

Stereography: the Art of 3D

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Buzz Hays

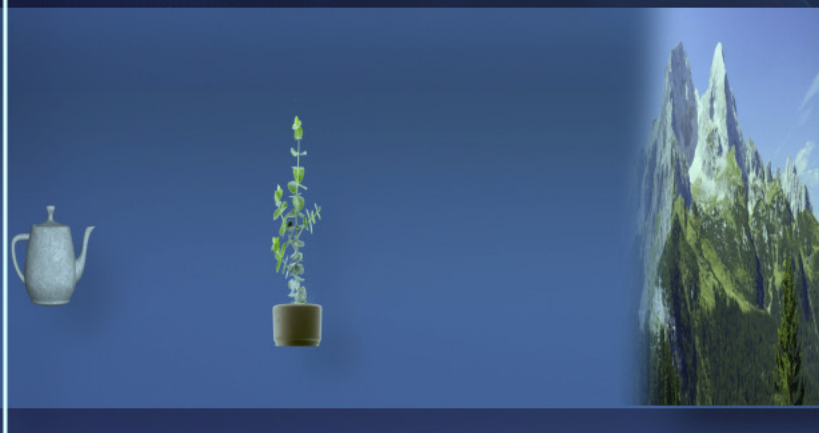
Senior Vice President, 3D Production

Sony Pictures Technologies





comfort zone



Stereography: the problem

Compress the full depth of the real or virtual world into the comfortable parallax range of our display.





Ortho-stereoscopic viewing (6.7m)

3D

...when projected on a 14ft wide screen. These settings are a good starting point because they replicate reality.

real scene



stereoscopic image



Viewer perception

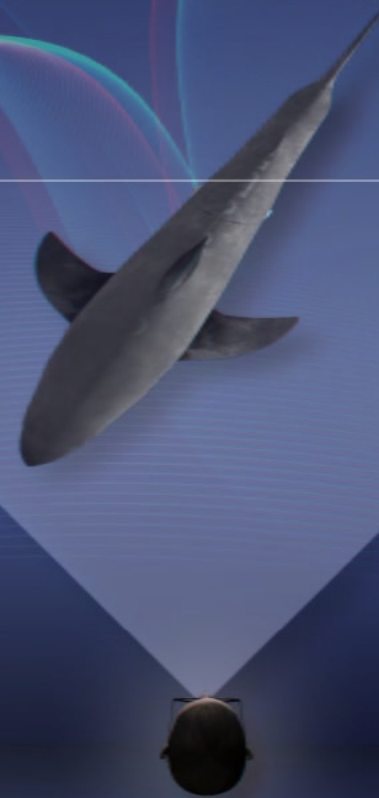
Sitting at the back of a cinema will give you the deepest 3D!



real scene



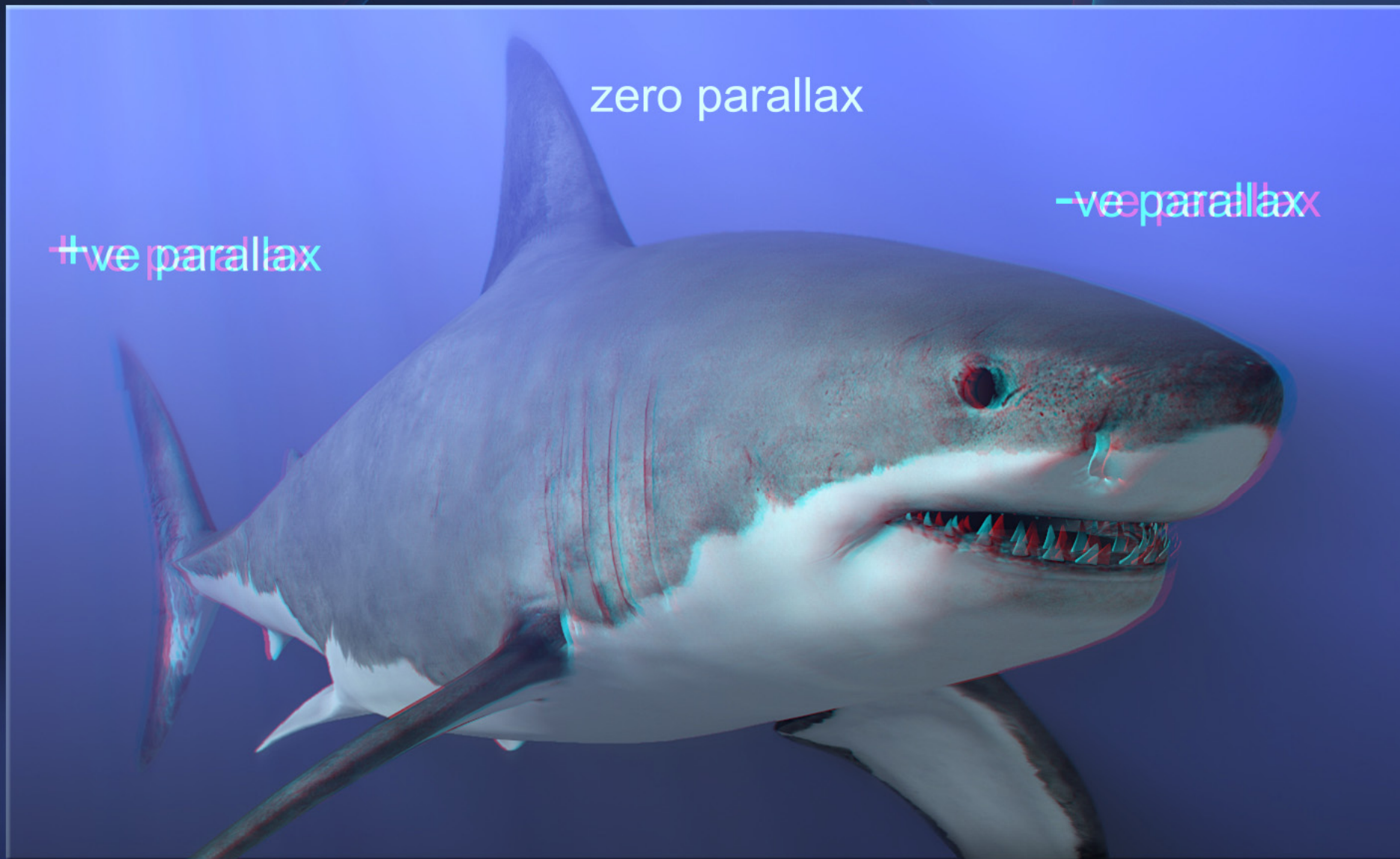
stereoscopic image



Viewer perception

3D

On the front row, the 3D may look flattened.



zero parallax

+ve parallax

-ve parallax

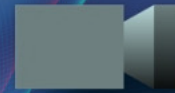
The stereoscopic window



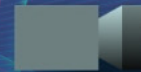
Ortho-stereoscopic viewing

...ortho-stereo doesn't work well for this shot. What can we do to solve this?

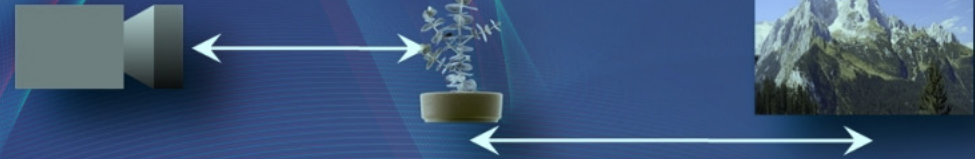
- Object range/Camera distance



- Field of view



- Object range/Camera distance



- Field of view

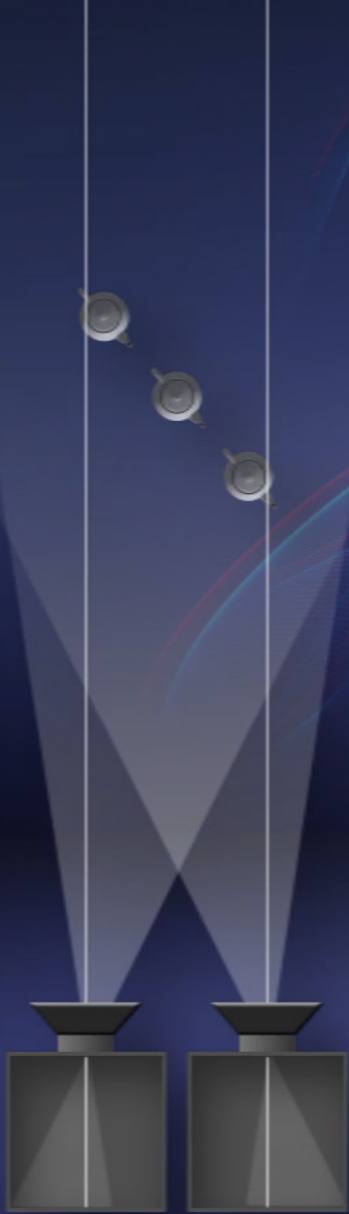


- Horizontal Image Translation

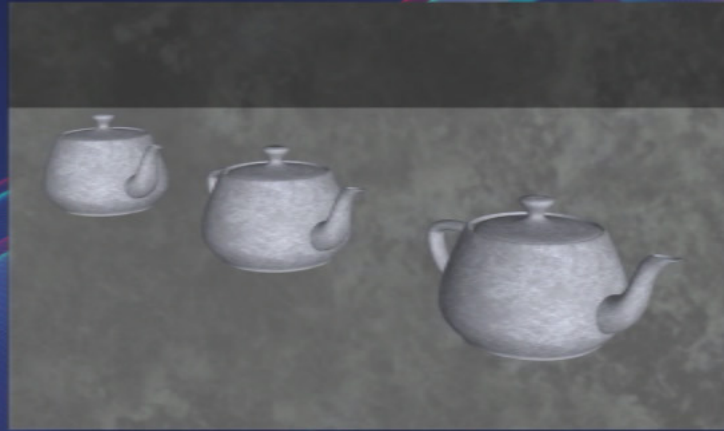


Basic stereography: parameters to adjust

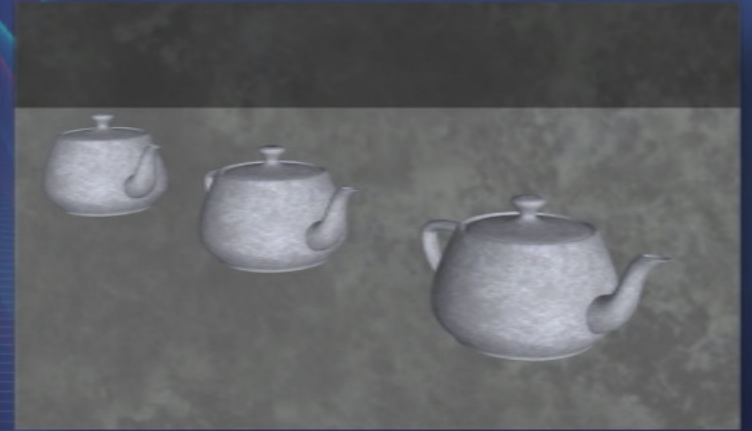
H.I.T measures the relative horizontal offset between the left and right images on the display.



