

Observant

I N N O V A T I O N S

360° Panoramic Imaging for Analytics and Robotics
Gareth Edwards

360° Panoramic Imaging for Analytics and Robotics

There are two principle types of 360° Panoramic Imaging:

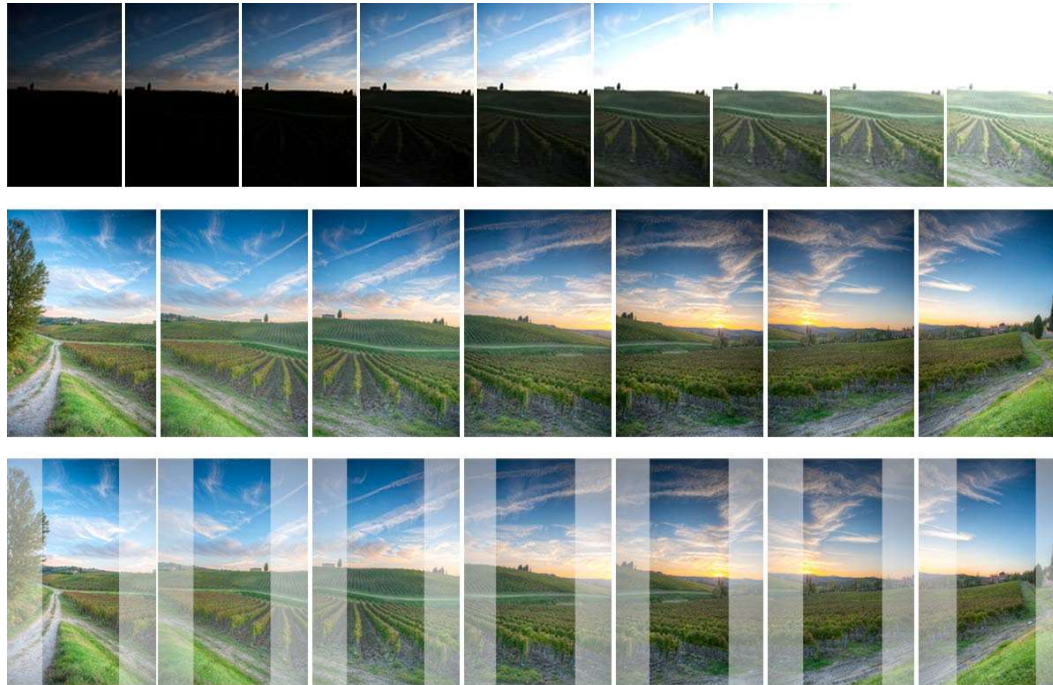
- Multi-Image, sourced from a sequence of still images, or from an arrangement of two or more cameras usually triggered simultaneously
- Single Image, sourced from a hyperbolic mirror based single camera

This presentation proposes that only Single Image provides the properties required for Analytics and Robotics, and considers Single Image:

- Spatial Accuracy
- Spatial 3D Measurement
- Observant Innovations Cameras
- 360° Panoramic application framework:
 - Acquisition
 - Exposure
 - Transform
 - Output
 - Archiving
 - Shared memory
 - Streaming

Multi-Image 360° Panoramic Photography

May look like the best compact, high resolution solution, but it's a trap.....



