IOD Manual V1.0

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1. Introduction to IOD

1.1 IOD Definition

Immersion-on-Demand (IOD) is a technical content standard introduced by LUCI, a technology and entertainment experience company. Compared with traditional video content, IOD is characterized by a larger field of view (FOV), high resolution, and stereoscopic imagery. The IOD standard technical criteria and guidelines are contained within this document.

1.2 Immersive Storytelling

Human obsession with story has progressed tens of thousands of years from early cave drawings retelling great hunting expeditions to seeing the latest blockbuster movies at our local big screen theater. As civilization advances, we need an evolved and immersive way to feel and experience the story that harnesses modern day technology. Storytelling must move beyond the confines of the physical movie and television screens. As content creators, the new benchmark in content creation must be for the viewer to feel "presence" in the story.

1.3 Industry Requirement

The global movie industry has seen modest gains over the last 10 years while digital video consumption via the internet has shown exponential growth. Mobile devices have been a larger driver as consumers preferring short form social content over long form narrative television and film content, yet television is still the predominant streaming device of choice for a better visual experience. IOD also serves as a mobile solution for those consumers who seek a premium cinematic content experience over short form video.

1.4 Technological Advances Supporting IOD

Display technology has progressed from LCD to OLED with improvements in pixel density, resolution, brightness, color space, contrast, response time, and energy efficiency. Wide application of gyroscope (angular movement detector) technology is being used to detect head movement. Microprocessor technology is progressing with new designs that can support 2k by 2k resolution with 120fps (frames per second). Instant positioning and SLAM are utilized to realize body tracking, position, and indoor spatial orientation. Wireless or extra spatial transmitters allow users to move freely in the digital environment. Content creators are now equipped with professional cameras capable of capturing stereoscopic +8k resolutions. Data transmission is entering the 5G network era which enables 8k streaming and ultrafast download speeds. All together these technological advances lay the groundwork for an immersive content category we define as IOD.

2. Visual and Audio Criteria

2.1 Display Quality

The optimal display quality is calculated by theoretical measurements of the vertical and horizontal field of view (FOV) of human eyesight and the range of motion (ROM) while watching traditional video content.

