Examining 360-Degree Fisheye Video Technology

As 360-degree fisheye cameras continue to grow in popularity, this technology is becoming an essential part of many surveillance solutions. Its unique ability to capture large areas of a scene with no blind spots has made these devices a powerful tool wherever total situational awareness is required.

DOCUMENT PURPOSE

At Oncam, we pride ourselves in being the experts in 360-degree technology. Built upon the heritage of Grandeye. the inventor of the first ever 360-degree panoramic camera., Oncam's sole focus in on single-sensor fisheye video technology.

This white paper explores the technology behind 360-degree cameras and the unique benefits these devices provide. Single-sensor fisheye images will be compared with other panoramic video technologies available on the market today, and various use cases and industry applications where this powerful technology is best deployed will be identified.

What Is a Circular 360-Degree Fisheye Image?

A circular fisheye image is created using a lens with a 180-degree horizontal and vertical field of view. This allows light from all directions to enter the lens and be focused to the image sensor. This provides the user a unique vantage point of the scene and is where the name 360-degree camera is derived from.

The visual distortion effect that is created when using specialist ultrawide angle lenses is commonly referred to as a "fisheye" effect and is another common descriptor for panoramic or hemispherical cameras. While these images must be corrected with special dewarping software, these cameras provide consistency, sharpness and reliability compared to traditional multi-sensor panoramic cameras, along with higher resolution, which increases accuracy.

Benefits of 360-Degree Images

The main benefit of 360-degree cameras is the ability for the devices to provide up to 100 percent coverage of a scene with no blind spots. Unlike multi-sensor panoramic cameras that each record a scene, then are "stitched" together to form a full picture, fisheye images provide a complete image of a scene without the added step of stitching the images together. Essentially, users get the whole book at once instead of individual chapters that must be put together like a puzzle.

The lens is mounted in a fixed position and does not need to move or rotate to capture an entire scene. This means that everything is visible all the time, both on live and playback and an operator is not needed to ensure the camera is pointing in the right direction to capture any areas of interest while the image is being recorded. This is especially powerful for retrospective analysis of an incident where different parts of the scene can be viewed independently and without prior configuration or set up of that view.
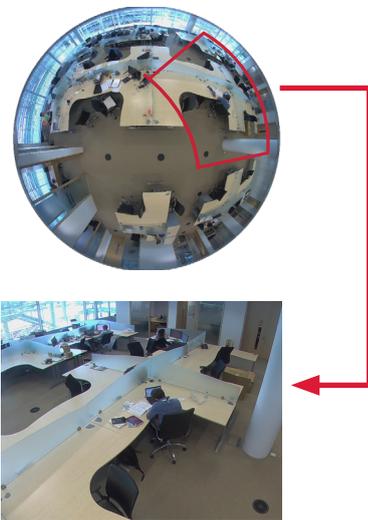

Example 1:
Circular 360-Degree Fisheye Image

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Dewarping

To maximize the benefits of the 360-degree lens, digital manipulation of the native image is required. The process is called "dewarping" and allows for any area of the original warped fisheye to be converted to have the look and feel of a more traditional video stream. A user can then move around the image and look at different parts of it in a more natural and conventional way.

Example 2:
Circular 360-Degree Fisheye Image

This is achieved using powerful software algorithms and can be done either onboard the camera itself or on a separate compatible Video Management System (VMS) or Network Video Recorder (NVR).
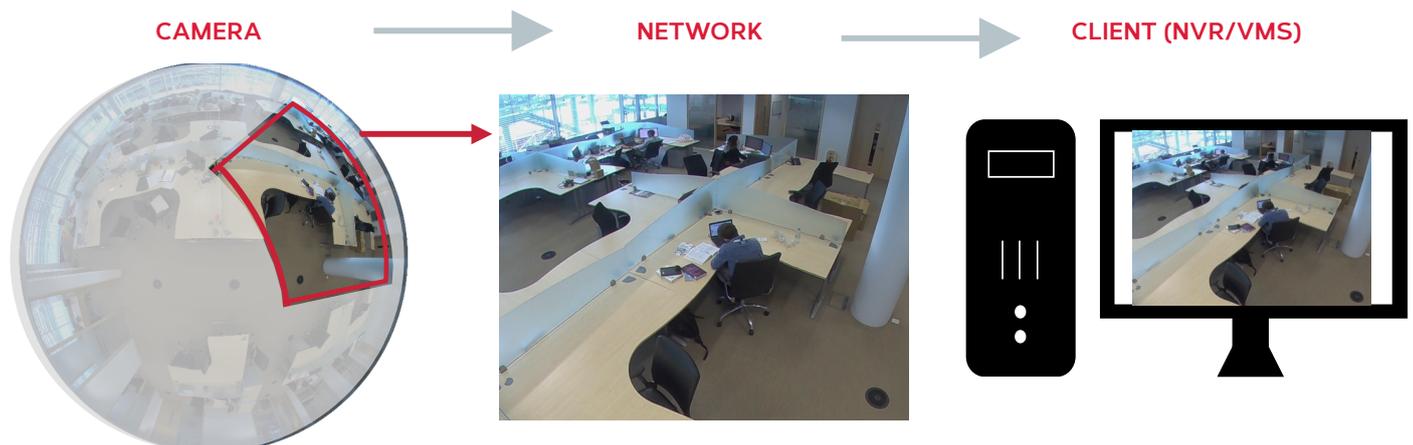
Onboard Camera Side Dewarping