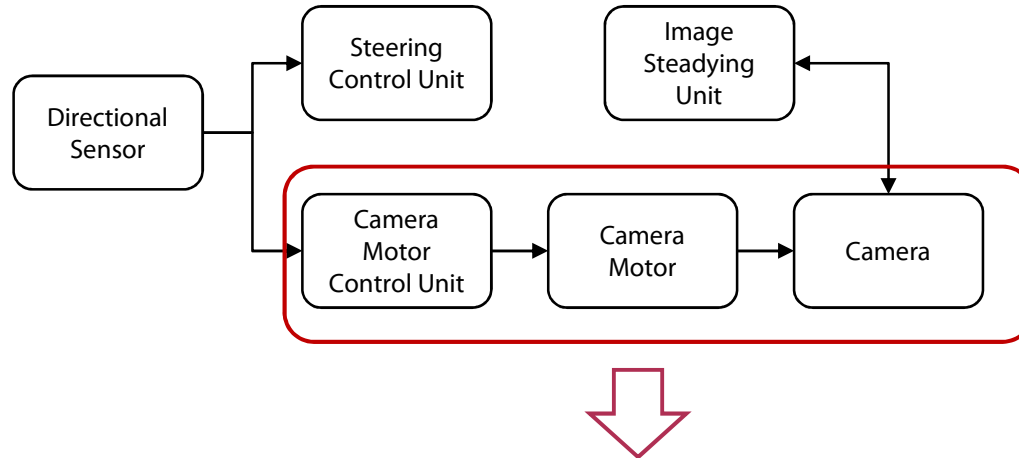
<https://blamethemonkey.com/hdr-photography-panorama-tutorial>

- 360° multi image or multi camera solutions use image stitching to combine multiple images into a single panorama
- Either with fixed dewarping and fixed BIG image blending areas OR
- Aligned – with BIG image blending areas – and combined using “good enough” image synthesis texture alignment and dewarping techniques
- Most pixels are not “real”
- IMHO, this precludes usage for imaging in Analytics and Robotics

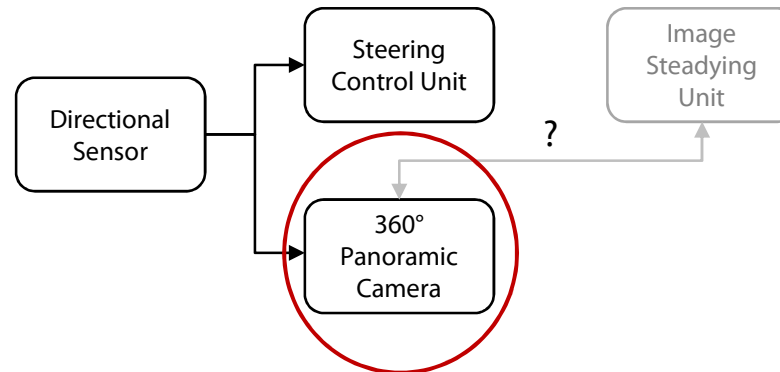
Single Image 360° Panoramic Photography

A simple one sensor, one lens, one mirror solution, with no moving parts

Example part block diagram for automated steering

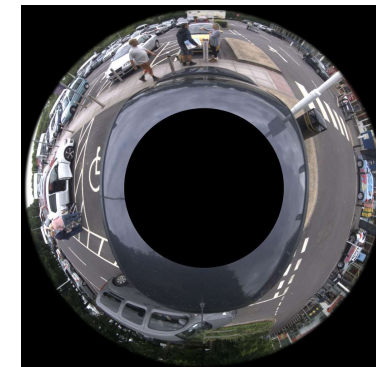


Example part block diagram for automated steering simplified with a 360° panoramic camera