2.1.1 FOV & ROM Calculations

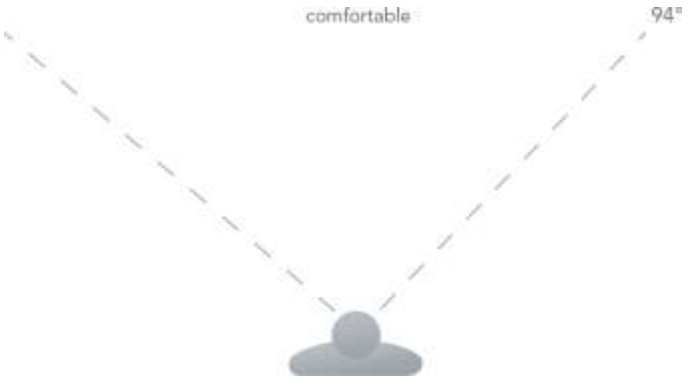

Figure 2.1 Comfortable Horizontal FOV: 94°

Figure 2.2 Upper Range Horizontal FOV: 208°

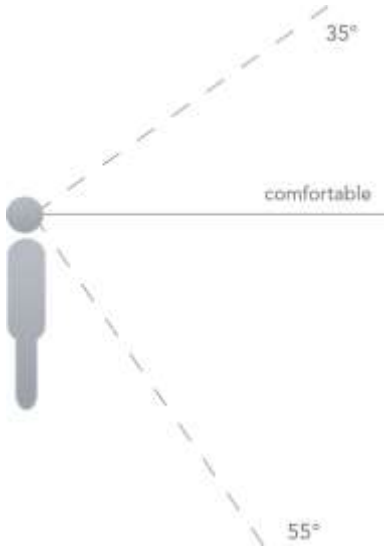

Figure 2.3 Comfortable Vertical FOV: 35° up, 55° down

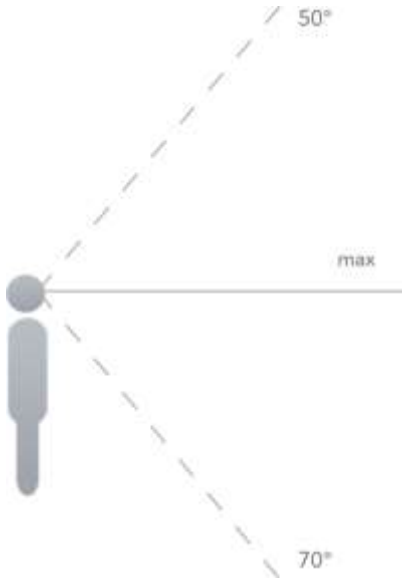

Figure 2.4 Upper Range Vertical FOV: 50° up, 70° down

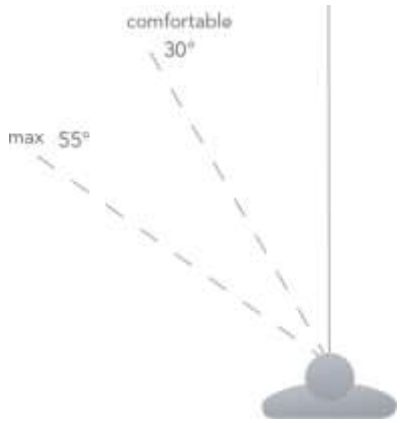

Figure 2.5 Comfortable Horizontal ROM of a human view perspective (rotation): 30° Left & Right, Upper Range (rotation): 55° Left & Right

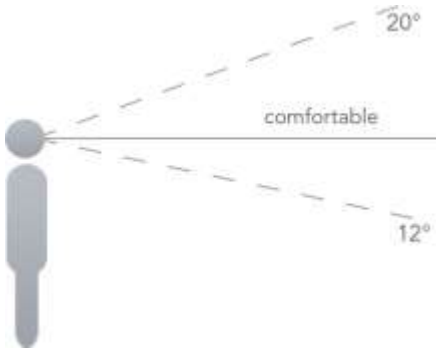

Figure 2.6 Comfortable vertical range of motion of a human head: 20° up (extension), 12° down (flexion)

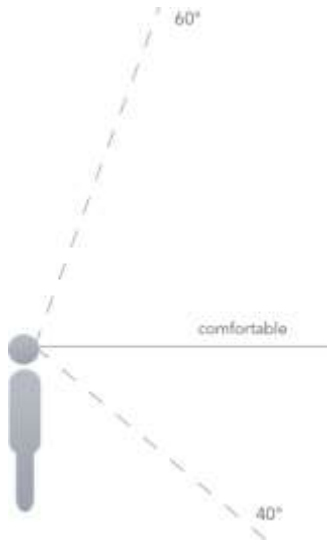

Figure 2.7 Upper Range extension: 60°, Upper Range flexion: 40°

2.1.2 Resolution and FOV

A minimum of 60 pixels per degree (PPD) is required. In an isosceles triangle where a viewer is at the vertex point facing a screen at the base and the vertex angle is 1°, the base must cover at least 60 pixels for a fixed distance d.

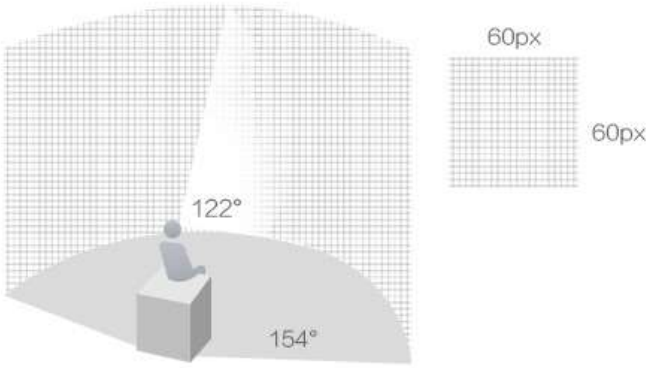

Figure 2.8 Ideal pixel per degree

Best resolution of highly visible area:
(94x60)x(90x60) = 5640x5400
Best resolution of all visible area
(268x60)x(152x60) = 16080x9120
Best resolution of visible area comfortable for both eyes and head:
(154x60)x(122x60) = 9240x7320

