Subtitling for Stereographic Media

Introduction

With the recent surge in interest for 3D stereographic movies, more pressure is being applied to the broadcast industry to provide 3D content delivery for the array of 3D media players and televisions. It is understood that 3D should be an additive technology in that it should add to, rather than reduce the viewing experience. In as much as there is a growing number of subtitle users on existing 2D material, the support for professional subtitles in the 3D content delivery marketplace is one that has been largely overlooked.

Scope

This White Paper will describe and summarise the stereographic delivery mechanisms being considered and their implications for subtitling. It will also summarise some proposed recommendations and solutions with regard to these mechanisms and implications.

Stereographic History

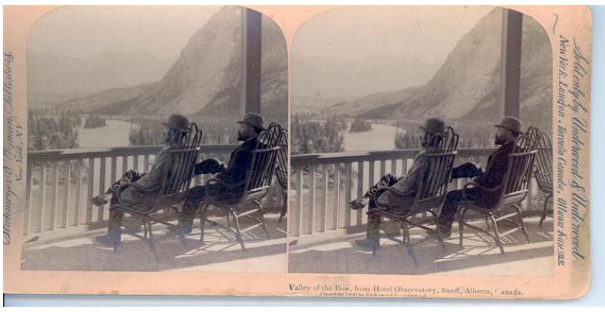
Stereographs are images which present a fixed position illusion of a scene in such a way that solidity and relative perspective appear to have been retained. This illusion relies on one of the ocular depth cues we use to judge depth within regular vision. The scientific reasoning behind this cue, named stereopsis, was first published in 1838 by Charles Wheatstone. In his paper he showed how the brain unifies, or fuses, the differences between the two eyes to form the realistic illusion. Sadly, the only technology available to Wheatstone to demonstrate this effect was pen and paper. However with advances in technology the first still stereographic images were taken as early as 1840.

By 1930 the same technique was being used within moving images and media. Much of this material rather than using the existing side-by-side layout, utilised anaglyphic filtering to present the effect. This technology reached its peak of interest with films such as “Creature from the Black Lagoon” and “House of Wax” and content was largely focused on horror or thriller genres. Many people complained of headaches or nausea resulting from prolonged viewings of this type of material, and with advancements in this technology stalling, the public largely dismissed stereography as an uncomfortable gimmick.

Several failed attempts during the 1980s to revive the medium saw the technologists return to the lab for solutions to the concerns raised by the public with regards to quality and uncomfortable psycho-physiological phenomena. They returned in the latter part of the 80’s with several polarised solutions which have addressed many of the concerns raised about earlier technology. However it is only in the early part of 2000’s that stereographic content finally found favour once again.

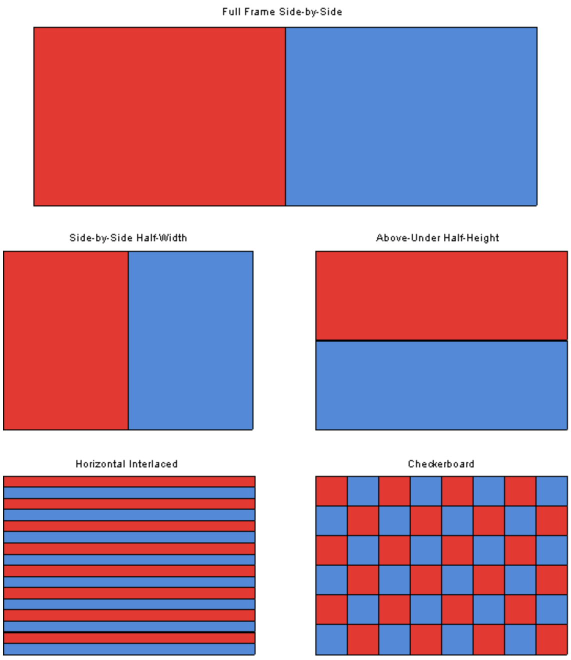
Modern Stereographic Transport Formats

Back in the 1930's a single stereoscopic image was created as two shots of the same scene from slightly different horizontal displacements. These two images were then shown to the viewer by way of a binocular arrangement.