In this process, the image is dewarped inside the camera itself and the resulting image is streamed as an independent view across the network. The resulting image is sometimes referred to as a V-Cam or "Virtual Camera" and depending on the specification of the 360-degree camera, multiple V-Cams can be produced at the same time.

The benefit of this approach is that no other software or system is needed to get a dewarped view and the network bandwidth of the V-Cam stream will be significantly smaller than the original fisheye image.

However, this approach limits the full potential of the 360-degree image as you only see the part of the scene that the camera sends and full retrospective dewarping of the whole scene in playback mode is not possible.

Client Side Dewarping

When client side dewarping is used, the whole fisheye image is transmitted across the network and recorded in full by the VMS or NVR. The dewarping is then carried out on the client and can be done on both live and recorded footage – meaning full retrospective dewarping of the scene is possible.

This functionality generally requires a bespoke integration between the camera and client manufacturers but provides the best end user experience.

Camera and client side dewarping are not mutually exclusive and can be used concurrently if required.

A V-Cam from the camera could be sent to an independent auxiliary system (i.e. for special monitoring or analytics) while the main system takes the complete fisheye in and use full client side dewarping.

What Is the Difference Between Single and Multi-Sensor Technology?

Wide-angle views can be achieved via single-sensor or multi-sensor technology. Single-sensor cameras have one fisheye lens which produces a seamless image. Multi-sensor cameras will use an array of lenses to capture the view.

Multi-sensor panoramic cameras can provide higher levels of detail at further distances as a result of the increased number of sensors being used to make up the image. Some models allow the lenses to be moved and some have different zoom and focus options. The individual images can either be viewed independently or stitched together using software to create a single image. The main benefit of this approach is more pixels on target due to the multiple sensors used.

Example 3:
Onboard Camera Side Dewarping

**CAMERA** → **NETWORK** → **CLIENT (NVR/VMS)**

However, multi-sensor cameras can present several challenges that can be avoided when using single-sensor camera technology

- The use of multiple cameras means they are not discreet units and the form factors can be very large and bulky.

- They can have image stitching issues: if lenses are not properly aligned, blind spots or overlaps are created.

- They can present light balancing issues, as each sensor is normally optimized for brightness and white balance differently and independently.

- They can be more expensive than single-sensor cameras.

- Multiple moving parts can create problems when repairs are required, often necessitating extensive troubleshooting when issues occur.

- Are better suited outdoors and have limited use cases indoors.

How Does 360-Degree Technology Compare with Other Types of Cameras?

A smart surveillance solution is one that leverages the different types of cameras available and integrates them based on their main benefits. Limiting to just one type in a system is never advised or encouraged.
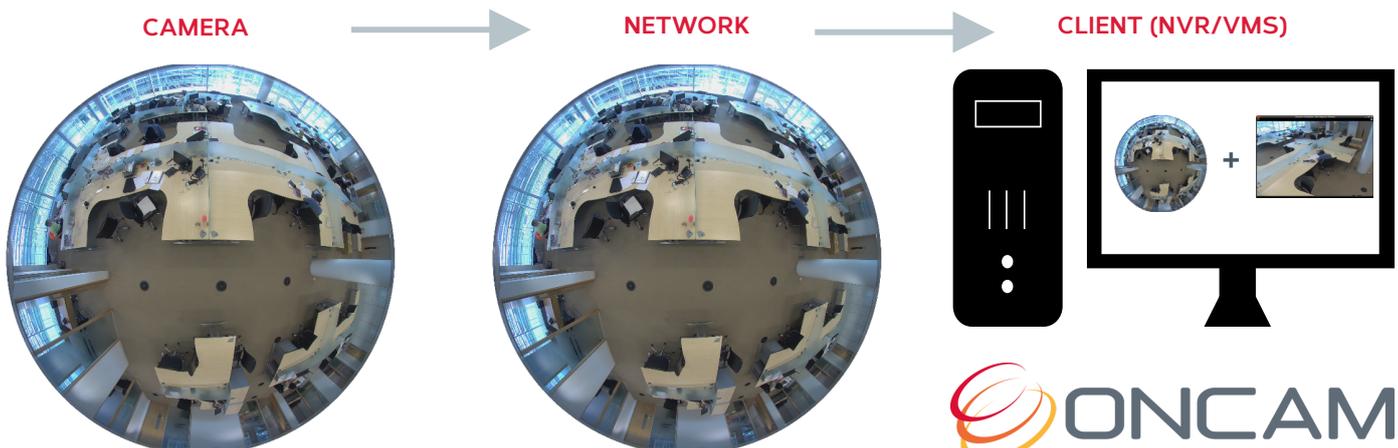
If a high level of identification or detail is needed, then a narrow field of view camera can offer more detailed coverage at specific choke points such as entrances and exits. The 360-degree images cover relatively large areas, so there may not be sufficient resolution in all parts of the image for applications such as facial recognition or license plate recognition.

