



## Discuss the examples of panoramic technology in the video industry — Video entertainment industry

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**Abstract:** The development of all kinds of intelligent hardware is essentially an extension of the human senses, according to statistics, more than 70% of the country's current human access to information from the eyes to watch, camera, as the expansion of human visual, has created a large number of information value, from entertainment to education and supervision to the security, video information is everywhere, has become one of the most important source of information. At the same time, different from the "narrow band" characteristics of ordinary sensors, the storage and transmission of video takes up a large amount of resources and belongs to the "broadband" sensor. The development of video technology is closely related to the basic computing power, transmission bandwidth, storage capacity and algorithm upgrade, limiting and promoting each other. In this paper, panorama technology is considered as a potential "general video technology". As an upgrade of ordinary camera function, a breakthrough in field of vision, and an extension of information comprehensiveness, panorama will be fully integrated into various video segments. Currently, there is no generally accepted classification method for the video industry. From the perspective of video content application attributes, the video industry is divided into two categories: video entertainment industry and video monitoring industry. The video entertainment industry pays more attention to the quality, individuality, entertainment, dissemination and culture of content.

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### I. The introduction

There are many segmentation use cases in the video industry. Strictly speaking, whether it is a motion camera used as a shooting device, a monitor and recorder used as a safety prevention device, or an image analyzer used as a visual sensor, it can be regarded as a segmentation use case of the video industry. The application of panoramic technology in the video industry can also be divided into video entertainment and video surveillance. Moreover, these two industries have different requirements for panoramic technology, and consumers also have different concerns. Next, we will analyze and study these two industries from the perspectives of key technologies, time nodes and industry conversion rate.

### II. Video entertainment industry

This paper uniformly divides the video industry with strong content attribute and sharing attribute into video entertainment industry. For high-quality content shooting, panorama technology, as a more convenient way of image capture, further reduces the technical requirements on the photographer, can achieve the "take a picture first, then find the Angle", with the help of gyroscope and other sensors to complete the full field of view of the picture capture. Then, the target

visual field can be presented through post-editing software or playback software, which can also perform fast and real-time image clipping, reducing the professional requirements of picture stabilizer, continuous focusing, perspective planning and real-time/post-editing. At the same time, the special shooting means of panoramic technology can effectively meet the VR industry's demand for full restoration of the original scene, and further distance from traditional video technology through immersive experience.

For the video entertainment industry, there are the following subdivided use cases:

- Professional film and television shooting
- Portable motion photography
- VR content production
- live class
- Mobile entertainment sharing apps

Video entertainment industry panorama technology, as a very important potential "general video technology", carries the high expectations of customers. Since the content entertainment industry has high bottom-line requirements for technology maturity, content quality and customer experience, this paper believes that it will be easier to promote the

industry if the reasonable industry development path starts from high-end professional products.

### **I- Technical challenges in the video entertainment industry**

With the continuous development of technology, a large number of panoramic technology products based on entertainment applications have appeared in the current industry, with a large price distribution range, most of which are between 500 and 10,000 YUAN, and tens of thousands of yuan more than panoramic devices. However, the viewpoint of this paper is: up to now, mature technologies and products that can meet the needs of video entertainment have not yet appeared in the panorama industry. Based on entertainment application products more category for "Low frequency" "Enthusiast" "Professional" use the product, if not at the bottom line requirements of our clients achieve customer experience inside, is easy to become "try products" of the closet, cannot produce large equipment sales, unable to create high quality content, also cannot constitute a vast amounts of information dissemination, will not become a "general video technology". For the video entertainment industry, this paper has put forward "bottom line demand" for many times. Such "bottom line demand" is the standard of panoramic product parameters. However, there is no "bottom line demand" recognized by everyone in the panoramic industry.

In the video entertainment industry, after research, there are the following key technological breakthroughs:

- Standard for shooting panoramic sharpness
- Immersive panoramic clarity standard
- High picture quality standards for electronic systems
- Optimization of optical structure design
- Optimization of screen stitching effect
- Playback display distortion correction
- Low threshold editing and post-editing
- Peripheral camera accessories support
- Content application platform

Below is a detailed description of each key breakthrough technology and related requirements.