left



right



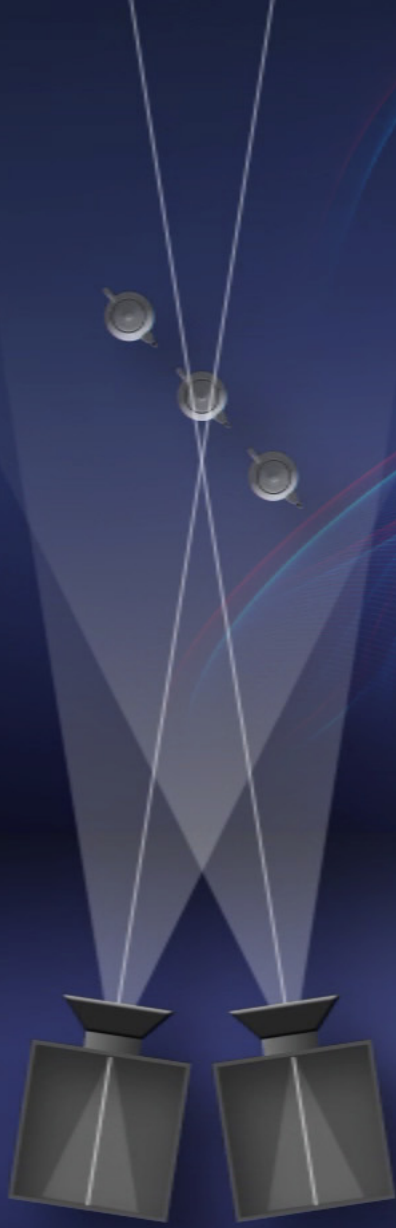
50-50



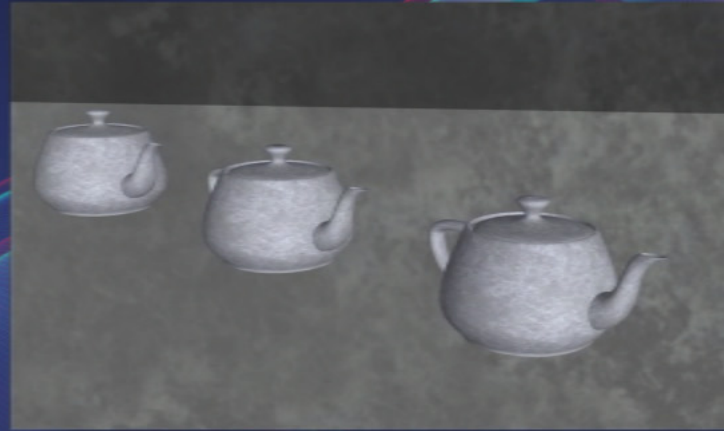
Horizontal Image Translation: offset the sensors



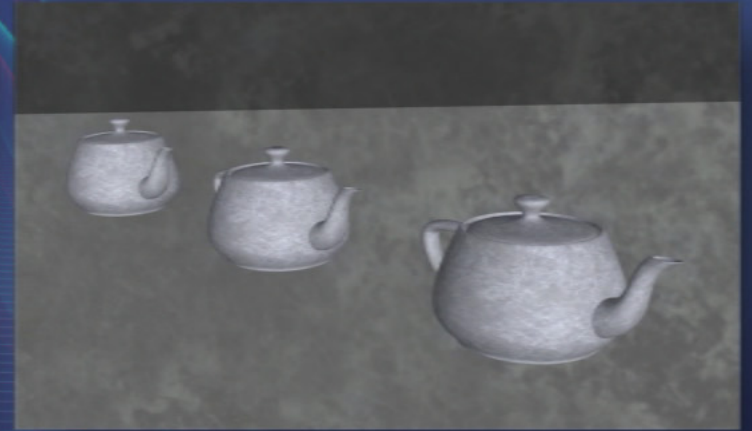
...like tilt shift photography. Can use the "film offset" parameter in Maya, define asymmetric viewing frusta in OpenGL etc.



left



right



50-50



Horizontal Image Translation: toe-in the cameras



...produces a similar effect but adds minor keystone distortion and vertical parallax: avoid in CGI!



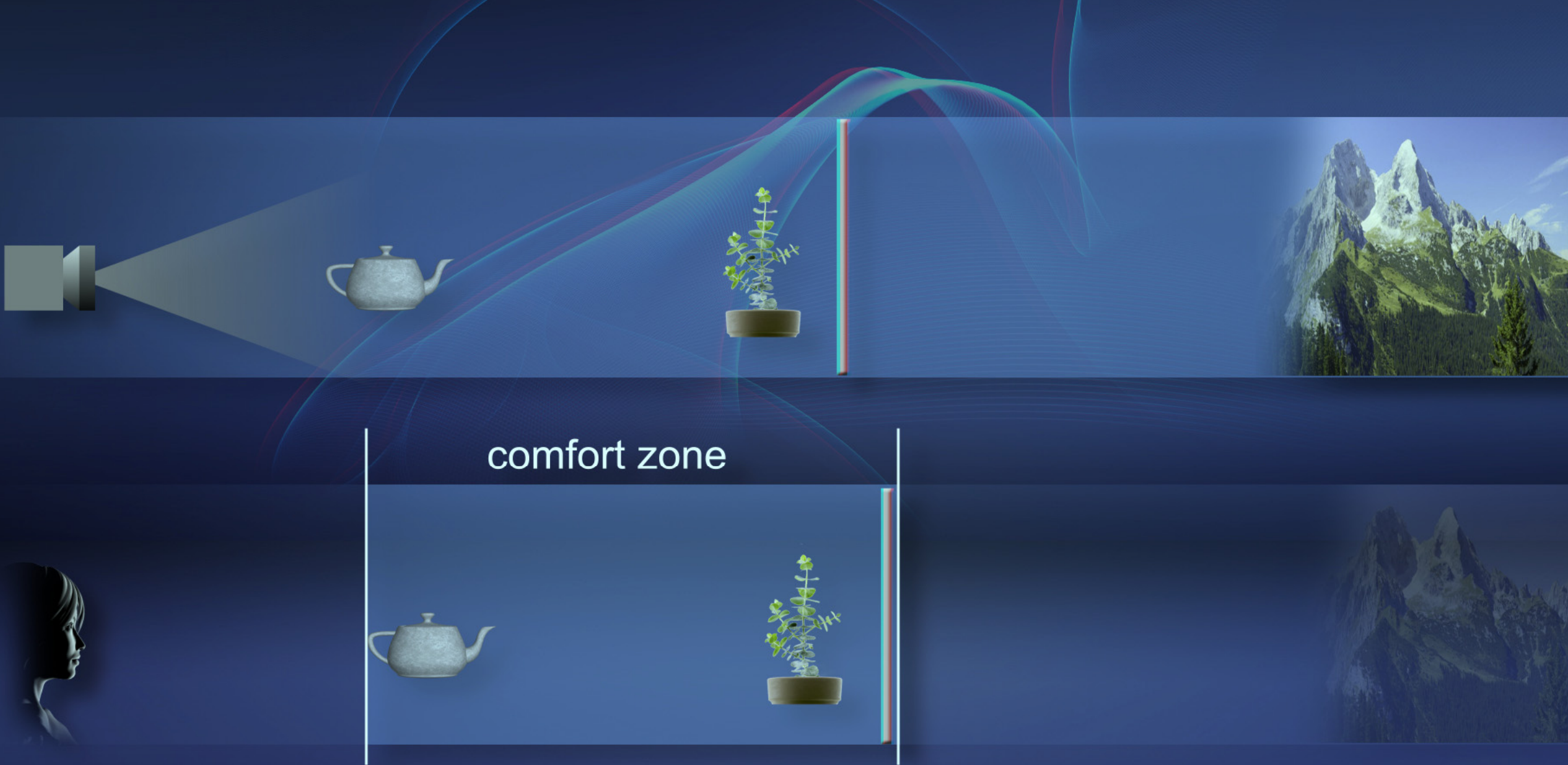
Ortho-stereoscopic viewing

Before adding H.I.T...



Ortho-stereoscopic: HIT added

...after: H.I.T is adjusted so that the man is now in the plane of the screen. Now the background has too much parallax!



Stereography: solution 1- limit the depth

...just add something like a wall to block off the excessive parallax



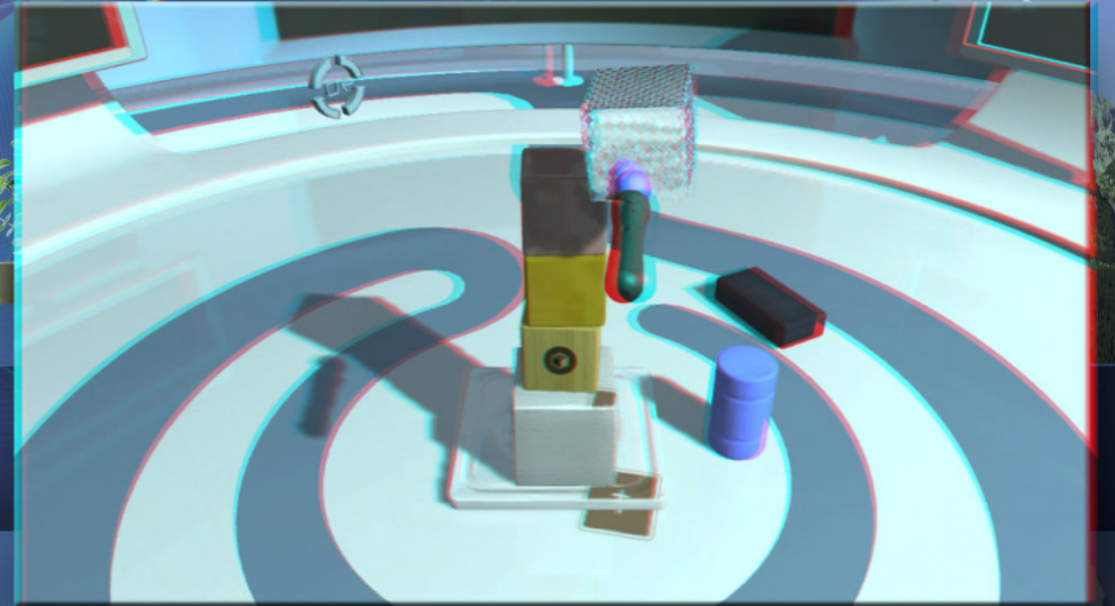


Limit the depth with a wall

...after. Now the image is comfortable to view.



comfort zone

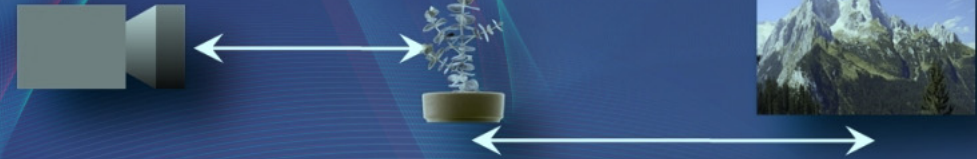


Stereography: solution 1- limit the depth

Games such as "Tumble", a block stacking game, use this approach.



- Object range/Camera distance



- Field of view



- Horizontal Image Translation



- Interaxial



Basic stereography: parameters to adjust

The interaxial is the final parameter available. It defines the distance between the (parallel) optical axes of the cameras.



Ortho-stereoscopic: HIT added



Let's reduce the H.I.T. and interaxial to reduce the overall depth range of the image...



