra-HD images and three-dimensional multichannel sound [3] Television history from the origin to the introduction of SDTV was based mainly on increasing the number of

scanning lines to achieve higher definition. TV screens have consistently become larger, from 12 inches in the 1950s to the current 50 inches. Two difficulties arose as TV screen sizes grew. The picture quality degradation produced by the shortening of the relative viewing distance – since the absolute viewing distance at home does not change much. The other is how to make such a large screen. HDTV was the solution to the first problem, and flat-panel displays were the solution to the second one.[3]

UHD is an example of where we are headed, beginning at 4K, going up to 8K and contains advances in optics, processors, and sources that can force higher resolution and technology . There are few 8K sources available today, but an 8K display could also enhance lower resolution video and other improved technologies. Resolutions such as 8K allow filmmakers to shoot in high resolution and edit to the appropriate size. NHK, Sony and Red Digital Cinema are presently implementation 8K, and filmmakers are aggressive for more.[4]

In this paper, We try to cover general outline and developed advancement of resolution imaging systems, applications and key specification of technology . We outline some of the differences between the technologies, highlight their key benefits and look at suitable application areas for each one. Openings for higher resolution imaging system are also identified and conclusions are drawn regarding the future of HDTV.

II. Evolution Of Resolution Imaging System

The figure shows the relative number of pixels in each of the major resolution formats. The terms like SD and HD, 2K used in today’s post-production situation to describe a particular image size and quality of data.

The primary purpose of a digital resolution standard is to fix pixel count, specified as a W x H array of rows and columns.

HD is a pixel array 1920 x 1080, or roughly 2K x 1K. Multiplied out, this is about 2 million pixels

The UHD standard has two parts.

- i. The first part, known as “4K”, doubles the HD pixel array in both dimension to roughly 4K x 2K, or 8 million pixels.
- ii. The second part, known as “8K”, doubles the “4K” pixel array in both dimensions, to roughly 8K x 4K, or 32 million pixels.

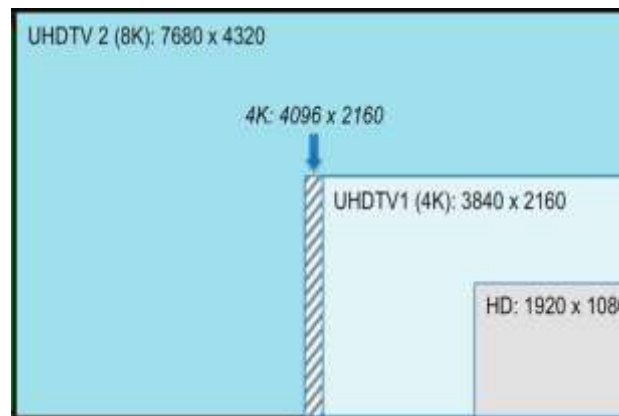


Fig. 2. TV Resolution WOW chart [5]

2.1 SD(Standard definition)

SD uses 704 x 576 (PAL) or 704 x 480 (NTSC) pixels, which is equal to 4CIF (704 x 576) resolution and sufficient to meet the demands of many reconnaissance applications. This resolution cuts down on the amount of video information in the signal compared to HD or megapixel, saving on bandwidth as well as reducing video storage needs. SD delivers the widest dynamic range and best feeling of any technology. Modern, advanced SD cameras offer the ideal balance between resolution, dynamic range and sensitivity. Their wide dynamic range makes SD systems great for high contrast scenes, illuminating details in both bright and shaded areas simultaneously.

SD Applications :-

SD systems have been the standard until newly and are still widely used. Typical applications for SD systems include:

- 1.Prisons and correctional facilities
- 2.Educational facilities
3. Hotels, bars and nightclubs
- 4.Commercial and government buildings[6]

Advantages:-

- SD television sets and displays cost less than HD models

Drawback of SD:

- Resolution of SD is half of HD

2.2 HD(High definition)

HD images cover either 720 or 1080 rows of pixels making up a 16:9 format image. A ‘vision-friendly’ 16:9 ratio image is compatible with today’s widescreen monitors. It also matches human eyesight more closely. The HDTV system has been developed to provide high resolution images, and we can enjoy truthful atmosphere in our home. Observer perception is affected by many factors, for example, resolution, screen size, colorimetry, smoothness of motion, viewing distance. Exclusively, the viewing angle is important and deeply related to realistic and immersive sensation. If we could use the factors more successfully and create the new television system beyond HDTV, it can open the new epoch for the future images.

HD systems offer:

- Better dynamic range to expose greater detail in scenes covering both shaded and bright zones simultaneously.
- More sensitivity to provide excellent detail as long
- Agreement with industry standards to ensure excellent colour reproduction, full frame rate and 16:9 format.