This form of providing the left and right image information in a single frame is known as side-by-side and is currently considered by many stereographic professionals as the best medium for the storage of stereographic video. One of the reasons this format is promoted over other multi-view or compressed techniques is the frame synchronicity provided by this format.

With various other multi-view formats the data for each view is provided as an independent stream within a file, or even as two distinct files. While these provide a good viewer experience the opportunity for the left and right frames to become out of step is significant unless additional precautions are taken with the delivery and decoding methods.



Variations on the side-by-side format are also found to be used in the industry such as above-under, horizontal interlacing and checkerboard formats. Each of these formats has particular advantages under certain circumstances. However for reasons that will be discussed later in this paper, side-by-side and side-by-side half-width are currently preferred for content delivery within broadcast chains.

Another delivery technique, known as frame sequential, provides each viewpoint as a single full-frame, one after the other, within a single stream. This again means that synchronicity will not be retained without buffering or other techniques. As a presentation scheme, this format works well for cinema, but for storage during a broadcast chain it introduces needless complexity.

Several other compressed formats exist utilising channel disparity and additional optimisations to deliver stereographic content. Most professional stereographers seem unconvinced by the claims of significant compression with near-full content retention, and still appear to prefer one of the fundamental types described above.

Certain broadcasters will consider dual-stream(two HD-SDI streams) travelling through a facility. In these instances synchronisation will be an issue, but this gives the highest quality of image and a choice of final delivery method. 3D media will be carried as dual-stream in 3G HD-SDI.

Modern Stereographic Presentation Formats

During the 60’s craze with stereo3D movies, anaglyphic filter formats were used to provide viewers with a 3D cinema experience. Customers were asked to wear red and cyan gels in cardboard crafted glasses to filter for the correct projected channel. One problem with original presentations was that each red and cyan filtered channel was supplied to the cinematographer as two separate reels, meaning that the presentation required two projectors. Technology was lacking to maintain synchronisation between the two projectors, and careful and constant monitoring by two projectionists was required. Even so, the results often resulted in clients experiencing significant nausea and eyestrain.

Later the combined anaglyphic image was finally distributed so that a single projector could be used to present the movie. However these presentations were still received poorly since they were essentially monochromatic and still resulted in uncomfortable sensations during prolonged viewings.

Anaglyphic filter techniques are still used today when presenting printed 3D material, internet 3D movies and images, and 3D DVD movies. They require no further technology to view than a pair of correspondingly coloured gel filters for each viewer.

There are now two major modern techniques that can be used to present 3D material: passive-glasses and active-glasses. Autostereoscopic techniques are available requiring no additional spectator view filtering (no-glasses), but these systems work on platforms that are currently commercially inaccessible and complex to deliver content for due to the inherent multi-view properties of the screens.

Active-Glasses

In these setups the glasses worn by the viewer are powered and generally use a rapid LCD flicker to shutter out alternate frames presented by a linked fast refresh display. These displays are often capable of response times of 3ms or faster meaning they can present sequential frames at up to 120 times per second. Linkage is performed most often via an infrared emitter synchronised to the refresh rate of the monitor.

Glasses are currently priced at around £100 per pair, meaning this is only an option for small viewing activities such as playing games or 3D material proofing. The glasses also tend to be quite delicate, so they may not be suitable for young families.

Occasionally crosstalk can occur as a result of less than optimal response timings, and ambient fluorescent lighting can cause uncomfortable sensations. These can be limited by controlling the environment around the display.

Passive-Glasses

This type of technology utilises light polarisation to filter frames. Until the late 90’s linear polarisation was used by most 3D projection cinemas, but issues concerning angles and tilt resulted in rotational-polarised filters that are now used instead. This solution, like the active-glasses setup, provides a full-colour 3D illusion that is very convincing. The low-cost polarised gel filters and high-cost projector installation lend themselves to cinema presentation.