From the calculations above, we define the parameter of IOD as:

*Fh=154°, Fv=122°, Resolution=9240*7320*

2.2 Audio Criteria

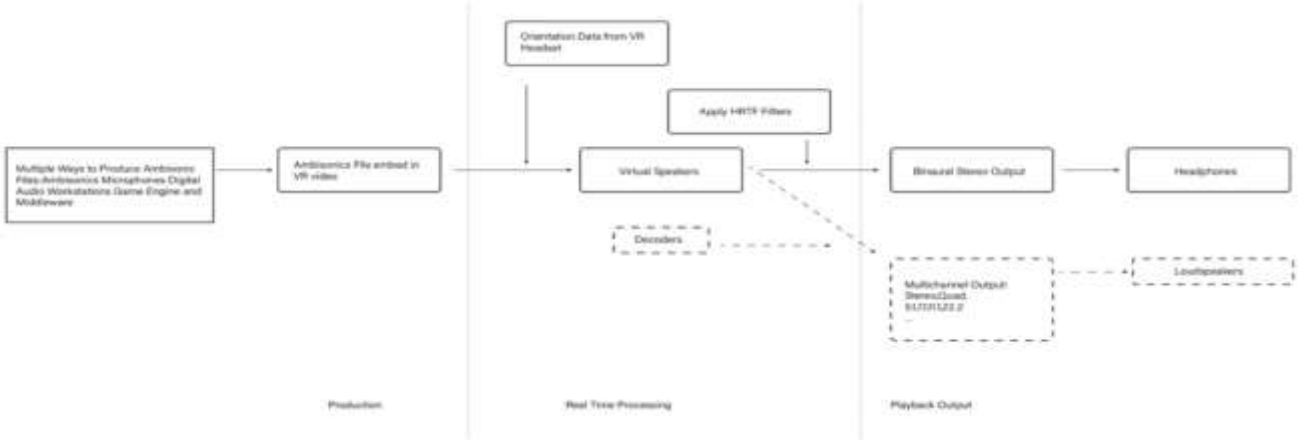

Figure 2.9 Audio Production Process

2.2.1 Audio Format

Use B-Format, which captures positional information for audio recording.

2.2.2 Audio Recording

At the recording stage, use Ambisonic Mics to record at least four channels simultaneously. Synchronize the mic with the camera to give the viewer an immersive audio experience.

2.2.3 Soundstage

A. At the stage of real time processing in the IOD device, apply orientation data and HRTF filters to the Ambisonic file to process the audio information from a specific direction, such as distance, latency, refraction, and reflection.

B. Add ambient sound effects to recreate a more realistic soundstage for every specific environment. Use the Shoebox Model to divide the soundstage into six facets and design their acoustic properties individually.

Figure 2.10 Shoebox Model

2.2.4 Playback

After sound field restoration and final output has adequate location information it can be paired with head movement, which is called Binaural Stereo.

3. Data Transmission and Playback Criteria

Because most media players currently are not equipped with a sufficiently powerful display, we categorize data criteria into basic, standard, and premium. This facilitates the enhancement of IOD content. The major differences between criteria are file rate, color intensity, bit rate, transmission bandwidth, following the chart below:

3.1 Data Criteria

Grade / Specs	Basic	Standard	Premium
Video			
Format	IOD	IOD	IOD
Visual Effect	3D	3D	3D
Video Coding	H.264	H.265	Future Video Codec
Frame Rate	30FPS	60FPS	120FPS
Video Resolution	3840x 1080	4096x 4096	9240x7320
Bit Depth	8 bit	10 bit	12 bit
Bit Rate	30Mbps	60Mbps	300Mbps
Audio			
Format	ACC	ACC	ACC
Multichannel Audio Coding	DTS	DTS	DTS-HD
Sampling Rate	44.1KHz	96KHz	96KHz
Bit Rate	768Kbps	1536Kbps	24.5Mbps