HD applications:-

They include:

1. City centres
2. Airports
3. Finance and banking
4. Traffic monitoring (air, land and sea)
5. Casinos and gaming
6. Government
7. Passport control[7]

Advantages:-

- High Definition television (HDTV) has at least twice the linear resolution of Standard Definition television (SDTV), which results in a much clearer, crisper image.
- Better picture quality due to higher resolution
- HD signals are not compressed while transmission so there is no de-gradation in signal quality.

Drawbacks:-

- Screen flashing errors caused due to authentication delays.
- More expensive

2.3 FHD(Full High Definition)

1080p or Full High Definition (FHD) has a resolution of 1920 x 1080 pixels and it is one of the most current resolutions for movie files. Usually Blu-Ray disks contain 1080p or FHD (1920 x 1080 pixels) video resolution. Total pixel amount is little bit lesser than 2K (2048 x 1080 pixels).

- Total Pixels = 1920 x 1080 pixels = 2,073,600 pixels = 2.07 million pixels
- FHD = QFHD / 4 = 3840 x 2160 pixels / 4 = 2,073,600 pixels = 2.07 million pixels[8]

FHD applications

- Full HD is the standard resolution for Blu-Ray, digital television, and most HD videos found online, like those on YouTube, Hulu, and Vimeo.
- This display resolution is common on Smart TVs and many modern smartphones, PCs, laptops and monitors.

Advantages of FHD:-

- Stunning picture quality and a truly exceptional cinematic experience.

Drawbacks of FHD:-

- More Expensive

2.4 QHD/WQHD (Quad High Definition /Wide Quad High Definition)

In the smartphone mutiny of the last five years, manufacturers have been worried to put higher resolution screens into phones even where they are not needed. It's often claimed that resolutions above that of Full HD are unused on such relatively small panels as even people with perfect vision find it hard to spot any

difference. But, phone makers have done it anyway, maybe for marketing purposes. Quad High Definition (QHD) screens have become a popular choice in modern handsets. QHD is four times the definition of standard 720p HD specifically 2,560x1,440 pixels, or 1440p. As with all HD-derived resolutions, this one has a wide 16:9 aspect ratio, so QHD can also be mentioned to as WQHD (Wide Quad High Definition) QHD display offers the following:

1. Clearer and sharper images given the 4 times greater number of pixels
2. Improved contrast
3. Improved colour radiance
4. The ability to view full desktop versions of web pages without image distortion

Applications of QHD/WQHD:-

Most flagship Android devices released in the earlier years have QHD displays after it was made popular in LG’s flagship G3 smartphone launched in 2014. The Samsung Galaxy S6, the Google Nexus 6P also feature QHD displays.

Advantages of QHD:-

- Battery performance of devices would have been better
- The brightness and overheating issues could have been avoided
- Photos, line drawings and text are crisp, clear and ultra-sharp.

Drawbacks of QHD:-

- Higher Cost
- Higher Power Consumption

2.5 2K

2K or 2048 x 1080 pixels is not a very much common or famous resolution. Term 2K originated from the term 4K, because it has a half the pixel amounts of both horizontal and vertical pixel amounts of 4K (4096 x 2160 pixels) resolution. That means 2K is one fourth of total pixels of 4K.

- Total Pixels = 2048 x 1080 pixels = 2,211,840 pixels = 2.21 million pixels

$$2K = 4K / 4 = 4096 \times 2160 \text{ pixels} / 4 = 2,211,840 \text{ pixels} = 2.21 \text{ million pixels}[10]$$

2K data go beyond our previous television broadcast standards for both SD and HD and is therefore most commonly associated with old-style cinema and the developing digital cinema creativity. 2K is usually defined as 2048x1556 pixels. 2K images, like SD and HD images, can come in 8 bit, 10 bit, 12 bit, 16 bit etc. But most usually, 2K files are in written in a 10 bit Log RGB or RGB format. This provides for 1024 progressions of a given colour in three equivalent colours of red, green and blue. By using RGB, 2K data can follow to some extent, film which achieves its colour reproduction via red, green and blue layers of mixture.[11]

Applications of 2K:

- 2K resolution found on high end TV sets.