While many consumers have stated preference for passive solutions with regards to 3DTV for the home, the significant initial cost is sufficiently in excess of existing active-shutter systems that most are holding back their purchase until this type of solution is more accessible financially.

Creating Illusionary Depth

It is worth pointing out that the illusionary depth of an object within a 3D space is not a linear function of stereo separation. In fact it is a fairly complex function largely dependant on the viewers' distance from the screen, a factor not easily calculable but which can be assumed given optimal viewing distances for monitor sizes.

When one wants to make an object move out of the screen, you can do so by moving the left channel towards the right of the frame in relation to the right channel. More often than not you will prefer to also move the right channel to the left to retain the same horizontal position. Likewise moving the left channel left and the right channel right gives the illusion that the focal object moves into the screen. The amount you move these channels apart is called disparity, and it requires the eyes to converge or diverge, and subsequently the brain fuses the two images. The position at which your brain determines the object exists within the 3D space is the illusionary depth.

There are limits to the range of depths that can be described by a given stereoscopic system. These limits are largely governed by the width of the screen, the pixel size, the screen resolution, the viewer's distance from the screen and the physical separation of the viewer's eyes.

The infinity [1]position is described by a stereo separation on the screen equal to the separation of the viewers eyes, widely approximated to be 6.5cm, such that the line of sight for each eye is parallel. The nearest position is the disparity necessary for the right-hand side of the object in the left channel to touch the rightmost edge of the screen, and conversely for the right channel. The latter effect is largely avoided due to the discomfort associated with it. However the infinity position is used, it unearths another issue for 3DTV broadcast.

On a computer monitor 6.5cm may describe 20% or so of the width of the entire visible area. So if an object is 'planted' at infinity it will be separated by a factor of 20% of the width of the screen. Now imagine we take the same image, and project it on to a cinema screen. 20% of the width of a cinema screen can be several metres. This would require the audience to force their eyes to look in opposing directions, a trick the muscles in our eyes are simply not capable of, and eye strain will result.

Equally if material is scaled from a cinema version for display on a monitor, the depth cue information will be very narrow, and will appear very flat.

So what is the solution? Cinematographers must be very careful about the way in which their material is shot so that when it comes to publishing their material for the cinema, they can be sure the infinity issue is avoided, but also that the source material can be re-sampled in a way to retain the depth cue information for the full 3D experience that the audience expects.

What this means for subtitles, is that subtitle files will have to be created for each intended medium of delivery, because a stereo-separation suitable on a 3D PC monitor will not be viewable on a cinema screen or a 42" plasma display. Additional precautionary measures and safeguards will have to be made to prevent this type of issue.

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[1] Infinity, in this instance, is used as a label rather than a definition. With convergence depth cues, a disparity of 6.5cm on screen will approximately related to 10m from the viewer. Additional depth cue information can be drawn from binocular disparity and other monocular depth cue information such as masking and shadows.

Subtitles in Stereographics

Subtitling First Principles

A common philosophy within the subtitling industry is that "Subtitles should be read but not seen". What this means in principle is that a subtitle or caption should complement the material it is attributed to, but should never be difficult to read or overpowering. Within a regular 2D presentation this means that a subtitler needs to make sure that any text they put up on screen is clear, legible and conveys the message intended, while not occluding the action and remaining visible only long enough to be read. Obviously the subtitler's job requires other stylistic and professional adjustments beyond simply transcribing, but for the purpose of this document these additional professional considerations are implied rather than explicitly defined.

Stereoscopic Considerations

Why can 2D subtitles not simply be applied to 3D material in the same way? Well they can, but the effect may be undesirable. Let us assume that you have generated subtitles such that during a 3D broadcast they are displayed with no 3-dimensional depth. A typical 3D presentation may have approximately 5% of out-of-screen effects, any subtitles displayed with no depth over these out of screen areas will conflict with the intended illusion and cause uncomfortable viewing.

In addition, certain professional stereographers don't like the idea of subtitles of any type being applied over the top of any 3D material, and would prefer in the first instance that they be removed and professional dubbing or voice over tracks be applied. In the instance that subtitles *must* be included, it is the preference of these professionals that they should appear in areas of the presentation where no depth cue information exists at all, such as in the black of a letterbox cut.