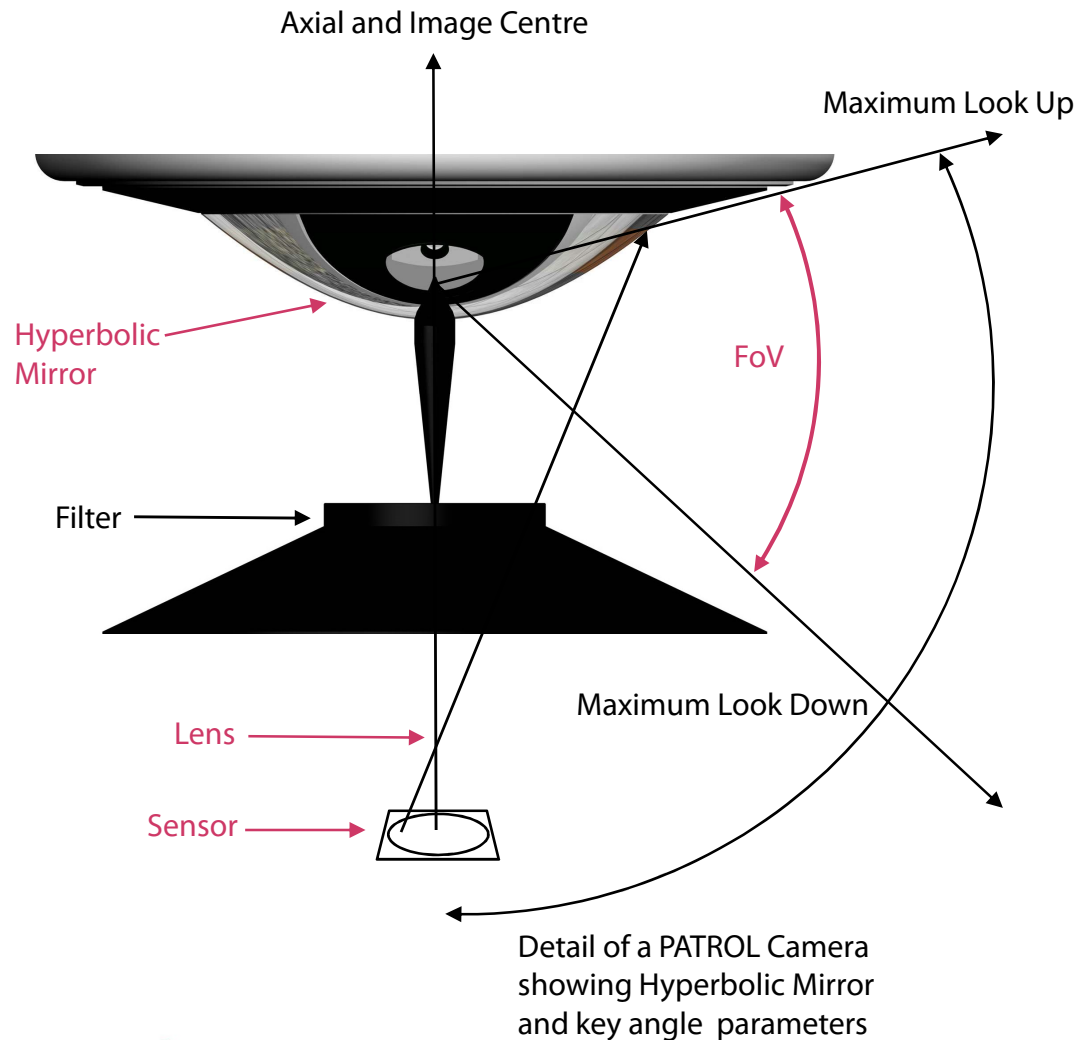
- Best “real” pixel imaging solution
- Prescription mirror with coatings
- Multispectral capability with fixed or (moving part) switched filters
- Resolution limited by single sensor
- Optical path hard to get “right”
- Tall - less compact
- Vulnerable