Traditional pan/tilt/zoom (PTZ) cameras continue to have many useful applications, especially where high-detail images are required at a long distance and a live operator is available to control the camera and follow objects and people of interest.

The unique views offered by 360-degree cameras are designed to complement existing technologies, not replace them, and also open up new solution possibilities outside of pure security applications.

Applications of the Technology

Thanks to the ability to monitor large areas and provide unparalleled views, the use of 360-degree camera technology is increasing. The addition of different camera form factors and specialist certifications have further added to the influx of adoption, taking the technology use way beyond that of just a conventional security camera.

In large waiting areas such as inside train stations, airports or ports,

Benefits of 360-Degree Images

1. No blind spots
2. 100% coverage live and on playback
3. Camera cannot be left looking in the "wrong" direction
4. Provides views and use cases not possible with traditional narrow field-of-view cameras
5. Scalable and flexible thanks to compatibility with various VMS and NVR platforms

whole area from a single screen, simplifying the way they carry out their daily work. This overview can also allow the forensic analysis of scene to ensure that maximum efficiency of the space is being achieved. During an investigation, the retrospective dewarping ability allows users to work backwards from the flashpoint and obtain more details to the build-up of an incident, or the aftermath, once people have dispersed.

Resorts, hotels and casinos that must balance safety and security with guest comfort, can achieve full coverage without the "big brother" feel thanks to reduced camera counts. Small form factors that are available with single-sensor fisheye

Example 4:
Client Side Dewarping

CAMERA → NETWORK → CLIENT (NVR/VMS)

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cameras also mean that cameras can be placed discreetly, maintaining surveillance in all areas and reducing risk whilst providing a relaxed and enjoyable customer experience.

The captured video data from 360-degree cameras is also valuable for use in smart data solutions. Either via onboard or client-based systems, advanced software analytics can leverage the video for many different automated functions and alerts. In a retail environment this can include people counting, traffic flow, queue management, wait times and interaction analysis. All these options, and more, will give a better understanding of customer behaviour and shopper experience to allow for improvements and efficiency to be implemented.

In education and training institutions, 360-degree technology can provide an increased learning and development experience for both faculty members and students. Solutions centred around 360-degree video are now available and provide innovative ways to help with teacher training, remote view learning and non-intrusive interaction and observation of lessons.

New 360-degree technology is now being used in more specialist industries and applications thanks to the introduction of bespoke housings and form factors. Oil and gas production facilities, critical infrastructure sites, and other verticals that have robust and strict safety compliance standards can now benefit from total situational awareness, increasing coverage of plants and industrial sites reducing risk and increasing safety.

Example 5:
Installation of Oncam Evolution 12 Outdoor in ticket hall of Hua Lamphong station in Thailand

FIND OUT MORE

We hope this white paper was informative and instructive. If you would like to discuss this topic further, please get in touch with the Oncam team, we would be happy to assist you. Feel free to drop us an email or call directly on the number below.

Alternatively, you can find more information on our website:

360-degree technology and products

ABOUT ONCAM

Oncam is an independent, specialised IP video and technology company with a reputation for being one of the most innovative firms in today's market. Oncam's sole focus is on 360-degree and wide angle smart IP video – working with partners to deliver high-value business solutions for customers that leverage Oncam's award-winning technology. Find out more about our company and products by visiting our website.

ONCAM MAIN OFFICE

Building 4, Chiswick Park
566 Chiswick High Road
London W4 5YE
United Kingdom
Tel. +44 (0)20 7371 6640
Contact us

ONCAM

www.oncamgrandeye.com