Fixed Position

Why not position the subtitles a set distance out of the screen to avoid the majority of these occlusions? Certainly you can do this. In fact in the latter part of 2009 "A Christmas Carol in 3D" was shown as the first 3D presentation with subtitles, using a fixed position out of the screen. As a quick fix this is a fairly good one, but it does suddenly introduce two issues:-

1. 2D subtitles are present on screen for a duration sufficient for an average reader to read them comfortably. However with the viewers focus of interest during a 3D movie constantly changing along with ocular convergences necessary for this focus to be retained, there is additional time required for the viewer to re-converge to read the subtitle at a given depth, and subsequently converge again to focus on the action. Stereo convergence, with our internal experimentation, has been seen to take anything up to about 1½ seconds each time. This means that a given subtitle must be present on the screen for perhaps an additional 3 seconds depending on the difference between the depth of action and the chosen fixed position of the subtitle. This length of additional time is unacceptable for most presentations. In addition to the re-convergence time there is also eye-strain and tiredness associated with this effect.
2. Assuming that the position of the subtitle does not occlude any 3D depth cue within a presentation, a risk is still taken that the subtitle visually obscures the action on the screen. Often times in 2D presentations it is necessary to move a given subtitle either horizontally or

vertically to avoid this type of issue, but with 3D the range of x,y positions available within a given depth plane can become quite limited.

Dynamic Positioning

The solution for both of these issues is the ability to move the subtitle in 3D space in relation to the action and point of interest occurring on the screen, dynamically positioning the subtitle in the 3D space. This additional complexity is further compounded when you consider that a single subtitle will often span, in time, across more than one shot. This means that additional care must be taken by the stereographic subtitler to assure that the on-screen depth neither occludes any depth-cue during this period, nor that it requires excessive re-convergence of the eyes to read the caption.

The accuracy with which this process must be within a tenth of a pixel disparity, and as such requires patience and skill to adjust. Additional line splits, vertical positioning and horizontal adjustment normally reserved for special circumstances within 2D presentations, become much more commonplace simply due to this phenomenon within 3D space.

Under certain schemes it is possible to describe an envelope for movement of a subtitle over a given duration, allowing for the subtitle to ‘follow’ the action within a scene. Although we understand that this can be an interesting effect, we are concerned that it could distract from the intended focus of attention, and may not work well over shot changes.

Scaling Considerations

One of the other cues we use within natural vision to determine if an object is closer or further away is its relative size within our field of vision. Namely, that larger objects will tend to be nearer to our viewpoint, and those that are relatively smaller will be further away. This effect works well with regular 2D images in combination with masking and object recognition cues.

If a subtitle has additional depth disparity sufficient to suggest it appears to hover in front of the screen, but has not changed in relative size to the same caption positioned with no depth disparity, it will, within the scope of the overall illusion, appear to have shrunk in size due to having not become larger as it moved forward. Likewise, objects that appear further into the screen will appear to have become larger if they do not scale correctly in relation to their illusionary depth.

Other Transformations and Manipulations

Having now considered depth and scaling properties of a given title, one should also consider other transformations that one might want to apply to a subtitle. Tilt, rotate and shear are the 3 affine transformations one may consider applicable to subtitle objects. One might see requirements for a subtitle to become part of the 3D scene in much the same way as was achieved in the 2D domain by the Russian vampire movie “Nightwatch” and the US TV Series “Fringe”. However we could possibly consider this superfluous under normal conditions.

One manipulation we would recommend is the ability to add 3-dimensional volume to a subtitle such that the title appears to have solidity and volume in its own right. The reasoning is that the purpose of any 3D material is to hold up the illusion of depth and solidity at all times. If an object exists within the 3D space that contradicts this illusion, it breaks the illusion for the viewer. In the instance of subtitles, providing only one or two 3D cues may limit the realism created by the illusion.