360° panoramic camera annular image



Single Image 360° Panoramic Photography

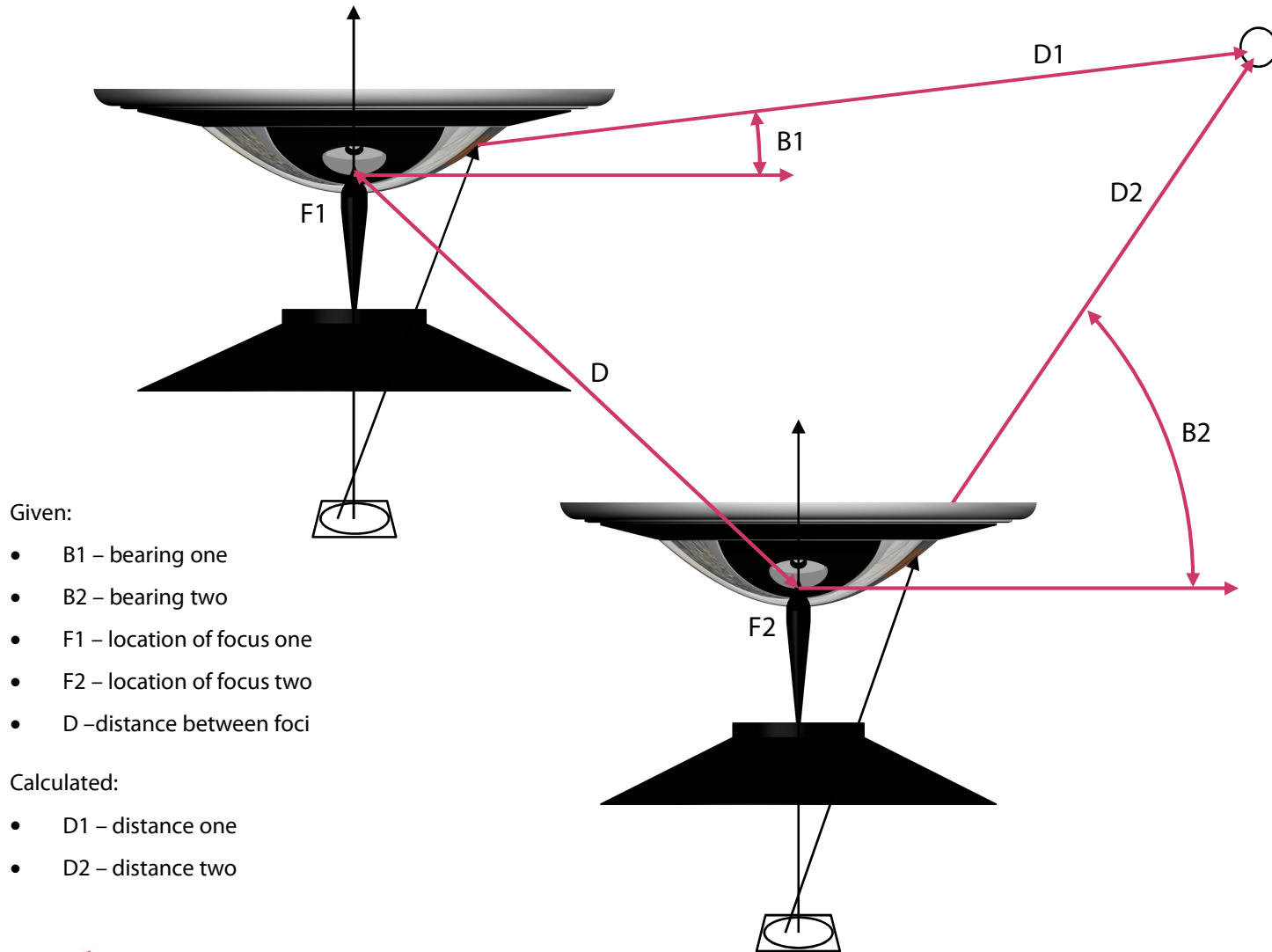
Spatial accuracy within a precise Field of View (FoV)



- Maximum Look Up angle can be pre-calculated for specific imaging requirements
- Maximum Look Up angle the only parameter required for spatial accuracy
- Every pixel within a 360° image acquired from a mirror based panoramic camera has a real-world bearing relative to the image centre
- Can be used to “paint” a 3D point cloud
- No stitching – every pixel is “real”
- **No moving parts!**

Single Image 360° Panoramic Photography

Spatial 3D triangulation measurement using multiple cameras



Single Image 360° Panoramic Cameras

Observant PATROL - a vehicle mounted 360° panoramic camera



- "Body worn video for vehicles"
- ONVIF PTZ compatible
- Streaming H.264 (including VR formats)
- Audio option
- GPS, Car and Camera metadata
- Integrated Image Management System
- Analytics 'ready'
- Rugged IP67 form factor

Single Image 360° Panoramic Cameras

Observant SENTRY - a mast mounted 360° IP surveillance camera



- Virtual "nest" of cameras
- IP H.264 camera
- ONVIF PTZ compatible
- Network IMS access
- Rugged IP67 form factor
- Easy installation
- Low maintenance