Advantages of 2K:-

- Display more data.
- Increased resolution enhances the digital viewing.
- Enrich User Experience and Improve Productivity

Drawbacks of 2K:-

- Higher Cost
- Higher Power Consumption

2.6 qHD(Quarter High Definition)

qHD is not to be jumbled with QHD. Despite having a very similar name, qHD stands for Quarter High Definition and is a display resolution of 960x540 pixels - one quarter of 1080p Full HD. This is used much less frequently these days. This resolution usually found on much smaller device displays for a relatively high pixel density when anything higher would be wasteful.[9]

Applications of qHD:-

- It was often found on high-end smartphones and handheld consoles -- such as the PlayStation Vita -- around 2011
- Many phone companies have started including qHD into the making of the screens in their devices and gadgets. Phones such as the Sony Xperia P, HTC Amaze 4G, HTC Sensation, HTC Evo 3D, HTC Desire 600, Motorola Droid RAZR, etc. contain of a qHD screen. Sony’s portable handheld gaming device, the PlayStation Vita also features a qHD display in it.

Advantages of qHD:-

- Used for Mobile displays.

Drawbacks of qHD:-

- Lower resolution

2.7 4K

Standard resolution of 4K or UHD is 4096 x 2160 pixels, but now for the resolution .Total Pixels = 4096 x 2160 pixels = 8,847,360 pixels = 8.85 million pixels

4K is the term used by the skilled video market to denote this higher resolution as currently used in film and TV production work. The image size in this case is 4096 pixels wide by 2160 lines, so it is slightly more than 4x the image size for HD. “UHD” and “4K” are not the same thing. UHD is 3840 pixels by 2160 lines.

The 4K design potentials important developments in the image and video viewing experience over 1080p, with multiply the number of pixels and 64 times the number of colours. However, 4K system design currently presents many challenges, including the lack of content, infrastructure, and processing power.

Application:-

- 4K displays are used in professional production and digital cinemas

Advantages of 4K:-

- 4K screens are noticeably sharper
- Better picture quality due to greater resolution.
- The colour depth may reach 12 colour bits compared to the 10 for Full HD.

Drawbacks of 4K:-

- The content recorded in 4K is still narrow.
- To transfer videos in 4K have a minimum bandwidth of 25Mbps.
- The exported files are very dense and take up a lot of space.
- The prices of 4K televisions are not manageable for all pockets.

2.8 UHD (Ultra high definition)

It is generally used to describe the transmitted video content. UHD have more pixels (3840x2160) than full HD and offers improvements that advance image quality and practicality.

These can include:

- HDR (high dynamic range) – brighter whites and deeper blacks
- WCG (wide color gamut) – a broader range of primary colors, enabling true-to-life color reproduction
- HFR (high frame rate) – more frames per second, providing sharper moving images with less blurring

The simplest part of the move to UHD TV has been the upturn in display resolution from 1920x1080 pixels to 3840x2160 pixels.

While resolution is important, it’s most noticeable on static or slow-moving content.

Fast-moving images typically display some motion blur, so there is less advantage in the extra resolution. Video compression can reduce image resolution significantly.

UHD is visibly better than full HD at 1.5 times screen height; for example, 84 inches at 1.6m.

UHD include:-

- High frame rate is visible to viewers. HFR is exclusively useful for sports content.
- High dynamic range was very clear to viewers. Perceived video quality and viewing ease increases with peak luminance
- Deep color was traceable to consumers with the right content.

Applications of UHD:-

- UHD resolution used in consumer display and broadcast standard
- UHD resolution used in live music films, mood films and ambient films.

Advantages of UHD:-

- It gives images a clearer, stunning look.
- Heightened streaming experience

Drawbacks of UHD:-

- 4K programming will likely be costly and time-consuming for cable, satellite and broadcast providers.
- There is not much 4K content on regular TV channels.
- Upgrading to a 4K TV likely may require other upgrades e.g. 4K Blu-ray player, 4K receiver etc.

2.9 Quad Full High Definition (QFHD)

The resolution of 3840 x 2160 pixels is also often called 4K but it’s not 100% accurate. 100% accurate term for this resolution is Quad Full High Definition or QFHD because it has a resolution equal to 4 times of Full High Definition or FHD resolution which is 1920 x 1080 pixels

Total Pixels = 3840 x 2160 pixels = 8,294,400 pixels = 8.29 million pixels

QFHD = 4 x FHD = 4 x (1920 x 1080 pixels) = 8,294,400 = 8.29 million pixels

Applications of QFHD:-

- QFHD used in 3DTVs and computer monitors.

Advantages of QFHD:-

- QFHD is combining four (two-by-two) 1080p TVs together.
- It improves the video display image for large screen applications.
- QFHD has potential to deliver depth same as 3D without the need for glasses.