Reduced interaxial and HIT

Now the image is comfortable to view but looks flattened into layers. How can we solve this?



comfort zone



Stereography: solution 2 - go closer & wider



Moving the camera closer to the subject and using a wider angle lens will solve this problem. Why? Let's draw a diagram...

real world

as perceived by viewer

convergence point

screen

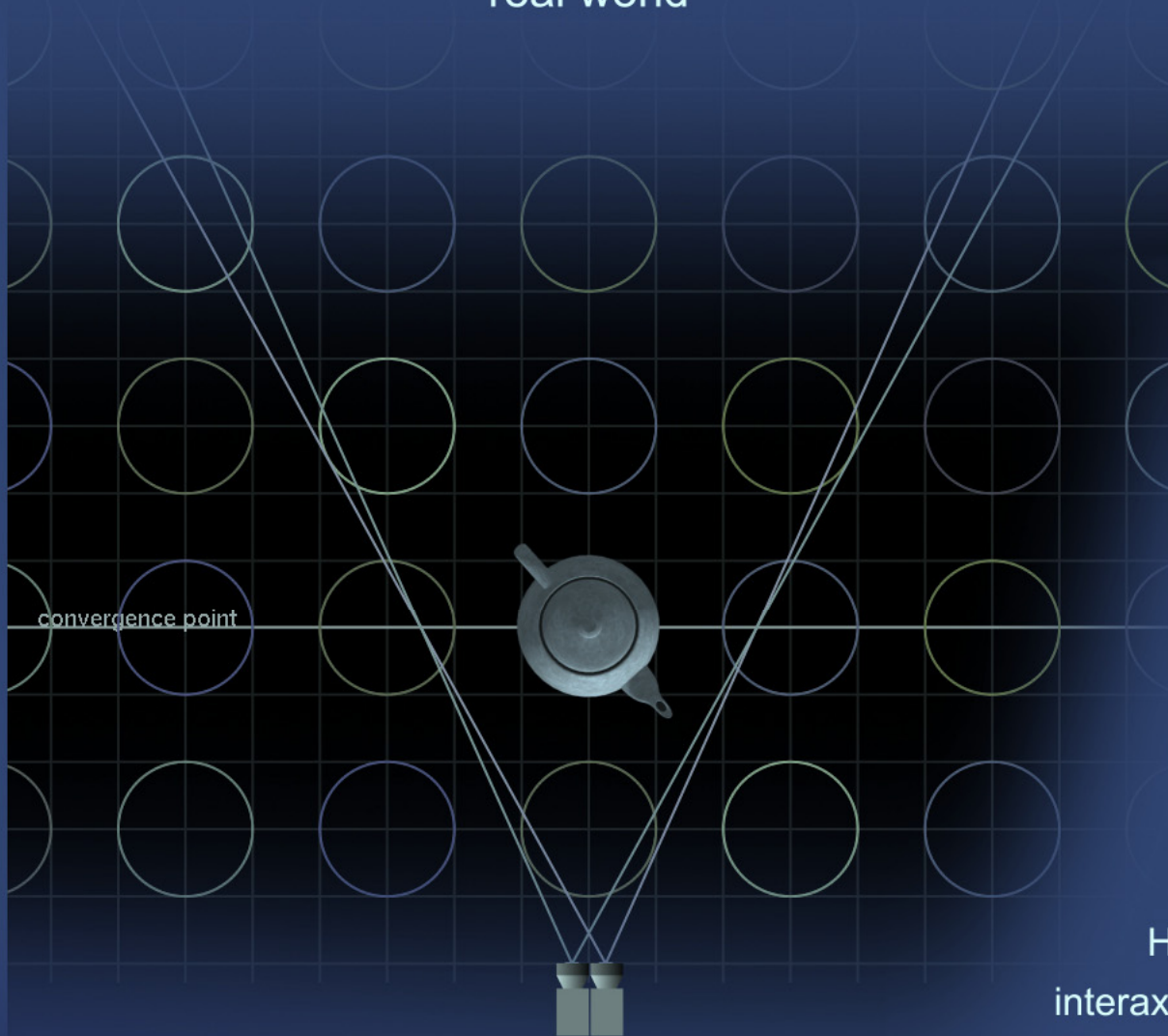
HIT = 1.0 X
interaxial = 1.0 X
focal length = 1.0 X
distance = 1.0 X



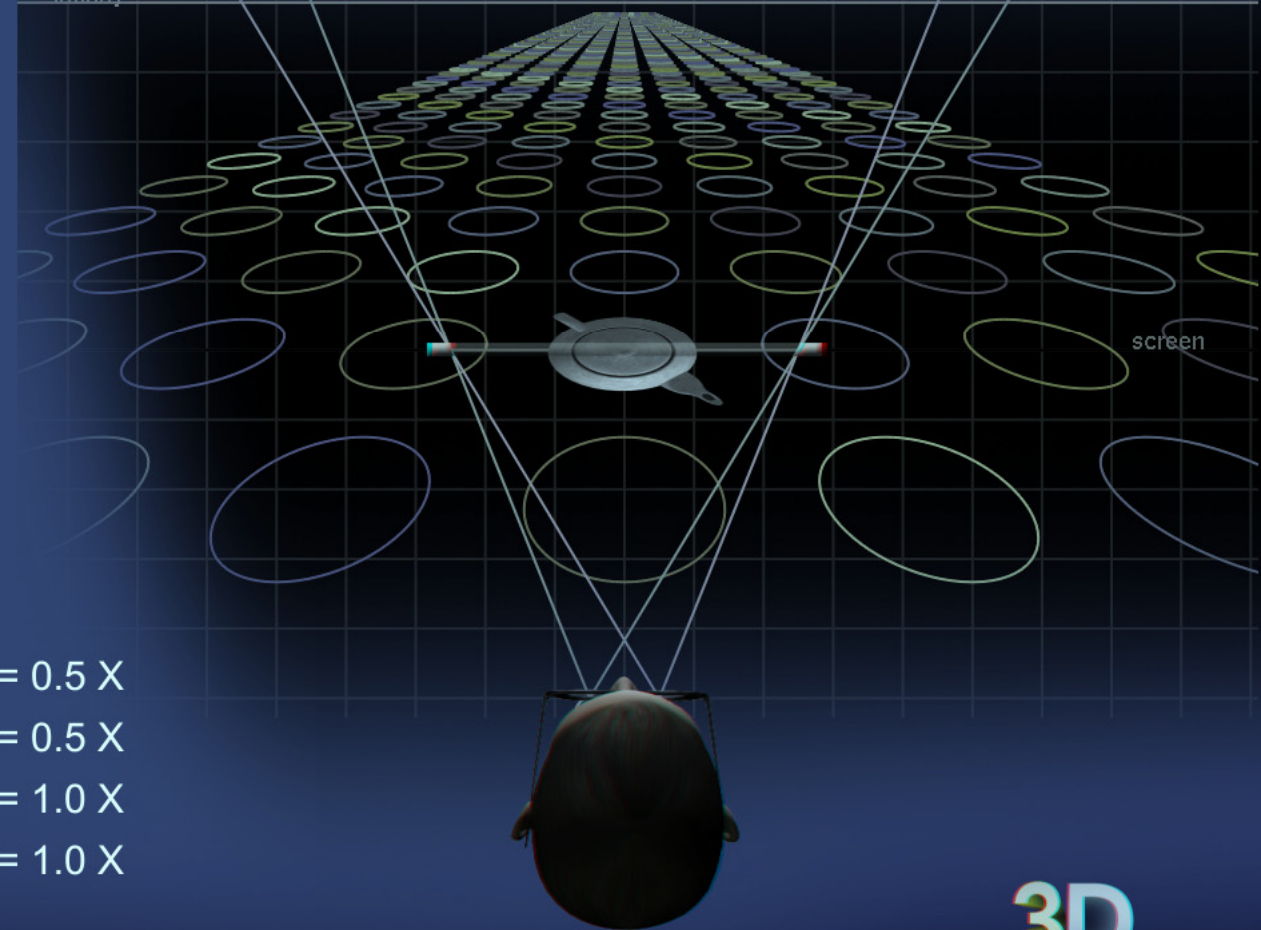
3D

Start with ortho-stereo viewing. This diagram makes some large assumptions about how we perceive depth but it is reasonably valid for close range viewing.

real world



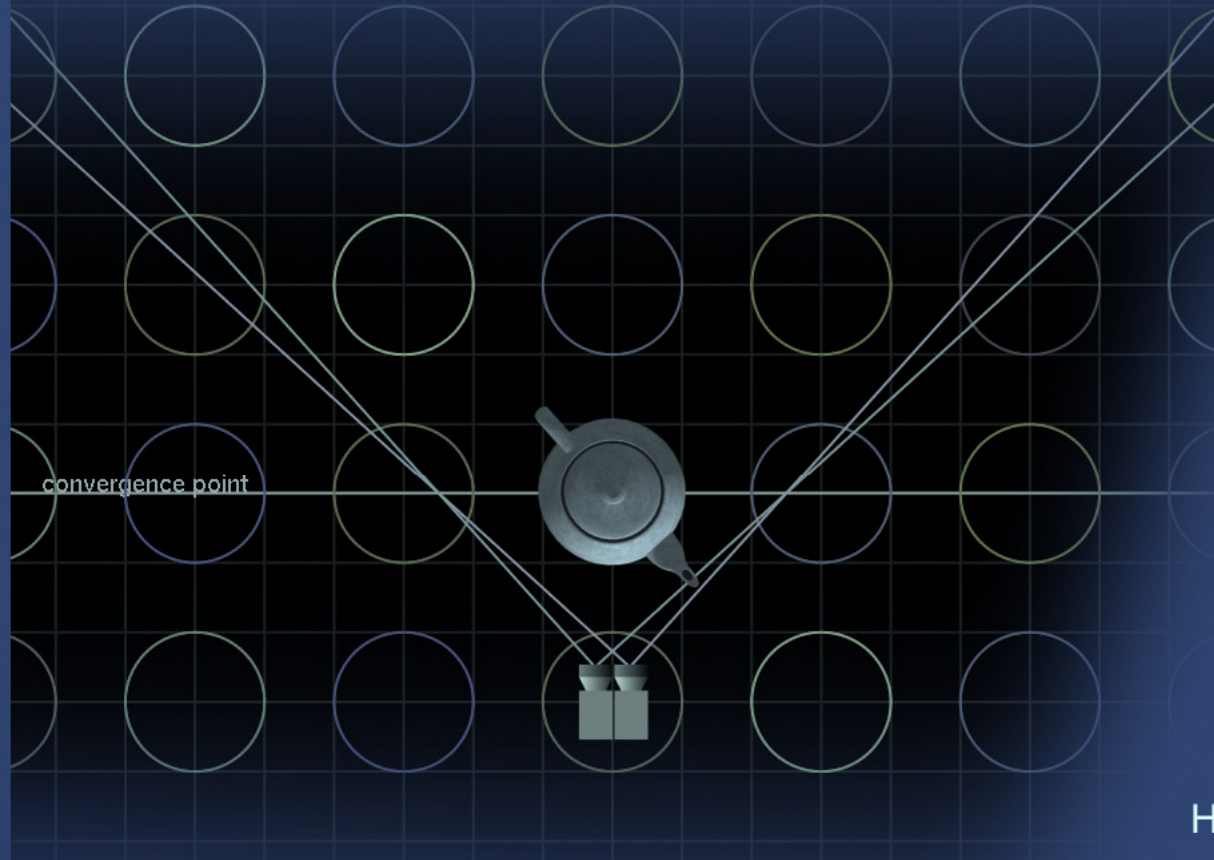
as perceived by viewer



HIT = 0.5 X
interaxial = 0.5 X
focal length = 1.0 X
distance = 1.0 X

Reducing the H.I.T. and interaxial reduces the depth range but flattens the subject when viewed on the display.

real world



as perceived by viewer



$HIT = 0.5 X$
 $interaxial = 0.5 X$
 $focal\ length = 0.5 X$
 $distance = 0.5 X$

Reducing the focal length and camera distance by the same amount restores the roundness of the subject at the plane of the screen.