Adding volume to the title by rendering it in 3D space may go someway to preserving the impression of the stereoscopic landscape.

Disparity Meta-Data

We've seen now how easy it is to break the illusion created so craftily by stereographers. But how is it possible to avoid the object occlusions that are so easy to create? The answer is not as simple as it may seem.

When the brain sees the disparity between the left and right eye, it uses clever object recognition to fuse the focal object within the brain (specifically, the occipital lobe). The degree to which the eyes converge to perform this fusion will describe the illusionary depth. It is this depth that we need to be sure not to obscure or occlude.

Computationally it is far more difficult to determine this depth given the stereo pair than one might imagine: Attempting to synthesise the processes carried out by the occipital lobe is incredibly tricky. Leaps have been made in the field of Computer Vision that make this process easier, but it is still not very accurate.

This type of meta-data is termed a depth or disparity map, and is a resource we see as being valuable to not only the subtitling phase of a given broadcast or production chain but also to bug insertion and on-screen graphics.

Existing Implementations

Many implementations exist, mostly the product of post-graduate theses rather than industrial implementations. Several open-source implementations also exist, which can be demonstrated to work with stereo pairs provided.

Unfortunately many of these implementations not only take an incredible amount of time to execute, but only produce good results when run with the material provided with the implementation; when run against screen grabs from actual broadcast quality material the results are less than adequate, and insufficient for our purpose.

For positioning subtitles within a 3D space, we are more interested in a coarse x,y map but one that has accurate depth information, since we will be assuming the subtitle will occupy a similar amount of screen space to its 2D counterparts, and that the accuracy of the depth position of the title is paramount, particularly when it comes to setting automated safeguards.

The requirement for subtitling is fairly specific in that we need a real-time or faster analysis of 1080 HD frames for large block areas of the frame. We also have the advantage that subsequent frames within the same scene will contain similar depth information, an optimisation we can leverage to great effect.

DepthSafe / DepthGuard

Both DepthSafe and DepthGuard are currently proprietary concepts and formats and are still under development, but are listed here for completeness.

A specialist software module will digest the 3D material to produce a greyscale stream that describes the depths present in each frame of the original material to a sub-pixel depth space. White describes the closest object, mid-grey the surface of the screen and black the infinity or unknown, while other shades of grey describe their relative disparity in relation to these maxima and minima values. We see this resource as an incredibly valuable asset for the entire broadcast chain, and term the resulting map as DepthSafe.

This greyscale map can be used later in the chain by DepthGuard to prohibit the positioning of objects (such as bugs and banners) within the scene that may cause uncomfortable sensations in viewers. DepthGuard data can be understood as a regional based diagram of nearest depth within a frame between two time cues, meaning it can provide information for safe areas of depth for particular periods: A map of closest calculated DepthSafe depths during a given period of material.