Table 3.1

3.2 Transmission and Playback

Grade / Specs	Basic	Standard	Premium
Transmission			
Bandwidth	60Mbps	120Mbps	600Mbps
Protocol	RTP	RTP	RTP
Play			
Screen Radian	24°	24°	24°
Processor	Intel i5	Intel i7	Intel i7
Graphics	Intel Iris Graphics 540	NVIDIA GeForce GTX 1080	Dual NVIDIA GeForce GTX 1080

Table 3.2 Note: Hardware reference brands are not exclusive providers and all comparable hardware is applicable.

4. Content Creation Guidelines

4.1 IOD Content Advantages

Content that comply with the IOD standard is a huge leap forward from traditional video content and can significantly improve the overall viewing experience.

4.1.1 Frame Size

IOD content is displayed on a larger frame that encompasses more visual information. Below illustrates IOD, 6K, and 4K frame sizes.

Figure 4.1 IOD, 6K and 16:9 4K comparison

4.1.2 Resolution

Below we have enlarged stills from the three formats to compare the resolution. IOD clearly demonstrates a superior resolution once magnified.

Figure 4.2 IOD compared with 6K, 16:9 4K contents

4.1.3 Pixel Density and the Screen Door Effect

IOD requires high pixel density (refer to PPD in table 3.1) to display without a screen door effect. Just as shown in figure 4.3, upper left and right images are from an IOD display, while the lower left and right are from a standard display. Once magnified, the pixel density of IOD is higher and the screen door effect present on the standard display.

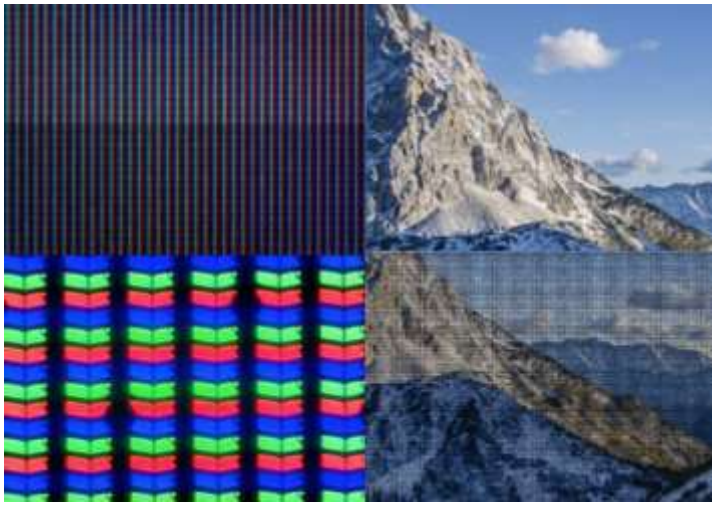

Figure 4.3 Pixel Density and Screen Door Effect Visual Representation
(Upper: IOD screen & Lower: standard screens)

4.1.4 Immersion

IOD content does not limit the viewer to a fixed 16:9 frame but aims to recreate what the viewer would see in a real-world environment.

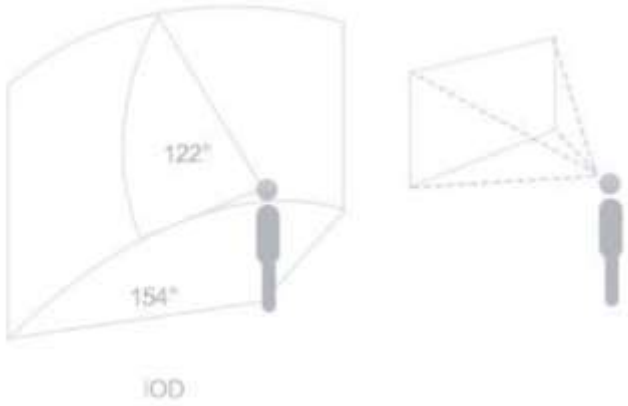

Figure 4.4 IOD and 4K Content Comparison

4.1.5 Camera Technique

New camera techniques focus on an immersed viewer's perspective.