Reduced interaxial and HIT

Let's see what happens to our image...



Reduce focal length and distance...



Reducing focal length and distance in this way is called a "Hitchcock zoom" - made famous in his film "Vertigo"



Reduce focal length and distance...



Reduce focal length and distance...



Reduced focal length and distance

Now the face looks rounded again though there is some perspective distortion.



comfort zone



Stereography: solution 2 - go closer & wider

3D

Fortunately most games already use close cameras and wide angle lenses.



comfort zone



+



+



Stereography: solution 3 - multi-rig/multi-cam

3D

Capture each layer with its own optimal parameters and composite the layers together: compress the gaps between the layers but preserve the roundness.



Foreground and background composited together

3D

There is no parallax overlap between the layers.



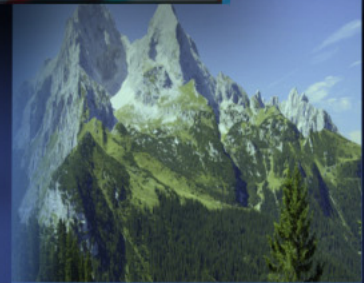
comfort zone



+



+



Stereography: solution 3 - multi-rig/multi-cam

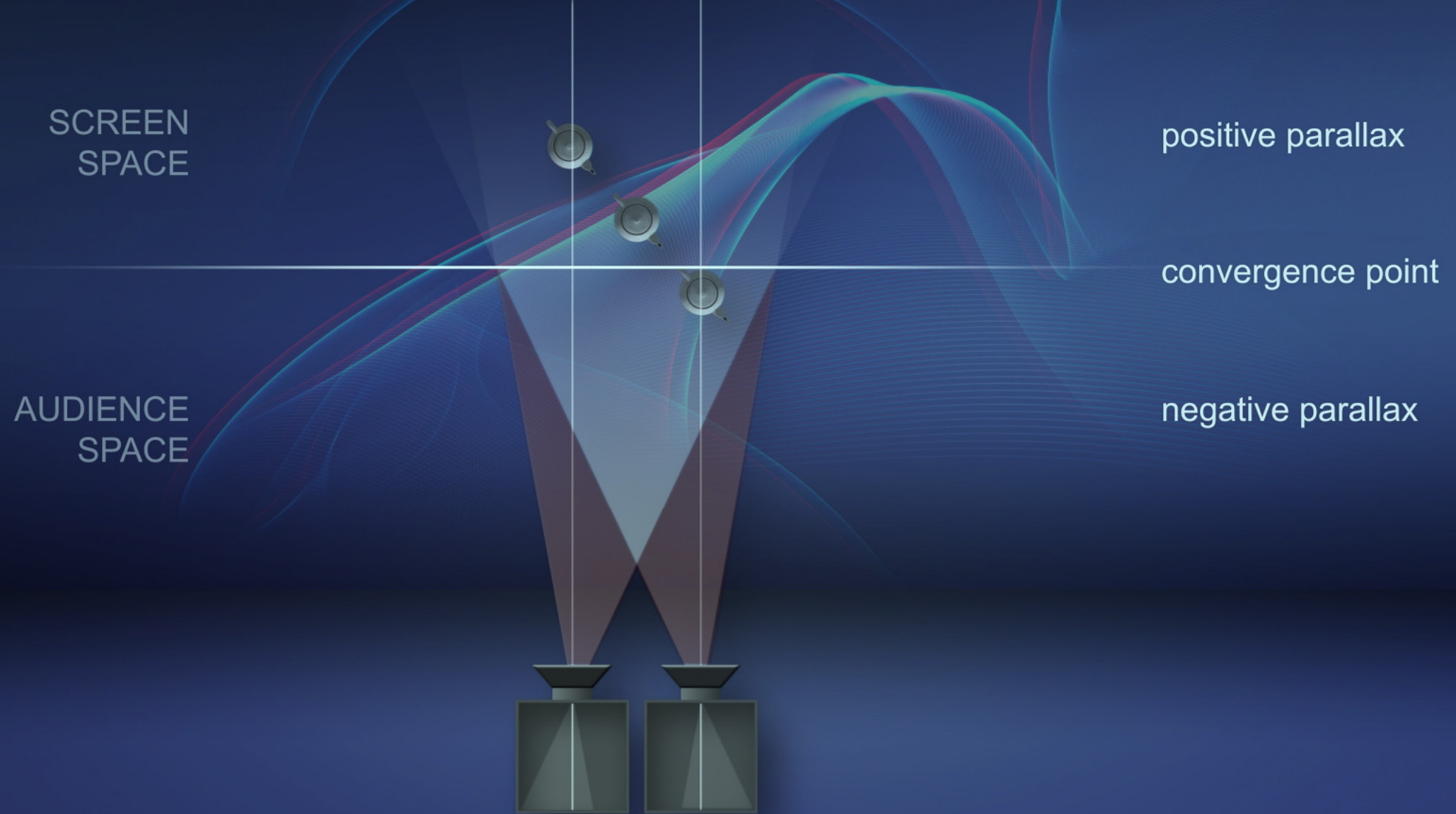
3D

First person shooters such as "Killzone 3" use this approach to preserve the roundness of the gun and provide good depth cues from the background.



Incorrect composition: a depth conflict

Be careful when compositing the layers. If the parallax overlaps, this can happen!



Defining the stereo window

We also need to avoid placing objects in the areas shaded in red. Why?



Window Violation



This is what we would like to see when objects come out of the screen...



Window Violation



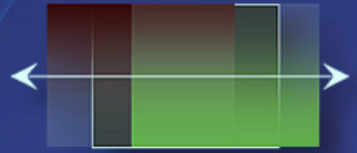
Unfortunately this is what we actually see. The area where the buggy hits the screen edge looks confusing.



Window Violation

This can be fixed by moving the camera, moving the object or adjusting the 3D settings.

scale



or

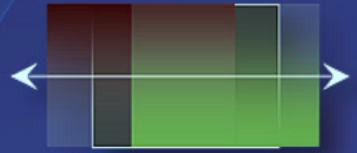


if equal, object appears
life sized

Parameters to adjust

The relationship between the H.I.T. and interaxial defines the scale of the object at the plane of the screen.

scale



or



if equal, object appears
life sized

zero parallax point



or



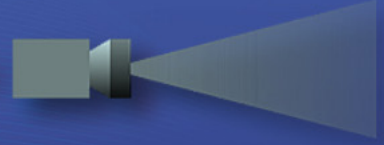
or



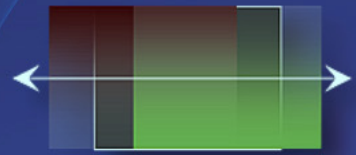
or



or



scale

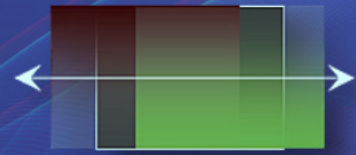


or



if equal, object appears
life sized

zero parallax point



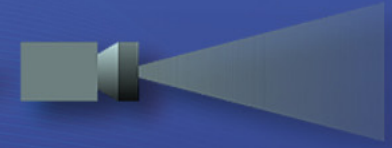
or



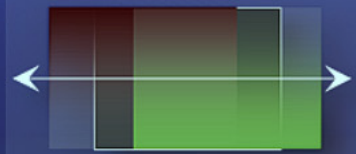
or



or



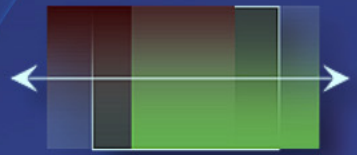
depth range



and



scale

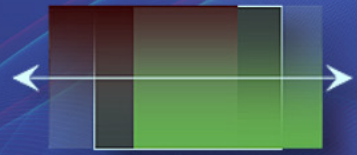


or



if equal, object appears
life sized

zero parallax point



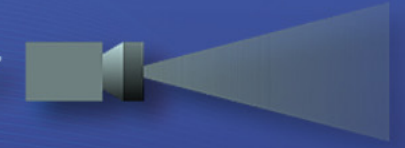
or



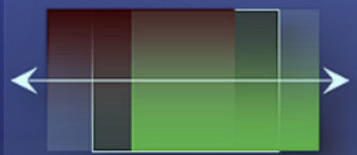
or



or



depth range



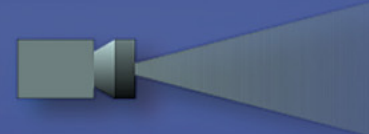
and



roundness



and



(Hitchcock zoom)



Parameters to adjust

3D

Altering the camera-subject distance and focal length together can be used to adjust locally the roundness of an object while preserving the overall depth range.



The story so far...

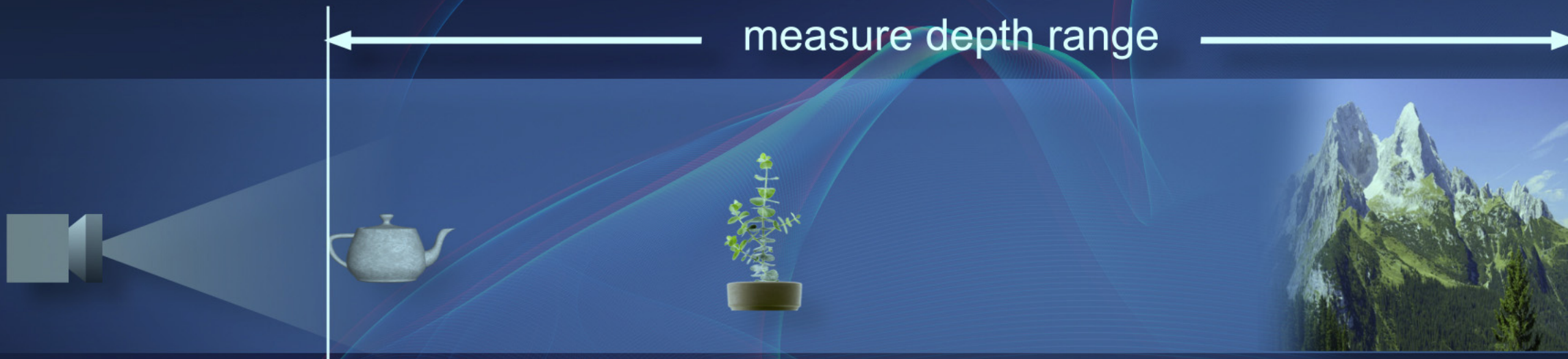
We can now create good quality 3D images but...