Drawbacks of QFHD:-

- Lot of infrastructure needs to be modify

III. Current Version Of Super Vision-8k

The current version of the Super Hi-Vision prototype is based on the predictable parameter values described in the table 1

TABLE 1 Picture Characteristics of the Prototype Super Hi-vision System [12]

Sr. No.	PARAMETER	VALUES
1	Picture aspect ratio	16:9
2	Horizontal pixels	7680
3	Vertical pixels	4320
4	Frame frequency	60
5	Image structure	Progressive
6	Bit/pixel	10
7	Colorimetry Received	709

8K image has the broader brightness and color range so it offers a way to improve picture quality independent of resolution. 8K TV is perfect for even wall-size movie viewing, and for displaying sufficient detail, such as text and graphics on average and large size PC monitors and digital signage displays.

IV. Challenges For Higher Resolution Techniques

1. Compatibility issues between upgraded technique and recent technique.
2. Consumer misperception about new technology has convoyed television’s upgrade to HDTV and digital services.
3. A lack of available HDTV material affected early adopters of HDTV sets.
4. Issues of bandwidth provision for TV. The bandwidth required for DTV was a barrier to its implementation for broadcast[13]

V. Opportunities For Higher Resolution Techniques

1. The live broadcasting of popular sports events.
2. The delivery of live broadcast and video on demand through existing stages including the internet and satellite.
3. The resemblances between large screen, wide field of view television and cinema.
4. The gaming market[13]

VI. Benefits Higher Resolution Techniques

1. Increased progressive resolution and dynamic range
2. Colourimetry may be noticed regardless of screen size and viewing angle on a television set. [13]

VII. Comparison of Viewing Distance for Different Higher Resolution Techniques

Viewing distances need to be closer:

TABLE 2. Comparison of Viewing Distances

Sr. No.	Resolution Technique	Viewing Distance
1	SD	6x screen height (4 meter for 55” screen)
2	HD	3x screen height (2.5 meter for 55” screen)
3	4K	1.5x height (1 meter for 55” screen)
4	8K	0.75x height (0.5 meter for 55” screen)

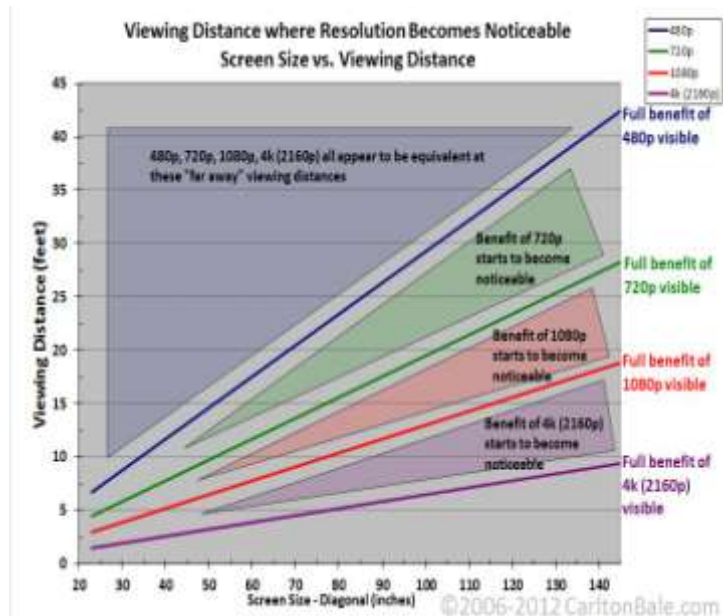


Fig 3. Screen size vs Viewing Distance[15]

VIII. Conclusion

HD delivers a number of assistances for IP security systems where SD cameras may exploit image usability and improving where bagging extra detail in scenes is required. The advantage of working with 2K images as different to HD is the size of the image that can be created, handled, and ultimately expected. The better choice for cinematic work is a 4K resolution but working with 4K would be exponentially more of a load than working with 2K’s because huge data requirements 4K is simply away from the possibility of many pieces of equipment be it scanners, storage or projectors. Some 4K and beyond resolution is already being done for select feature films—and even then for select shots in many cases.

4K will replace 2K as HD is substituting SD, but that day appears to be fairly detached, so for now a large body of the motion picture community has established on the high quality of 2K. 4K’s enhanced resolution can be an important backer to adding extra value to your quality screens

8K display can also be used for the purpose of improving lesser resolution videos with a combination of techniques currently used in video and film editing. If you thought that 4K resolution was the most awesome thing you’ve seen or heard of in digital displays and were simply overcome by the potential that 8K might have down the road. The basic difference between HD and 4K , and between 4K and 8K, is simply a 4X increase in the number of pixels a screen can display: twice as many lines of twice as many pixels where color depth and frame rate parameters are ignored. The future holds a expanding surge of opinion in favor of 8K resolution, as the market for 4K TV sets becomes drenched [14]

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