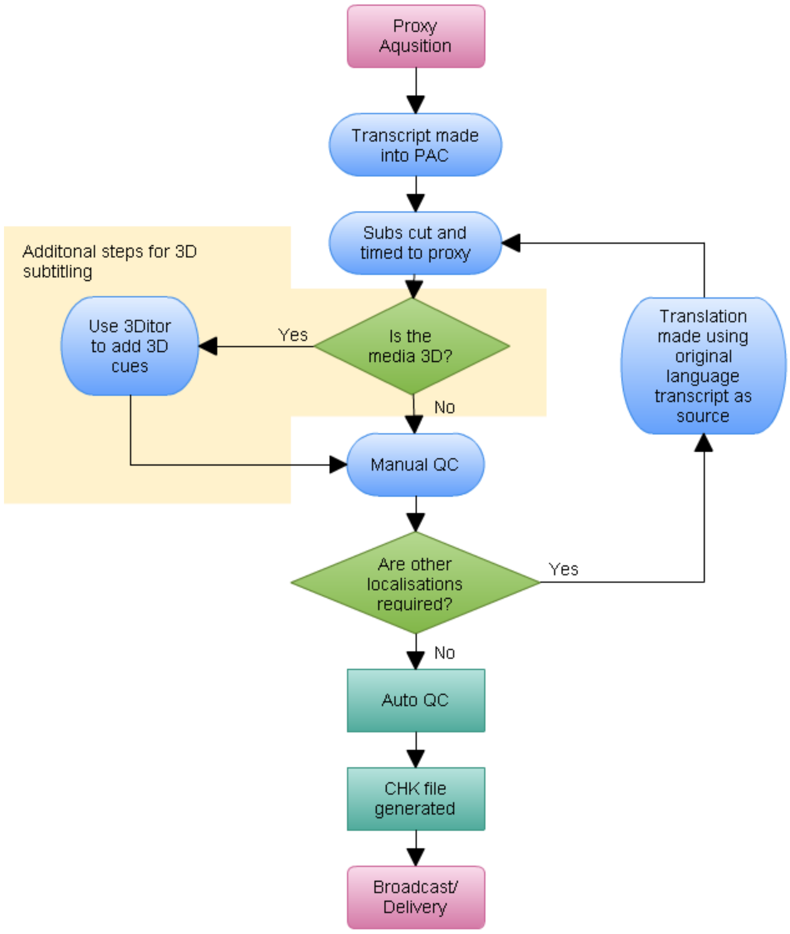
3D Subtitle Preparation

A new 3D version of Poliscript, our subtitle authoring tool, will be used to add the necessary depth and transformation meta-data into our proprietary formatted file structure.

Workflow for the generation of subtitles for 2D material requires a transcript to be made, and then for the subtitles to be timed and cued in to the material. Quality Control stages follow this production process to assure the subtitles conform to stylistic and operational parameters.

The production of 3D subtitles supplements this process, rather than becoming a new workflow.

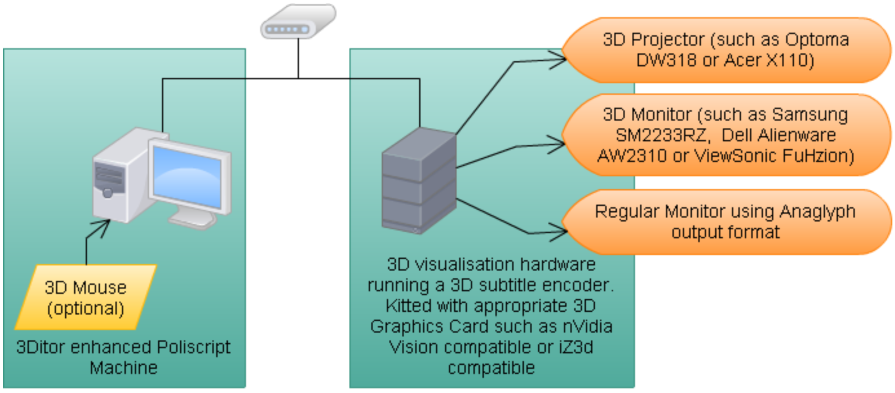
We see the process of adding 3D cue information to a file as being a specialist job assigned to a trained stereographer. Ultimately with the additional safeguards made by the DepthSafe information, the system can automate a significant part of the job.



Machine Configuration

To perform this task the user will require two screens; one for text edition and timing, and one visualisation. Poliscript can connect over a regular TCP/IP connection to the 3D visualisation module. The 3D module opens the required 3D material, and inserts subtitles cued by the Poliscript machine by utilising a 3D subtitle encoder. The 3D visualisation machine is equipped with a 3D display technology suitable for the intended target type. Our visualisation technology is sufficiently agnostic to provide a display of the given material on almost any of the 3D panels and projectors available today.

First the user loads in the existing 2D subtitle file, which contains both captions and timing cues. This file acts as a foundation for the process of adding 3D data, and in fact the attributed 3D data will be ignored by any non-3D aware encoder within our range, making it backwards compatible.



By using one of a variety of supported techniques, including support for the 3Dconnexion 3D mouse, the user positions each subtitle with sub-pixel depth-space accuracy. An isometric view of the illusionary depth of the subtitle in relation to the screen is provided within the Poliscript window, while the 3D visualisation updates the 3D panel or projector with the what-you-see-is-what-you-get encoder output in near real-time.