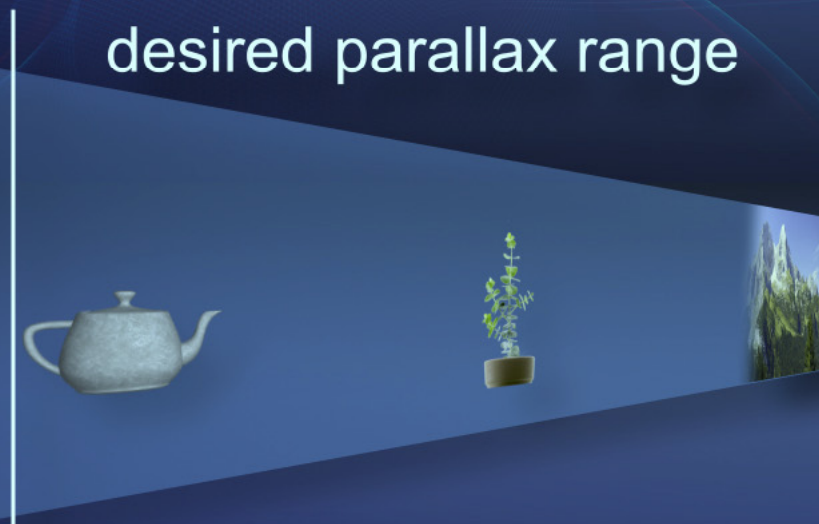


The story so far...

...as soon as we move the camera or the subject, the viewer comfort may be compromised.



desired parallax range



Automatic calculation of parameters

We need to calculate the 3D parameters automatically.



Automatic calculation of parameters

Here we have handed control to the software. In this case the parallax is being kept between 0% and 2% of the screen width.



Automatic calculation of parameters



As the camera goes close to the subject, the interaxial is reduced to compensate.



Automatic calculation of parameters



This works really well...but



Automatic calculation of parameters



...at larger distances it perhaps look artificial. The subject never seems to get any further away and shrinks in size.



Automatic calculation of parameters

Try adding an extra rule. Perhaps we could limit the interaxial...



Automatic calculation of parameters

Now the subject moves deep into the screen.

3D



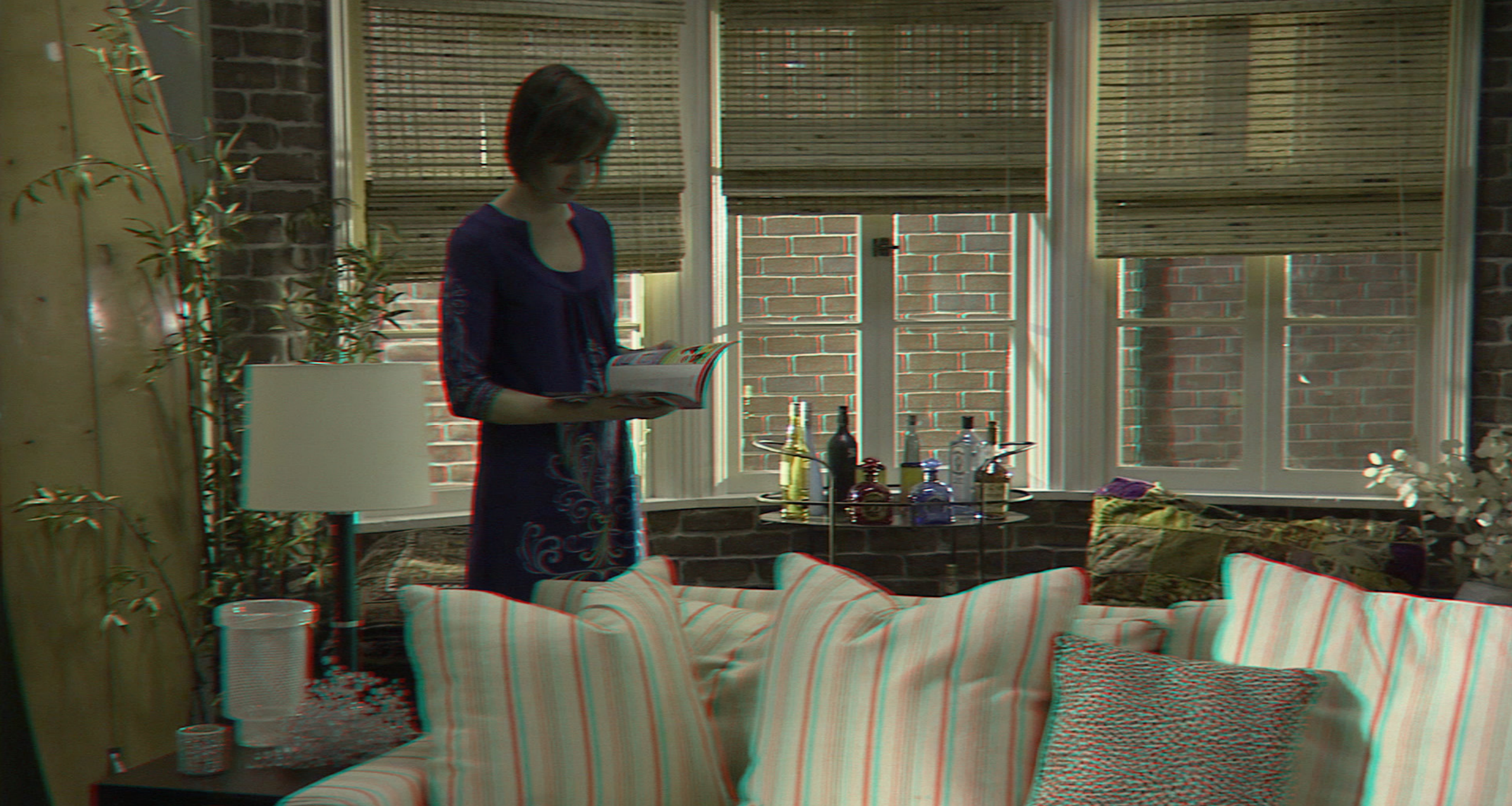
Automatic calculation of parameters



...but the parallax is still kept within range for close-ups as before.



The rules are a creative choice. This scene from Sony Pictures is shot with the subject always in the plane of the screen.



This approach was used in Avatar.





This time, the settings remain constant with the subject moving in depth relative to the screen.



Many films use this approach.



Which do you prefer?



Automatic calculation of parameters

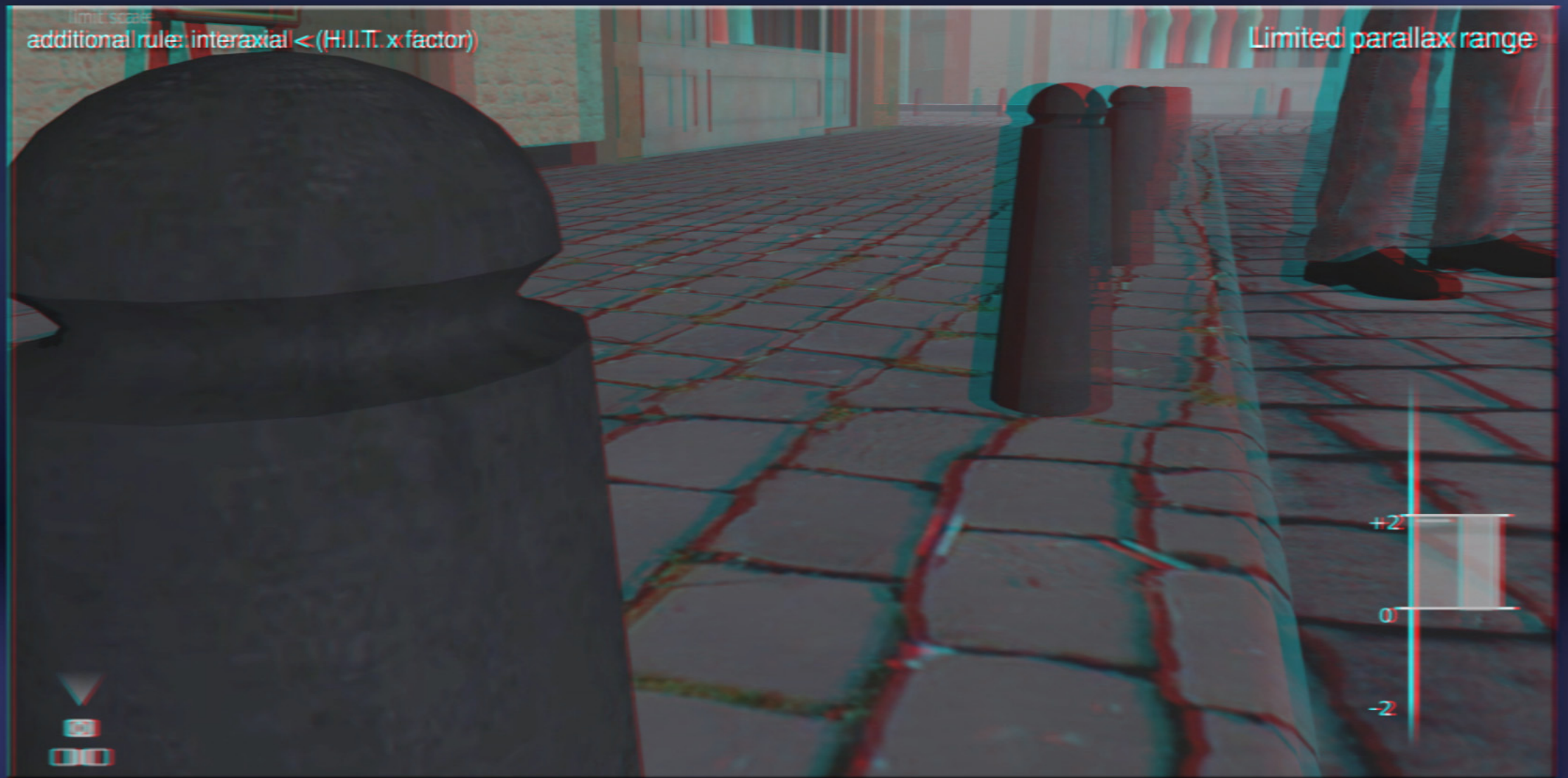


Going back to the automated parameters: let's see how the software performs for various camera positions....