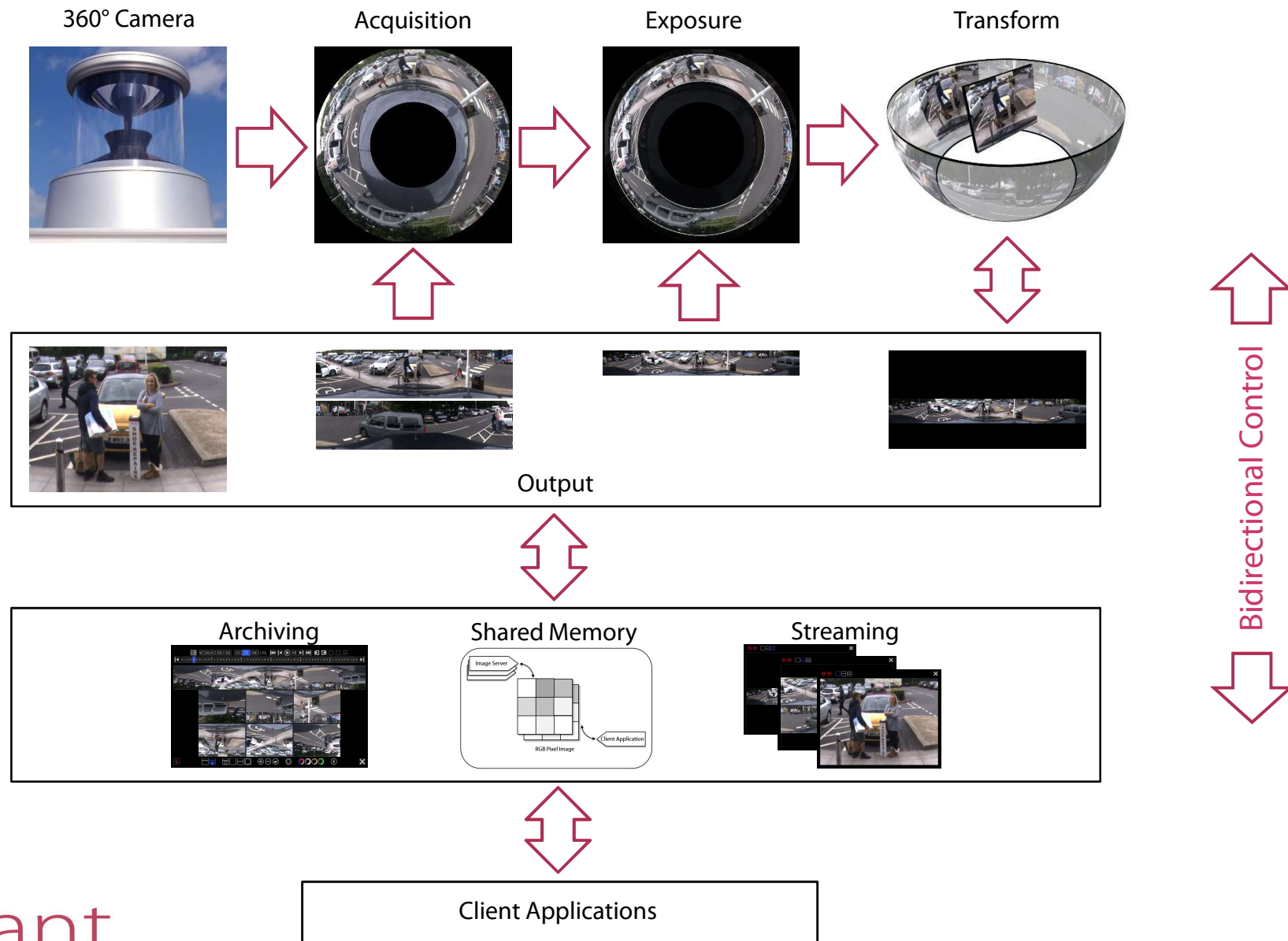
Single Image 360° Panoramic Cameras

Observant SENTRY - a mast mounted 360° USB 3.0 surveillance camera



- Collocated storage and power
- ONVIF PTZ compatible
- Streaming H.264 (including VR formats)
- Integrated Image Management System
- Analytics 'ready'
- Rugged IP67 form factor
- Rapid deployment
- Easy to operate and maintain