#### **1. Take panoramic reference definition and resolution**

"Definition" and "resolution" is the concept of industry has not yet completely unified, is consistent with the view that the two concepts, but this paper have a different point of view: macro "definition" refers to the human eyes see clear degree of the image, is by the objective performance of systems and equipment comprehensive result caused by people's subjective feeling for the final image; "Resolution" refers to the image quality recording index used in the process of recording, transmission and display, as well

as the inherent screen structure of the display device itself to show the degree of image detail. Specifically, it refers to the scanning format of a single image signal and the pixel specifications of the display device. This definition makes it easier to understand the relationship between the sharpness and resolution of a panoramic camera and a normal camera.

This paper puts forward arguments, 8K resolution for the panoramic video entertainment technology industry "shooting benchmark resolution", if the technology for this resolution, means that at the same resolution and other equipment daily experience, panoramic get images of a bigger field of vision, no dead Angle information, convenient and flexible use, broad space for the real-time/editing, obvious advantages. At this point, it will reach the bottom line of mass consumers "good use experience."

#### **2. Definition and resolution of immersive panoramic reference**

As an important content source of VR industry, panoramic original picture can enable consumers to get immersive on-site experience through VR devices. The ultimate experience demand of consumers for VR must be the pursuit of a state consistent with the real feeling and effect, otherwise it is difficult to talk about "immersion". This means that both the display, transmission, storage, computing and content of VR are greatly challenged by information flow, while the monocular clarity of VR devices has been gradually upgraded from 2K to 3K and 4K in recent years. Now, the general standard of recognition in the industry is that the clarity of VR display devices needs to reach monocular 8K.

Since it is an immersive on-site experience, consumers' ultimate expectation for the screen is that "the screen viewed in the device is equivalent to the experience in daily life". Since the theoretical resolution of human eyes can reach hundreds of millions of pixels, after calculation, the equivalent panoramic image resolution needs to reach more than 2 billion (we call this level of panoramic resolution "retinal panorama"). Obviously, it is unrealistic to pursue this parameter in the short term. However, the actual "resolution sharpness" of the human eye is much lower than the resolution brightness and color, so a relatively reasonable resolution range can be calculated, so that the benchmark expectation of the consumer can be described as "the resolution of the picture seen in the device is equivalent to the experience in daily life". After calculation, the equivalent baseline resolution of panoramic image is 15K, which also takes into account pixel loss and super resolution requirements, so the baseline resolution of immersive requirements is obtained

$$72M/50\%/80\%=180Mpixels$$

This is called the "immersive baseline resolution"

of the panorama.

### 3. High picture quality standards for electronic systems

As a potential "general video technology", panorama can be said to be the gourmet of sensor resolution. With the increasing requirements of content quality in the industry, it will bring huge pressure of display, transmission, storage and calculation. But high pixels alone don't always mean high quality. Even with the same target and sensor technology, higher pixels mean lower quality, which is not acceptable especially in the high-spec content shooting industry.

### 4. Optimization of optical/structural design

With the continuous improvement of the level of involvement in the optical industry, the panoramic technology has been gradually locked in the structure scheme of "back-to-back double fisheye". In principle, two fisheye lenses larger than 180° level are used to capture images of two hemispheres respectively, and then the two fisheye images are fused and processed by the way of image Mosaic in later period. At present, there are two mainstream segmentation schemes for "double fish eyes back to back" -- "double fish eyes and double Sensor" and "double fish eyes and single sensor". Among the many technologies that need to be broken through, the two solutions differ in many implementation details, but the challenges facing the two solutions in the video entertainment industry are similar.

- Resolution improvement

The main purpose is to improve the clarity of the whole panoramic image to meet the increasing clarity requirements of general users for panoramic image. According to the above discussion, the benchmark resolution needs to reach 50M~180M as a whole, which means that the resolution standard for a single fish-eye lens is 25M~90M. This poses a great challenge to the optical design and manufacturing capability of mobile phones and other applications that have a very strict requirement on size.