Automatic calculation of parameters

3D





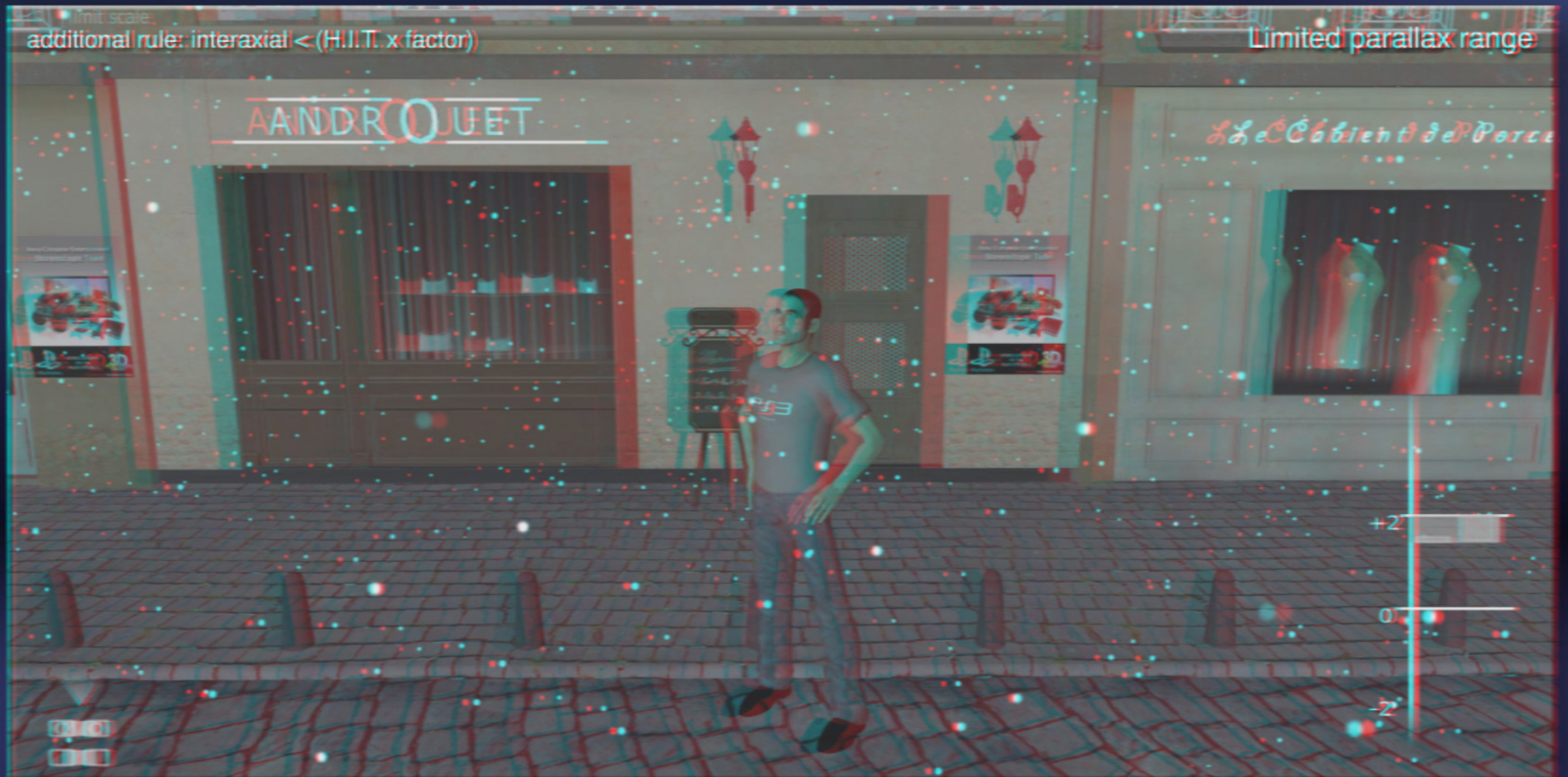




Automatic calculation of parameters



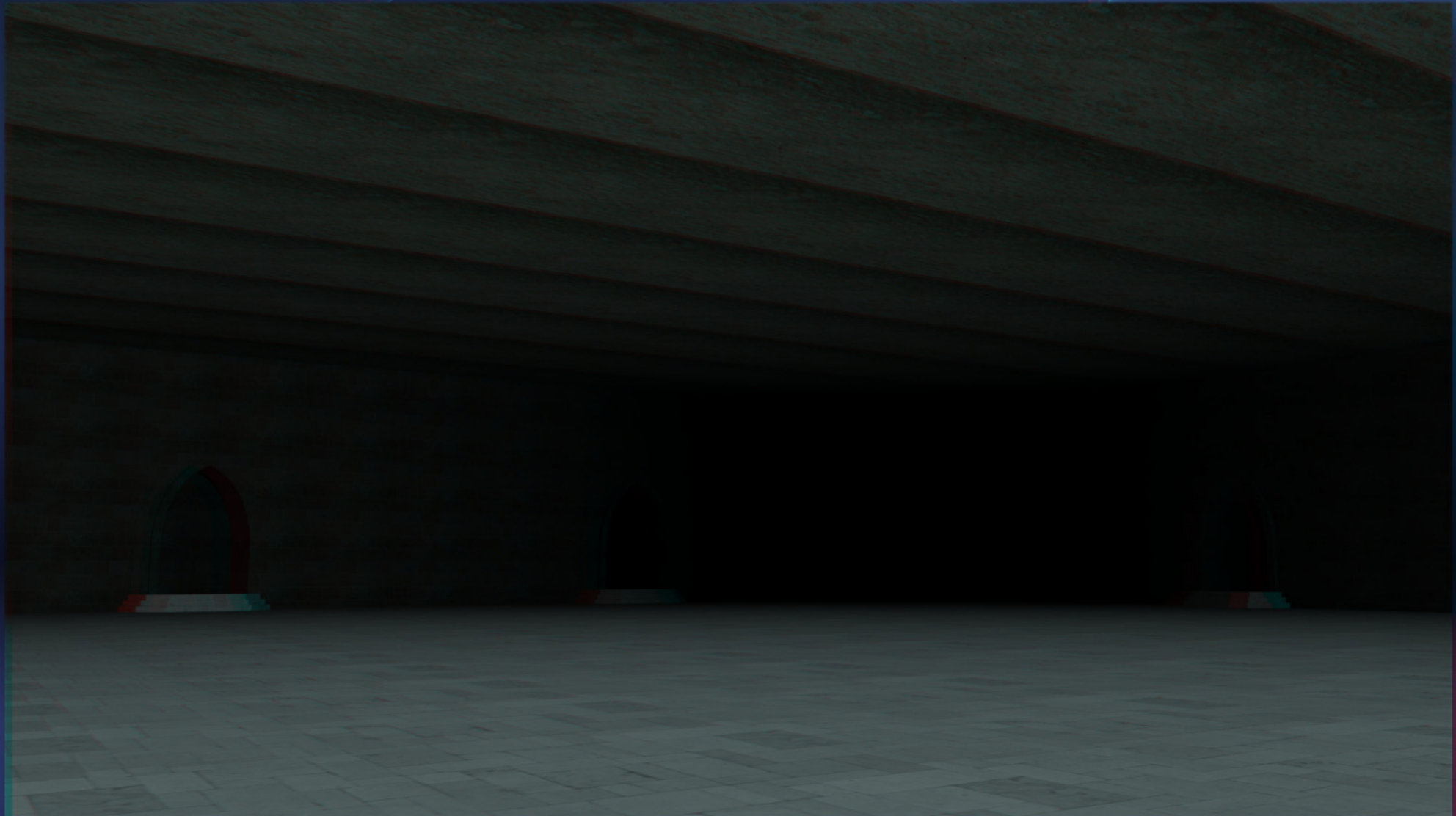
Adding particle effects such as snow helps to define the depth in the scene.