Single Image 360° Panoramic Framework



Acquisition

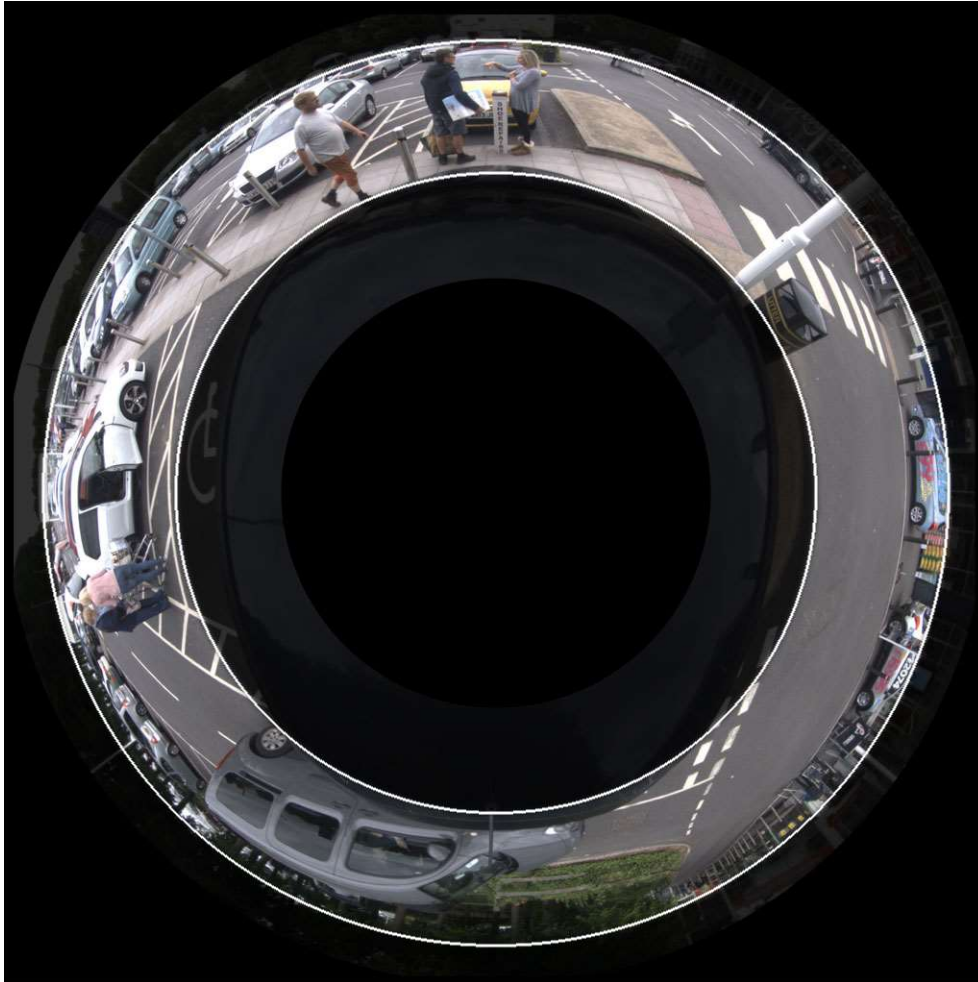
Annular Image – high quality



- Uncompressed RGB
- Up to 12 FPS
- Max 3684 x 3684 resolution
- Shared memory ready
- Shared memory vPTZ control
- ONVIF PTZ compatible
- Streaming H.264
- GPS metadata
- Exposure metadata
- Continuous annular image archiving
- Image storage management
- No image distortion
- No 'stitching'
- All acquisition, shared memory, streaming and image archiving features user configurable