When available, DepthSafe and DepthGuard meta-data can be loaded during the depth cuing phase, to provide additional cues, automated guesses and snap-to reference depths for precise positioning. This would increase the speed with which the cuing can be done, and reduce eye strain and other undesirable physiological phenomena in the subtitler.

3D Subtitle Delivery Considerations

As with many aspects of broadcast and content delivery, many standards exist which may or may not presently provide sufficient flexibility to transmit 3D subtitles along with 3D material. In the following section each of the more prominent subtitle delivery mechanisms and standards are discussed briefly.

Open Subtitles

Open (or burnt-in) subtitles are obviously very easy to support. Considerations should be made however with regard to the contrast within the subtitle itself. Where large contrasts exist on the horizontal plane, such as in regular boxed subtitles, undesirable phenomena, such as crosstalk, can become visible, making the experience less than completely professional. Adaptive contrast control and clever blurring techniques can be applied to the burnt-in text to provide a softer contrast gradient, reducing the visibility of crosstalk.

Teletext

If subtitles are to be delivered over teletext, then a mechanism will be required to deliver the disparity information and the receiver will need to implement the rendering of left and right subtitle images with disparity. The disparity value needs to be accurate to $1/10^{th}$ of a pixel. Other metadata (X/Y position, Size, Scale, other transforms) could be attached, but it is unlikely that all receiver manufacturers would provide a full and appropriate implementation. For these reasons, Teletext subtitles for 3D material are unlikely to rival DVB Bitmap for quality.

DVB Bitmap

Thankfully the DVB subtitle standard allows for the transmission of subtitles with disparity for side-by-side content (the industry preferred format). However concerns have been raised with regards to scaling due to fixed region requirements and the non-standard manner in which certain decoders handle regions that butt up to each other. In addition to this, in instances where subtitles have been 3D rendered to add volume, the palette depth may be insufficient under certain circumstances.

Checkerboard, above-under, interlaced and frame-sequential formats are difficult, or impossible, to support within the current DVB Bitmap standards, and there are good reasons for avoiding these formats where professional subtitles are a requirement. However with modification to the relevant DVB standards it will be possible to deliver subtitles alongside these formats.

To avoid synchronicity issues at decode, the left and right halves of 3D subtitles should be delivered within a single package rather than as two separate pids or pages; however this challenges PES packet size and requires further thought. A scheme using a single image plus depth metadata would work, but would preclude adding volume to the subtitles, and the decoder would need to resample the subtitle image to achieve the 1/10th pixel disparity resolution required.

US Closed captions; 608/708

US closed captions have the same constraints as teletext; additional metadata could be sent, but the renderer implementations in receivers are very variable, and hence any use of these standards in the 3D domain are likely to be fraught with difficulties unless in a closed end to end environment.

We are happy to work with receiver manufacturers where required to facilitate a result for both Teletext and US Closed caption based solutions.

D-Cinema

Many digital cinema solutions prefer the source material to have open subtitles prior to projection. However scope does exist to provide subtitles with a 'z' parameter describing the associated depth. This type of format is one we can support, but it doesn't offer the flexibility for transformation and manipulation which we would prefer for superior quality subtitles.

Since this is a fairly juvenile standard, in as much as the subtitling specification is fairly limited, it may be justified to make recommendations for amendments to be made to the SMPTE DCI 428-7 outline for subtitling and captioning.

Sony BluRay3D

The BluRay standard is very difficult to obtain in general due to its proprietary nature. With regards to BluRay3D we do know that it will use an MVC standard to provide two streams of video. A likely combination will be that one stream will contain the full frame left eye channel, and the second stream will contain a proprietary depth map of sorts. Either way, extensive support has been considered for subtitling in 3D space within the BluRay3D standard, and once it has been completed and released, our subtitling solution will support this mechanism for subtitle delivery.