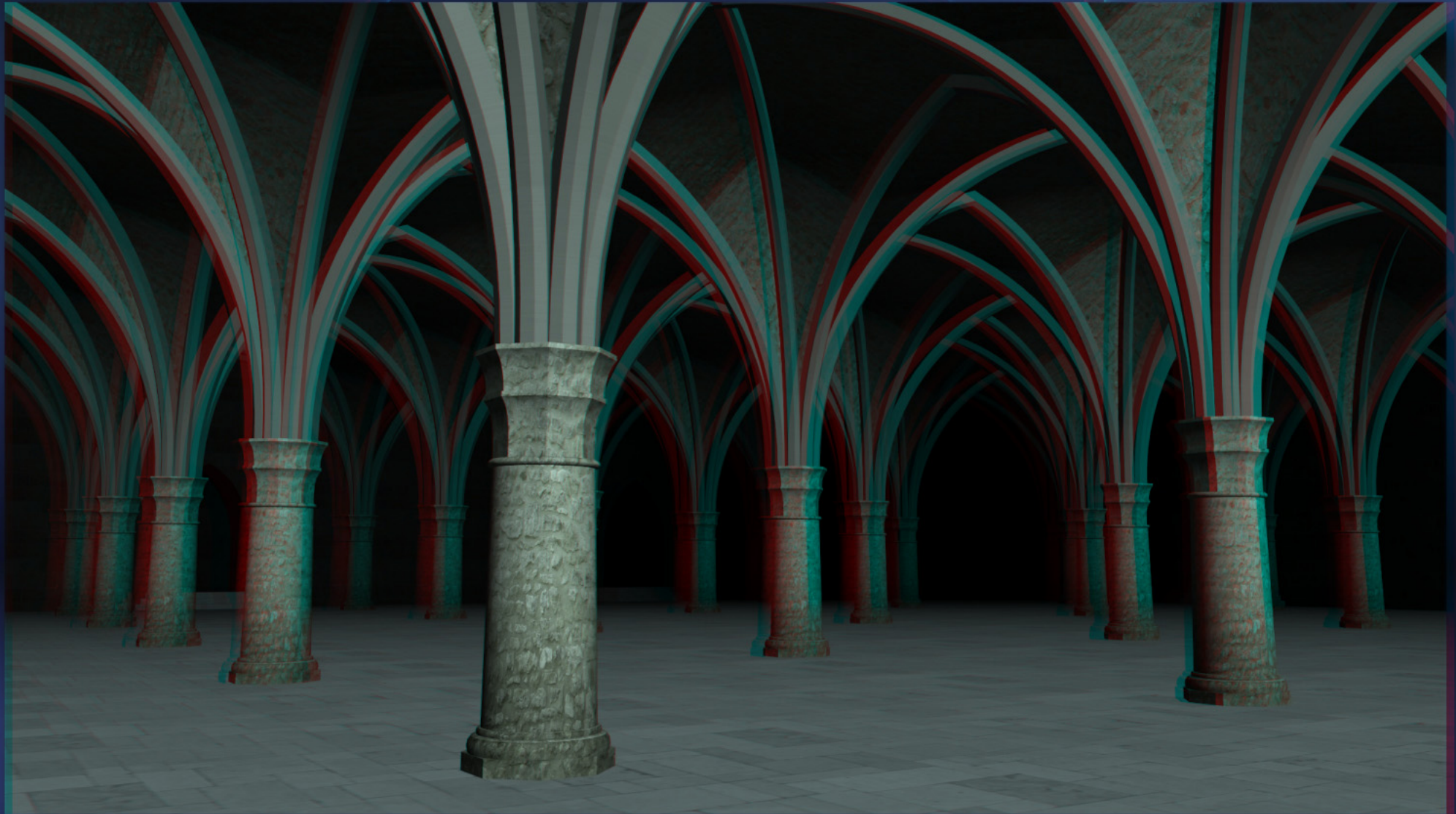




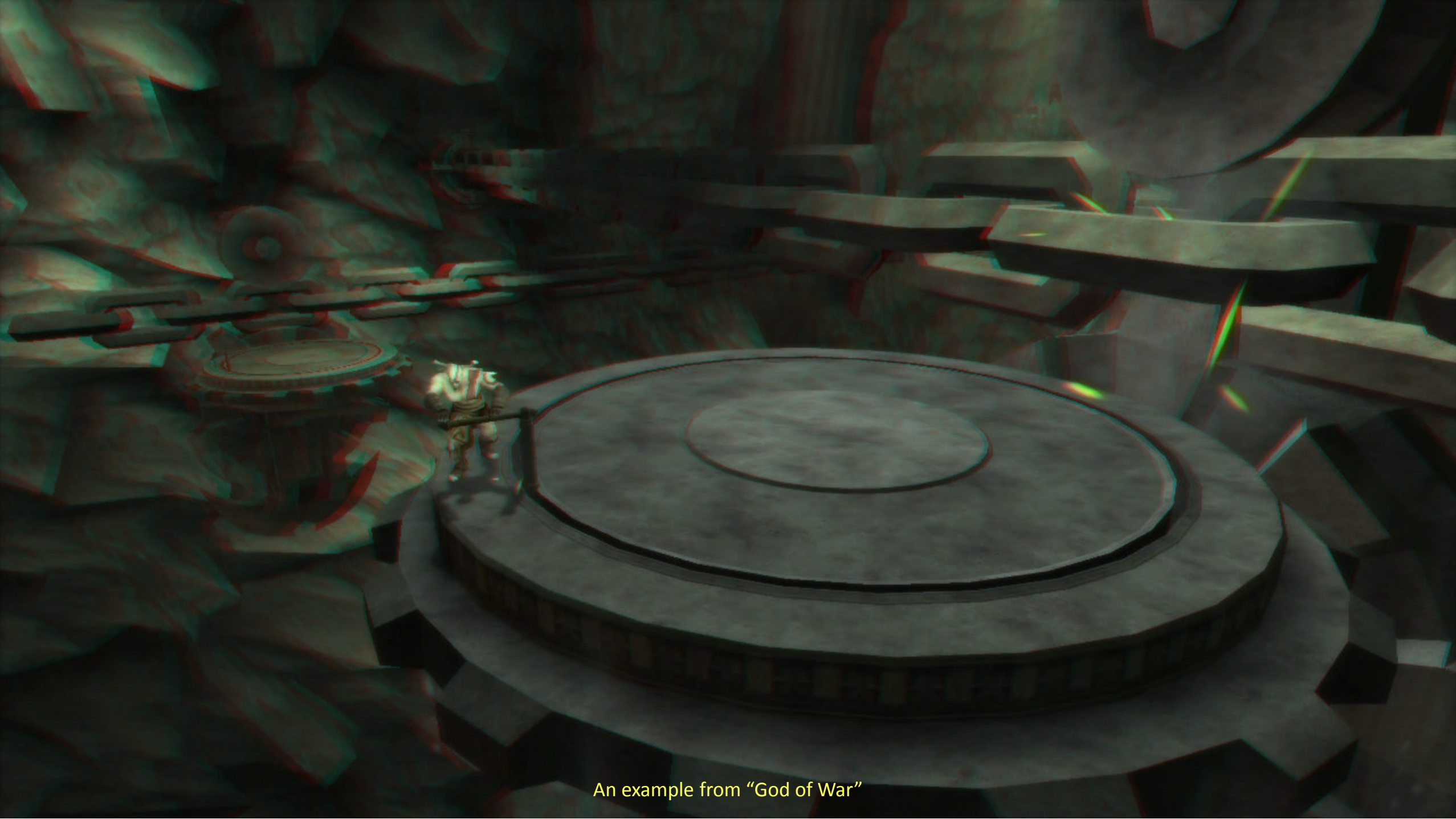




Distribute elements in depth
for better 3D scene composition

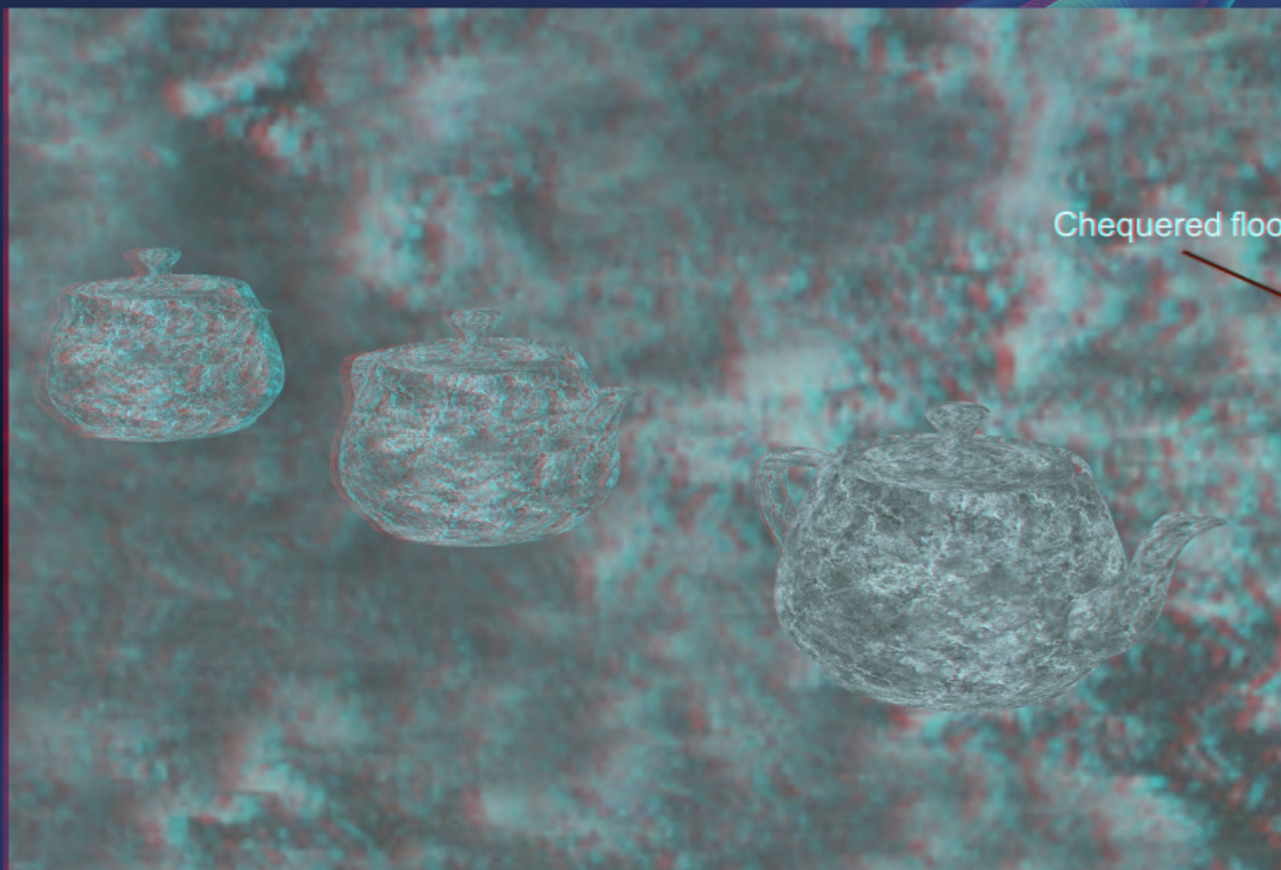


Distribute elements in depth
for better 3D scene composition



An example from "God of War"





Detail in ceiling



Patterned walls

Chequered floor

Detail on all surfaces

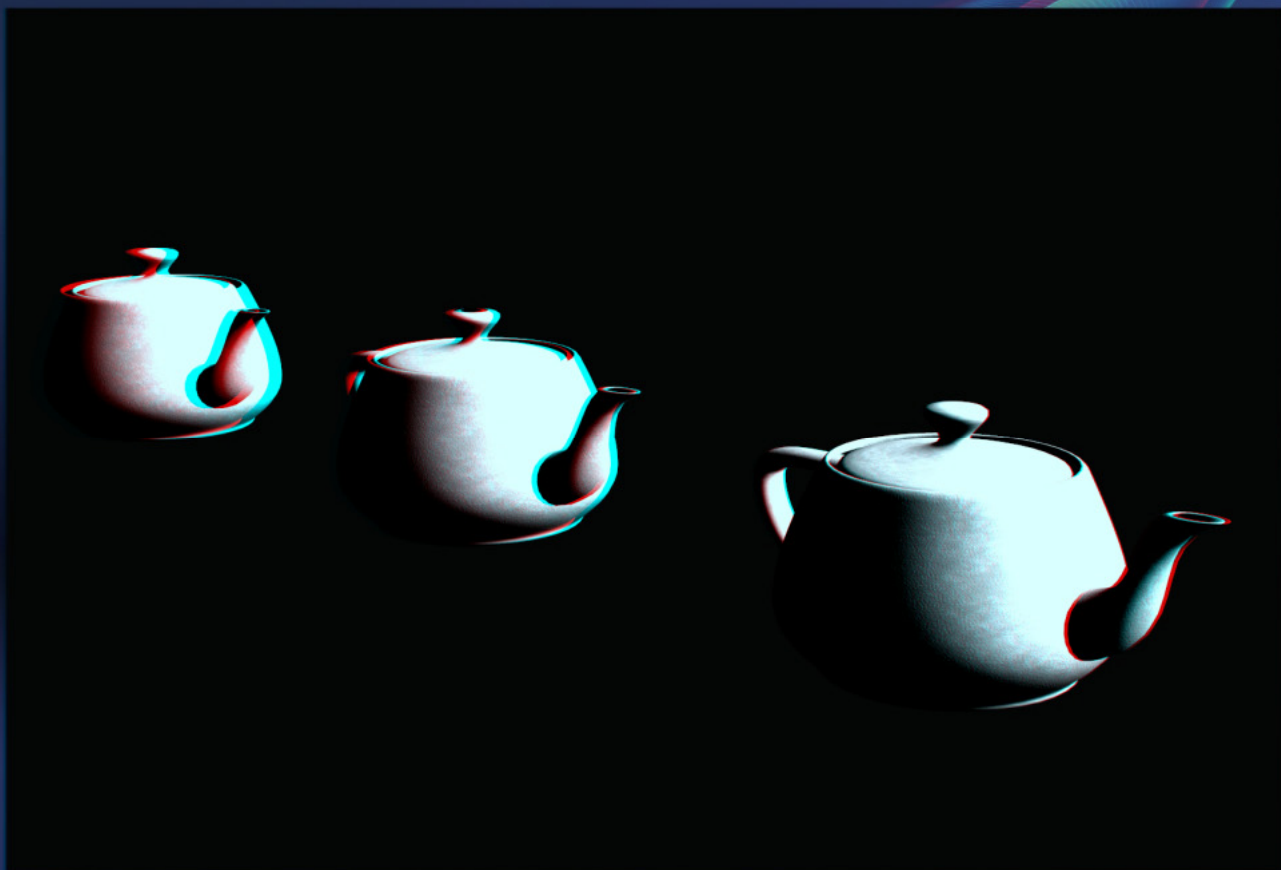


3D

Good texture detail helps to sculpt depth when using a wide depth of field. This is a great alternative to the narrow depth of field approach used in many films.