Exposure

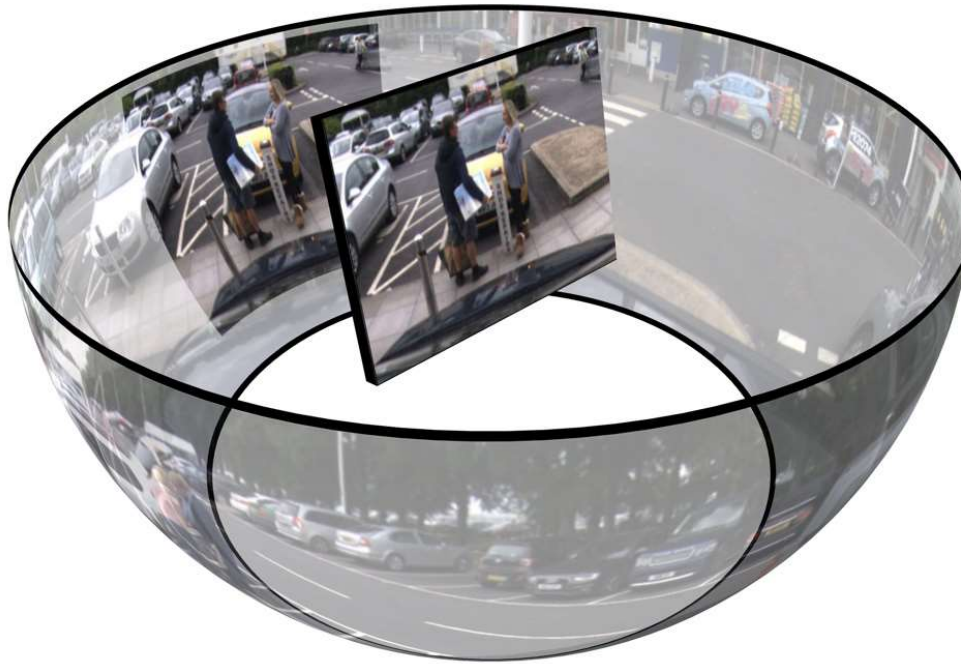
Annular photography



- Annular, multi-zone AOI auto exposure control
- 5 auto exposure modes
- 3 FPS speed modes
- 3 brightness modes
- Interactive exposure
- Interactive panoramic setup
- Annular sweet spot focus
- All photographic features user configurable

Transform

Dewarped and Unwrapped – using real time GPU and CPU accelerated parallelism



- Displayed or embedded high-quality rendering of complex 2D and 3D panoramic dewarping, with in-line image processing at 60Hz steady frame rate
- Camera applications support simultaneous image archiving to IMS, image transfer to shared memory, GPS NMEA and ONVIF compatible H264 streaming
- IMS Review application provides real-time playback and image processing of both “live” and pre-recorded image archives

Output

Formats include - apart from the source annular image -



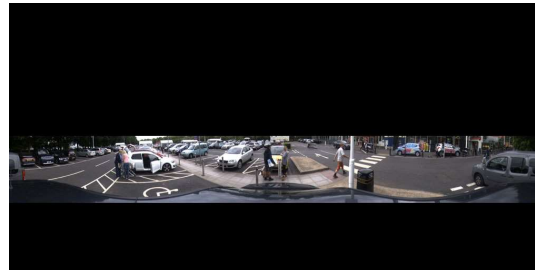
3D spherical view with vPTZ management and control



2D split panorama displaying 180° forward and back – or rotated by virtual Pan (vP) value