Glossary

Affine Transformation	2D and 3D transformations of objects which allow for motion, rotation, scaling and shearing. These are often mathematically described as a compound transformational matrix.
Anaglyph	Anaglyphic filtering is a mechanism for presenting 3D material where the left and right images are filtered using opposing coloured gels on the colour wheel (commonly red and cyan). When the viewer uses glasses using correspondingly coloured gels, the overlaid 3D illusion is recreated. This is one of the earlier 3D presentation technologies, and is only used where modern polarised or lenticular techniques are effectively unachievable.
Autostereoscopic	A clever use of parallax barriers whereby stereoscopic and multi-view 3D illusions can be recreated without the requirement for the viewer to wear any apparatus, i.e. no-glasses. Currently these displays are expensive and support for them is sparse. Autostereoscopic techniques will no doubt become the future for 3D presentations due to the ease of accessibility for audiences.
Bugs / Banners	Burnt in graphics overlaid on to an existing presentation, often carrying channel watermarks or other supplementary information or advertising.
Convergence	When we look at objects that seem closer to us than those that are further away, our eyes will naturally tilt towards each other horizontally. This process of directing each eye is called convergence; when they tilt in towards the centre of vision. Conversely divergence is where the eyes move away from the centre of vision, to focus on something further away. The muscles responsible for converging the eyes are also directly linked to those responsible for focusing. The unnatural way the eyes are converging while holding a fixed focal depth is another cause of uncomfortable sensations in audiences during 3D presentations. The range of depth perception using convergence alone is up to 10m from the viewer, all other depth perception is done using binocular disparity or a monocular depth cue.
Crosstalk	An optical phenomenon associated with both active and passive stereo presentation formats whereby a residual 'ghost' of a given channel is visible in the opposing channel. In the instance of active glass solutions this is a result of poor response times. In the instance of passive solutions it is due to the inefficiency of the barrier technique.
Depth-Space	This is the available range of depths available to the stereographer. Often this is limited by the pixel resolution of the display. Our solution offers sub-pixel resolution meaning that we can offer a smooth interpolated depth between stepped pixel spacings of disparity.
Disparity / Binocular-Disparity	The rendered difference between the left and right channel positions on the 2D surface of the 3D display. It is this disparity that forces convergence or divergence in our eyes, and therefore the perception of depth. Disparity can be altered at great technical expense during the post-production phase, and is considered one of the more difficult elements to correct within the stereoscopic shooting process.
Divergence	*(see Convergence)*
Lenticular Display	A display where an array of lenses is arranged on the screen such that each channel within a 3D presentation can be directed either actively or passively at an audience. Interest in lenticular postcards and printed

	media peaked during the mid-1980's and they are still used with great effect.
Occipital Lobe	The area of the brain reserved for the processing of visual information. It is this area of the brain that is responsible, predominantly, for mapping our 3-dimensional environment.
Occlusion	The masking of one object within a 3D space with another object at another depth. In natural vision we use occlusion and object masking to determine that the masked object is behind the masking object. However these physical constraints are not so easily enforced within a stereoscopic frame, and in fact can be easily violated. Violations of this type can lead to severe psycho-physiological sensations of discomfort, and should be avoided at all costs.
Parallax Barrier	A clever filtering/masking technique whereby the viewer's horizontal position within the space of a display can be accounted for, and thereby subtly different images can be projected. This technique is used to great effect with autostereoscopic displays.
Polarised Display	Two types of polarisation are currently used within the field of stereography: linear polarisation and rotational polarisation. The latter is considered optimal due to the reduction of the acute tilt-filtering effect present in linear systems. Clockwise and anticlockwise filter gels are inexpensive to manufacture and provide one of the better 3D effects currently available. Displays for retail consumers are still expensive though.
Stereographic Channel	Each channel within a stereoscopic pair, by definition, describes the separated viewpoint of each eye. Each channel is normally referred to as either the "left" or "right" channel depending on its relative position to the other.
Stereography	The study and practice of recording and presentation of 3D illusions using 2D media.
Subtitle	A caption or text used to provide localised language descriptions of the audio channel within a presentation.

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