- Uniform lens distortion and edge dark Angle

High quality image content requires high resolution consistency in fisheye lens imaging area. The existing problem is that the sharpness of the center area of fissure lens is generally higher than that of the edge area. In the panorama Mosaic process, the sharpness of the corresponding central area may be significantly different from that of the edge area, which to some extent affects the Mosaic effect and broadcasting experience of the panoramic image. At the same time, due to the certain curvature of the glass, it is difficult to achieve perfect consistency of the imaging surface and coating film, leading to the image defects such as green edge and dark Angle in the edge

image. This kind of problem needs to rely on the planet wheel coating machine \* and aspheric lens design and other special processes to solve.

- Longer rear focal length, shorter TTL

Existing multi-fisheye lens splicing, because of the structural complexity of the fisheye rear focus requires longer to make room for the structure. In addition for stitching effect under different distance in order to better fit the stitching effect, to reduce the parallax between different lens, can be done by reducing optical center distance between the lens and the general fisheye lens optical distance head piece of glass, through the design based on coke after reducing lens TTL is a good solution; The existing problem is that the optical center distance between two lenses is too far, which leads to poor stitching effect under different distances.

- Micro panoramic lens size and head glass protrusion

Once panorama technology is applied to mobile terminals such as smart phones, it not only has high requirements on imaging quality, but also has very high requirements on optical lens size. At present, the large fisheye design has the natural bow glass protrusion, which is no small obstacle for the mobile phone whether it is knocked or scraped or other structural design. At the same time, few big fisheye lenses are made into micro lenses, so there are many breakthrough points in design and production technology.

### 5. Screen stitching algorithm optimization

- Image Mosaic consistency and robustness

Video entertainment industry of panoramic image stitching has a very high quality requirements, the generic class panoramic camera are based on more than one camera images fusion splicing, therefore require multiple camera consistency from batch to batch consistency, sensor technology, picture clock synchronization, exposure, white balance parameters consistency requirements is very high, and the language image edge or easily under the condition of the lens more exposure conditions inconsistent "sea" of Yin and Yang to be spliced.

The accuracy of the existing image Mosaic technology is largely dependent on the accuracy of the existing image feature acquisition. The main research direction is to improve the image feature extraction and matching accuracy. The existing problem is that when the resolution of the original image is not high, the actual image feature extraction and matching accuracy will be not high, resulting in a certain degree of poor stitching effect. In some general scenes, if the scene content is relatively simple, the image quality is not high, the image features are difficult to extract, and it is difficult to improve the stitching effect.

- Real-time stitching optimization

Similar to prime lens focus, panoramic view of the existing image stitching effect is usually in a particular range of adaptation, and for a more complex scenarios such as movement distance fit for real-time scenario requires real-time optimization under different distance to achieve the splicing effect promotion, here is the main research direction of multiple cameras overlap parallax distance calculated assessment to identify adaptation effect, in addition to real-time applications such as mobile terminal need to raise algorithm of adaptive algorithm running effect.

#### **6. Distortion correction of playback display**

In general display devices, because the human eye for conventional image distortion is, to some extent, adapt to the requirements on the panoramic effect show that need to be adjusted according to human visual effect panoramic image visual Angle of view and the view distance, adjust the picture to adapt to the human eye, the optimal effect, broadcast of panoramic images for conditional limit to improve viewing experience; In the perspective view of the display device during the process of transformation picture frame rate lower phenomenon too rapidly, it is easy to let the viewer vertigo discomfort, here the main optimization of panoramic image rendering efficiency, reduce the hardware requirements for display devices, and further improve the image view in the process of switching frame refresh rate (line 24 fps, ideal 60 fps).