4.1.6 Interactivity

IOD content is interactive with an active viewer that can influence objects, characters, and the plot within a storyline.

4.1.6.1Sight Indicator

As Figure 4.3 shows, when the viewer clicks on the hand-shaped sight under a hot air balloon, his point of view will zoom in on the balloon and see the corresponding plot and details on the picture.

Figure 4.5 IOD interaction through sight indicator Example 1

4.1.6.2 Interface Based on Head-Tracking

Head-Tracking technology allows the IOD device to collect real-time information about the orientation of the viewer's head. A specifically designed plot or visual can lead the viewer to face an area or object, hence triggering the interactive experience.

Figure 4.6 IOD Interaction through sight indicator Example 2

4.1.4.3 Interface Based on Eye-Tracking

Eye-tracking technology allows the IOD device to collect real-time information about the motion of the viewer's eyes. Visual indicators and plot devices can appear at the most frequently watched areas to enable the viewer to interact with the content. This data can also guide the creation of more interactive content, helping the content creators to maneuver the trigger points in the plot, characters, and environment.

4.1.7 Sound Orientation

IOD content delivers a more spatial and realistic audio experience. As the viewer's head turns, the positions and distances of the sounds at all directions will adjust to what the viewer's ears should hear at each orientation during head motion. When a viewer extends his head towards the left, for example, he will hear the sound from right distancing from him.

Figure 4.7 IOD Panoramic Sound Demonstration

4.2 Filming Solutions

Two ways to achieve 8192ˣ 4320 per eye, 8192ˣ 8640 total. Constrained by the performance of the mass-produced cameras currently available, this resolution is the closest to the IOD Standard.

4.2.1 Half-Frame Solution

Video Camera: EPIC-W HELIUM 8K S35 (WEAPON HELIUM 8K S35)

Lens: Entaniya 250°

4.2.2 Full-Frame Solution

Video Camera: WEAPON DRAGON 8K VV

Lens: 8mm

4.2.3 3D Tripod

The 3D tripod needs to accommodate two video cameras. The tripod must be able to align the two cameras' focal points on the same horizontal level, adjust their included angle, control the I/O horizontal parallax, and eliminate any vertical parallax.

4.2.4 Frame Synchronizer

3D Tc Frame synchronizer

4.3 IOD Content Creation Guidelines

The following guidelines are the fundamental principles and best practices for creating IOD content and helping content creators to avoid the basic technical oversights.

4.3.1 Frame Size

A. Fh = 154°, Fv = 122°, while complying with the IOD parameters in Section 3.1.

B. Put the main subject in the comfortable area: 94° horizontally, 35° vertically up and 55° vertically down.

4.3.2 Safe Distance

Keep an actor at least 0.5m away from the camera to place him within the boundary.

4.3.3 Composition

The large frame size and immersive point of view offered by IOD allows creators to adapt to new interpretations of composing shots that are different from traditional filming.

4.3.3.1 Rules of Thumb

A. Avoid distortion by distancing vertical objects from the far edge of the frame

B. Shoot from the viewer's normal perspective – not too high, not too low. Avoid view obstruction unless otherwise requested.

C. Maintain reasonable brightness. Avoid excessive, recurrent contrasts of colors between shots.

4.3.3.2 Cohesion

The visual structure must be thoroughly consistent. A unified visual style should run through each independent scene.

4.3.3.3 Balance

Visual balance and imbalances should be carefully designed. A view from the centric position is recommended. For example, when filming in a room, position the camera in the middle of the room to deliver a sense of balance and that allows the viewer to have a comfortable view of the scene. When creating a spying point of view, a visually imbalanced depiction could be optimal. Both balanced and imbalanced visuals are designed to produce striking impact.