2D panorama configurable up to 8K horizontal resolution



2D equirectangular view for VR, 8K, 4K and 2K formats

Archiving

High quality JPEG format images

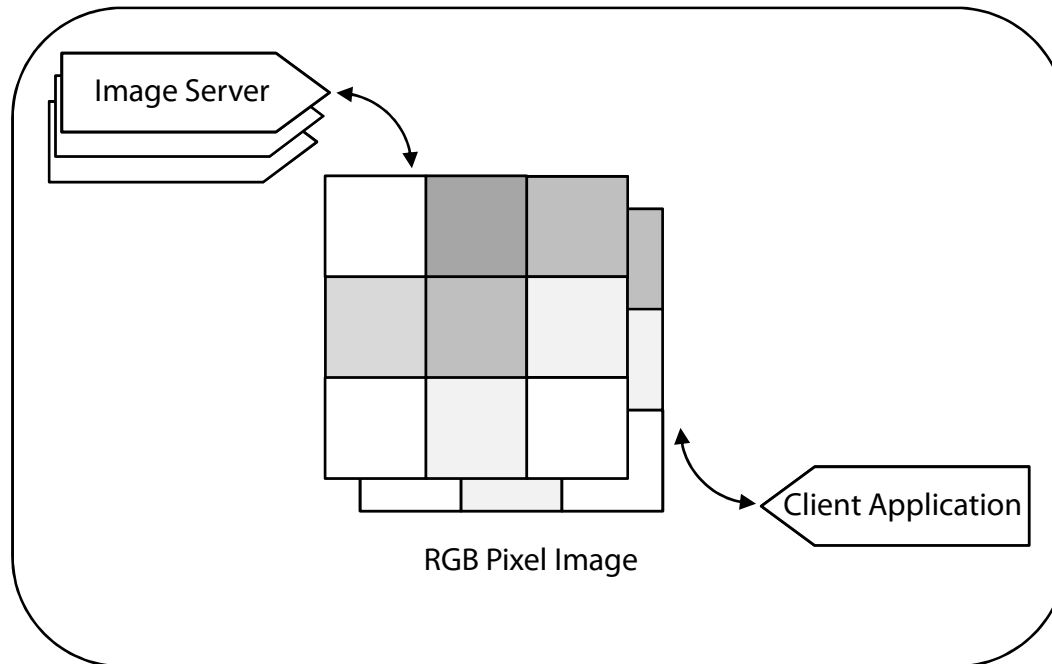


Using a supplied access C++ code framework, process, analyse, **interact with**, and/or display, using one or more Client applications

- Configurable resolution and quality dependant image file size – typically from 1.2MB up to 3MB
- Configurable hour/minute limit file storage, with automatic file management and clean-up
- Continuous, day or last session archiving
- User selected clips can be exported on network or local machine to a new clip with meta data
- Multi speed and configurable real-time image processing with low light boost
- Bi-directional vPTZ and AOI control
- Bi-directional imaging control

Shared Memory

Raw RGB - or JPEG - images and imaging data - straight from the camera...



Access using a supplied access C++ code framework, to process, analyse and/or display archived images

- Configurable shared memory is memory that may be simultaneously accessed by multiple programs with an intent to provide **interaction** and share data amongst them
- Shared memory is an efficient means of passing data between programs
- Configurable shared image type and resolution
- Bi-directional vPTZ and AOI control
- Bi-directional imaging control

Streaming

RTSP H.264 server



- Using technologies for accelerating H.264 compression on NVIDIA devices, this video encoding process carries out prediction, transform and encoding to produce a compressed H.264 bitstream



Interact with the H.264 stream using ONVIF, a global standard for the interface of IP-based physical security products, such as communication between video management systems and devices (i.e. cameras and encoders) as well as access control systems



View H.264 stream using applications such as VLC, and VMS such as Milestone and Wavestore

Observant

I N N O V A T I O N S

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Imaging for Analytics and Robotics

High level requirements include:

- Spatial accuracy
- Low latency
- High resolution combined with high frame rate
- Optimised QE and Read Noise
- Image-to-image stability

House keeping requirements include:

- Area of Interest (Aoi) control
- Exposure zone control
- Fast image processing
- Fast image geometry processing (e.g. spherical dewarping)
- Fast imaging encoding & archiving
- Access to raw source
- Image and camera data archiving
- H.264 Streaming
- ONVIF