#### **7. Low threshold editing and post-editing**

As the panoramic original image is 2:1, the original data image is greatly distorted. However, in the display side player, the original picture is presented to the viewer after Angle selection and distortion correction. Therefore, there are many times of distortion correction in the process of panoramic video editing, and a large number of common post-production effects cannot be directly applied to panoramic video.

For non-professional consumers, there is obviously no condition for professional editors. Consumers need simple and convenient fool-editing software, which can further promote the fragmentation of the amount of data Shared by the public.

#### **8. Supporting peripheral photography accessories**

Whether it is professional film and television industry, portable sports photography and other subdivision use cases, there are a large number of peripheral accessories to obtain more extreme shooting effects, the following only select a few essential accessories of panoramic photography for a brief introduction.

- Panoramic radio equipment

Like the panoramic image capturing device, panoramic sound is captured. The capture of full-range

sound quality can further improve the viewer's immersive feeling and obtain a complete sound experience.

- Panoramic equipment bracket

Just like ordinary shooting equipment, the panoramic shooting equipment also needs stable bracket support. The difference is that since there is no dead Angle shooting, the panoramic bracket needs to cooperate with the later stage to quickly hide the bracket from the picture when needed.

- Panoramic gyroscope

The high-precision gyroscope equipment can not only correct the downward direction of the panoramic spherical image, but also achieve the stability of Angle and orientation. Meanwhile, the accurate recording of displacement can further facilitate the image calibration and calibration and effect addition in the later editing process.

- Panoramic stabilizer

In a moving scene, a stabilizer is also needed for the panoramic photography equipment, but the stability of the Z-axis is more needed due to the panoramic property. The design of the stabilizer needs to take into account the hiding in the panoramic picture, just like the requirement of the bracket.

- Panoramic light/flash

The history of photography is the history of light and shadow. In the process of shooting, the control of light greatly determines the quality of the picture. Since there is no dead corner in the panoramic picture, the supplementation of light in the outfield becomes a great challenge.

#### **9. Content application platform**

The way of content transmission has become the most important prerequisite for the popularization of content. Due to the particularity of the technical form and display form of panorama, there is still no universally recognized platform for panorama content and panorama application. From the perspective of "universal video technology", with the industry's upstream and downstream complete, there will eventually be one or more mature platforms. At present, in addition to the maturity of the platform itself, there are several important breakthroughs in technology.

- The popularity of panoramic/sharing plug-ins

Due to the large distortion of the original 2:1 frame of panorama, viewers will have a poor viewing experience if they directly watch it, which means that the panoramic picture and video cannot be directly Shared as the ordinary picture. In order to realize the smooth propagation of panorama content, it is necessary to embed the panorama broadcast plug-in on each playing, sharing and application platform to promote the universality of panorama. At present,

most of the mainstream sharing/social/video platforms have been inserted into panorama playing plug-ins (YouTube, Facebook, Youku, etc.). However, both the playback experience and content proportion are far from reaching the general standard, which not only requires the improvement of technology, but also requires the standardization of the international industry.

- Panoramic standard compression technology

As discussed above, under the requirement of the same definition, the pixel of panorama is much higher than that of ordinary picture, which causes great obstacles in the process of content transmission and sharing. In order to save bandwidth and data amount, it is necessary to optimize the data compression of specific panoramic picture. In the current industry, a variety of compression optimization schemes for panoramic images have been formed, such as hexahedral compression, etc., but there is still a certain distance from practical landing and popularization.

## 10. Conclusion

The above key technologies to be breakthrough focus more on the maturity of high definition, high picture quality and platform. In the view of this paper, these are the technical preconditions for the panoramic video entertainment industry. The panoramic technology here is more similar to the early smartphone technology from a certain perspective. In order to meet the bottom line demand of entertainment consumers and achieve the application upgrading of immersive experience and entertainment experience level, the above benchmark standards need to be broken as soon as possible. This is obviously not a single technology or a single operator can break through. It requires all companies in the panoramic technology industry to jointly create a good ecology, give full play to their own advantages, go deep into the technology bottom, emphasize original innovation, and then accelerate the panoramic technology to become the "universal video technology" in the video entertainment industry.