4.3.3.4 Proportion

The main frame should comply with the golden aspect ratio. The proportion of an object to the picture is a mean of emphasis. Placing the camera closer to an object increases its importance within the scene. Changing the proportion is also a means of depicting emotion.

4.3.3.5 Contrast

The contrast of brightness, colors, and textures is an important storytelling and plot-highlighting method.

4.3.3.6 Depth

This requires intricate design of layered, tridimensional scenography to create pictures with extraordinary depth.

4.3.3.8 Camera Angle

A. Eye level: When filming a person's stance, level the camera's height to the person's eye level for creating an interpersonal viewing angle.

B. High Angle: Shooting from above your subject to view the whole scene empowers the viewer.
C. Low Angle: Shooting from below allows the viewer to see the world from the perspective of a dog or a child. Like high angle shots, low angle shots can also depict character's emotion and the relationship between characters.
D. Dutch Tilt: Leaning the camera sideways can transfer horizontal pictures to diagonal, canted pictures. This camera angle can portray visually intense ambience and suggest emotions such as paranoia, anxiety and fear. This can also be done in post-production.

4.3.4 Video Editing
IOD content requires more sophisticated editing and transitions. Unlike following the view given by the director of traditional content, viewers see IOD content from inside the scene. This requires IOD content to have a better shot continuation and visual transition.

4.3.4.1 Continuation
Within the same environment, one long take is preferred unless the script requires zooming.

4.3.4.2 Transition Indicators
Transitions from one environment to another should be accompanied by clear indications. Transitions can be done by:
A. Action: the actor's body motion, e.g. pointing to the sky;
B. Spoken Line: e.g. when the actor says he wants to be a bird, the next shot will be a bird in the sky;
C. Sound: e.g. the sound of thunder transitions to the raining scene outdoor;
D. Overexposure: manipulate light exposure to introduce the next shot;
E. Prop: e.g. an actor opens a door to introduce the next shot.

4.3.5 Motion Shot
Keep the tilling speed constant (unless acceleration is required), keep the camera steady, and the moving direction straight. Spinning shots are not recommended for transitional shots.
4.3.6 3D Effect
The optimal distance for shooting 3D is between 1 to 4.6 meters. Place the characters and important objects in the scene within this range from the camera for achieving the best 3D effect.

4.3.7 Interactive Plot
A. The Viewer chooses one of the many storylines and follows it to the end.
B. In a point-of-view storyline, the viewer becomes the protagonist, who shows scripted body movements and dialogue.
C. The viewer follows the lead of the non-player characters, actively looking for an object or engaging with characters or objects to move the plot forward.

4.4 Post-Production

The post-production activity of IOD content is largely like that of traditional content. A few differences are mentioned here.

4.4.1 Reducing Distortion

Both wide-angle lens and long-range zoom lens produces distortion that bends the pictures. A thorough clean-up of any visual distortion, especially those on the edge of the frame, should be implemented after the rough cut.

4.4.2 Video Cropping

Crop the motion pictures according to the standard IOD frame size. Visual balance and composition of the pictures should not be neglected during the process.

4.4.3 Frame Synchronization

The post-production process requires editing the two video tracks simultaneously and frame synchronization. Once the editing matches brightness, contrast and the color grading of one track, all the same edits should be applied on the other track. If the same shot appears to have different focus levels, magnify or shrink one of the tracks to make the two pictures as similar as possible.

4.4.4 Eliminating Vertical Parallax

There should be no vertical parallax between the left and right eyes. Only horizonal parallax is allowed. If the vertical parallax is inevitably captured, it should be edited out while maintaining the same convergence, hence bringing up the 3D visual effect.

4.4.5 Audio Production

Spatial sound is produced in accordance with the parameter set in Section 3.1 and added to the video.

4.4.6 Export

The final IOD content is exported in accordance with the parameter set in Section 3.1.

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