## II- The key technology of video entertainment industry panorama breakthrough time singularity expected

According to the above analysis of key technologies in the video entertainment industry, there is still a certain distance between the current panoramic technology level and the "bottom line demand" of consumers. The following is the forecast of the technology development time of the industry in this paper. Although it is a preliminary judgment without any rigor, it can be used as an initial point of view to draw inspiration:

- Shooting panoramic sharpness meets 50M resolution benchmark (~)

- Immersive panoramic resolution meets 180M resolution baseline (~)
- Electronic systems meet the universal half/full frame standard (~)
- Optical resolution enhancement (~)
- Optical distortion and Dark Angle Optimization (~)
- Optical lens miniaturization (~)
- Mobile phone and Micropanoramic Optics (~)
- Image stitching effect optimization (~)
- Display distortion Correction (~)
- Low-threshold editing and post-production (~)
- Peripheral photography accessories support (~)
- Content Application Platform (~)

## III- Market increment expectation of panoramic video entertainment industry

Before predicting the development prospect of panoramic video entertainment industry, this paper believes that the development of general consumer entertainment technology can draw lessons from the development course of the smartphone industry in the past decade.

In 2001, Ericsson launched the world's first smartphone using SymbianOS - R380sc, followed by Nokia and MOTOROLA launched their first smartphone. Then, in 2004, RIM introduced the blackberry 6210, billed as the first smartphone to be more like a phone. Then, in 2006, Nokia launched the N73, ushering in the SymbianS60 heyday, when smartphones were still out of fashion. Smartphones didn't really hit the market until 2007, when Apple introduced the first iPhone and ignited smartphone sales with Mature touch screen + apps are driving smartphone sales.

During this period, the scale of mobile phone market has been steadily expanding from 2001 to 2015, with the sales volume growing from 400 million units in 2001 to 1.5 billion units in 2015. However, it has taken 15 years for smart phones to take up nearly 0% of the market share in 2001, 30% in 2010 for Android+iOS, and nearly 100% in 2015. The iPhone of 2007 was the source of the smart phone industry.

From the current point of view, the first generation of iPhone technology is not insurmountable, or even with the continuous development of the mobile phone industry, has been eliminated by the constantly updated technology. However, it was the first iPhone that opened the door for consumers to try smart phones and completely overturned the traditional feature phones. In the same period, there were also many smart phone manufacturers, but they did not complete this historical task. Is this because there are huge technical barriers between Apple and other vendors?

This paper argues that the development of consumer technology and market is not a linear rising state. With the upgrading of entertainment and application experience, technology-based products will be completely separated from the previous generation of technology products once they reach the "bottom line demand" of consumers and realize disruptive substitution. Often "generic technologies" have great potential to disrupt the industry, such as AI technology, VR technology, etc.

Video entertainment is no less than the industry of smart phones. Video is more entertaining than text and pictures, but its early development is often limited by the shortage of data transmission and content. In the current Internet market environment gradually entering the "second half", with the improvement of 3G-4G information technology, a new round of traffic dividend has been clearly directed to the video field.

Since the first year of "Panorama" in 2015, "Panorama" and "720°" have gradually become popular among consumers through the continuous investment in market cultivation of enterprises that combine panorama application, and the consumer groups have been generally aware of panoramic video. Panorama, as a more complete information flow transmission medium, has an interface of information flow that can be viewed independently and controlled by users. In the field of entertainment video, the development of emerging communication media is more driven by innovative companies than by traditional video giants. Panoramic video will develop rapidly in an incremental rather than stock market.

### III. Conclusion

It is difficult to estimate the size of the video entertainment industry, which can achieve a market space of more than ten billion dollars in a single category, no matter according to the classification of equipment tools, content, advertising, platform and other functions, or according to the classification of film, television, mobile phone, sports and other scenes. It is estimated that the global market share of the big video entertainment industry exceeds \$100 billion every year.

(Hereby declare: Part of the original text has been abridged and edited.)

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