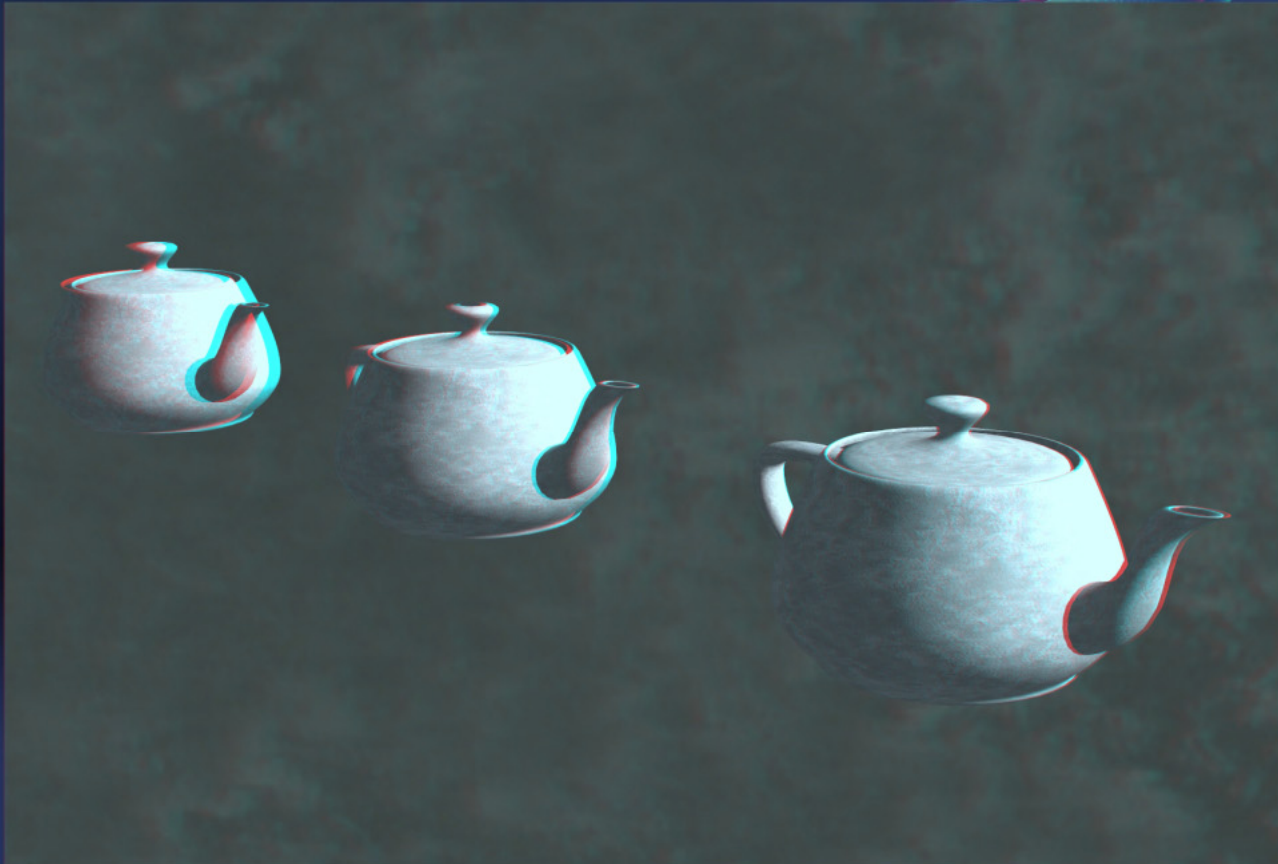


Textured surfaces in "Resistance 3"



Harsh shadows
remove texture
detail





Harsh shadows
remove texture
detail



High contrast lighting reduces texture detail

Use fill lights and be careful with exposure.



Large depth of field

Viewing the cross hair is difficult due to the sharply defined gun. We tend to prioritise viewing of objects in depth order.



Foreground out of focus

Blurring the gun makes the cross-hair easier to view

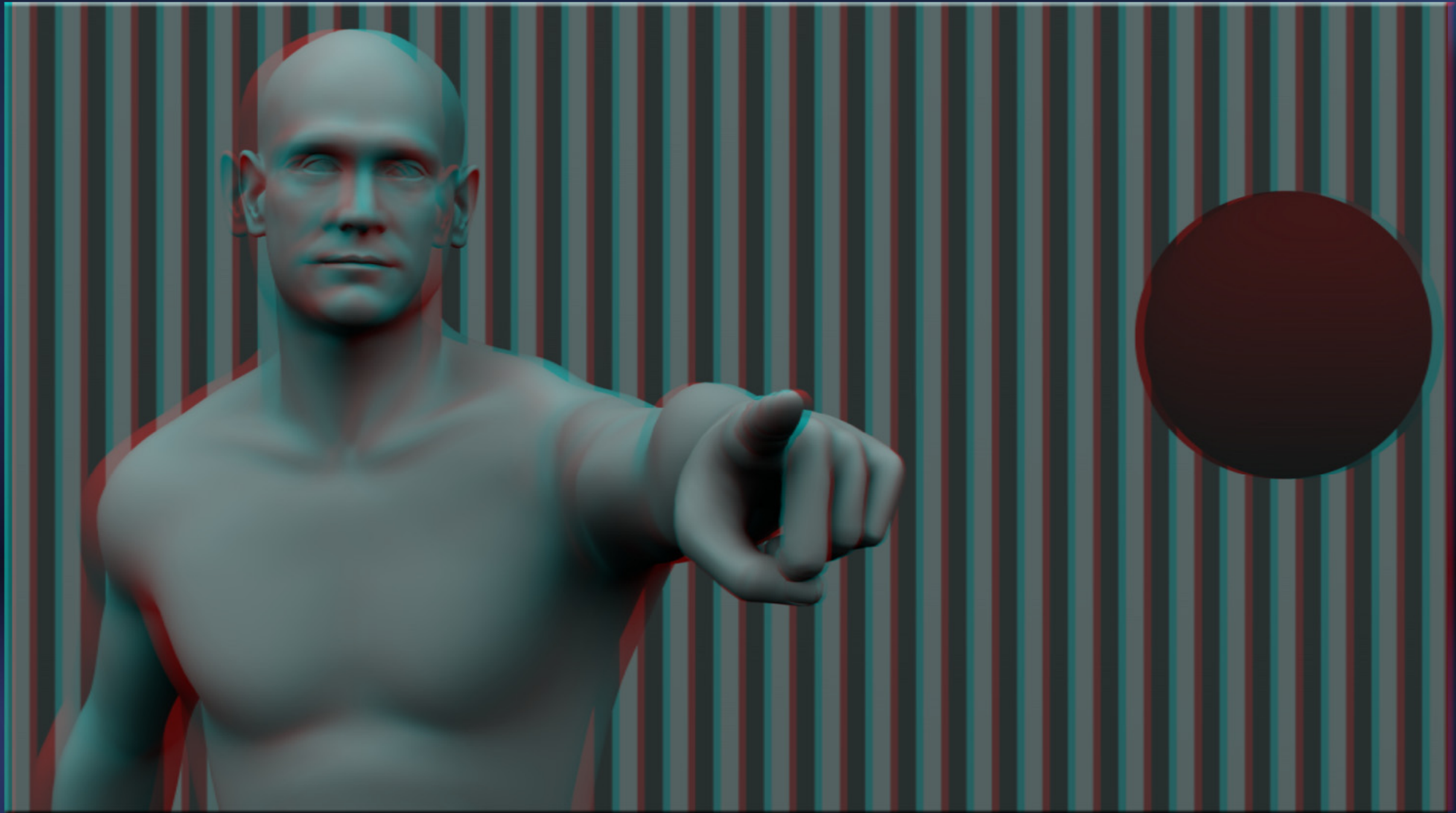


3D Scene Construction



Most objects are placed behind the screen. Many overlays are kept close to the plane of the screen. Occasional objects are placed in front of the screen.





Repeating patterns

The depth placement of this pattern is ambiguous and therefore confusing!



Repeating patterns


Breaking up the repetition solves the problem.



MENU SETTINGS



Horizontal lines can have ambiguous depth.



MENU SETTINGS

Adding vertical edges helps.

224

11

Merlot



GT LIFE >

PROFILE

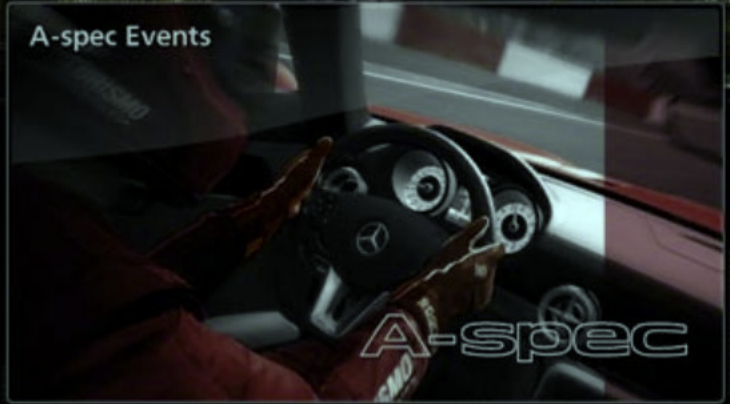
COMMUNITY



Official Events

Open Lobby

A-spec Events



B-spec Events



Special



Licenses



Dealerships



Used Car Dealerships



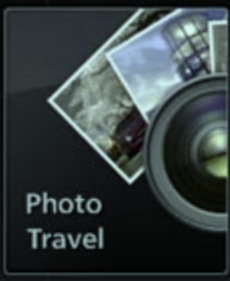
Practice



Tuning Shop



Photo Travel



3

Car Delivery

A

11

B

9

6,810,000

C4 Coupe 2.0VTS '05

8:42 16

WELCOME TO GRAN TURISMO WORLD

A 2D screen makes the viewer remove their glasses

Confirm

Cancel

Merlot



GT LIFE

PROFILE

COMMUNITY



Official Events

Open Lobby

A-spec Events



A-spec

B-spec Events

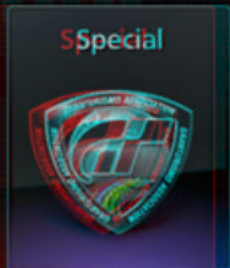


B-spec



Car Delivery

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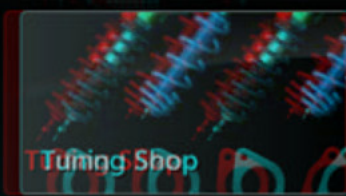
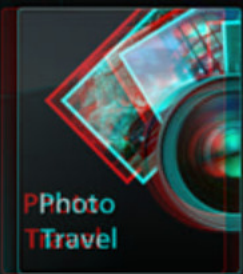


Photo Travel





If possible, cut scenes should be rendered properly in 3D rather than being converted from 2D.



Even the best stereographers can get the eyes the wrong way round. Be careful!



...that's better!

Telling Stories in Three Dimensions

BUZZ HAYS - SVP 3D Production - Sony Pictures Entertainment



Telling stories in 3D requires a completely different language to 2D

The Art of Stereography

- * understanding of 3D storytelling
- * designing for compelling 3D
- * crafting the emotional connection to the viewer
- * techniques to enhance 3D and its visceral connection to the audience



Pina (2011)

The Art of Stereography

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Pina (2011)

3D Storytelling

- * pre-production and pre-visualization
- * depth scripting / 3D scene analysis
- * exploring techniques specific to 3D
- * emotional impact of parallax decisions
- * understanding subjective vs objective viewpoints



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Pina (2011)

Designing for compelling 3D

- * production design
- * color & texture
- * lighting & shadow
- * stereo window
- * depth // parallax decisions
- * convergence points
- * blocking of action
- * camera decisions
- * pacing
- * transitions
- * sound design
- * visual cheats



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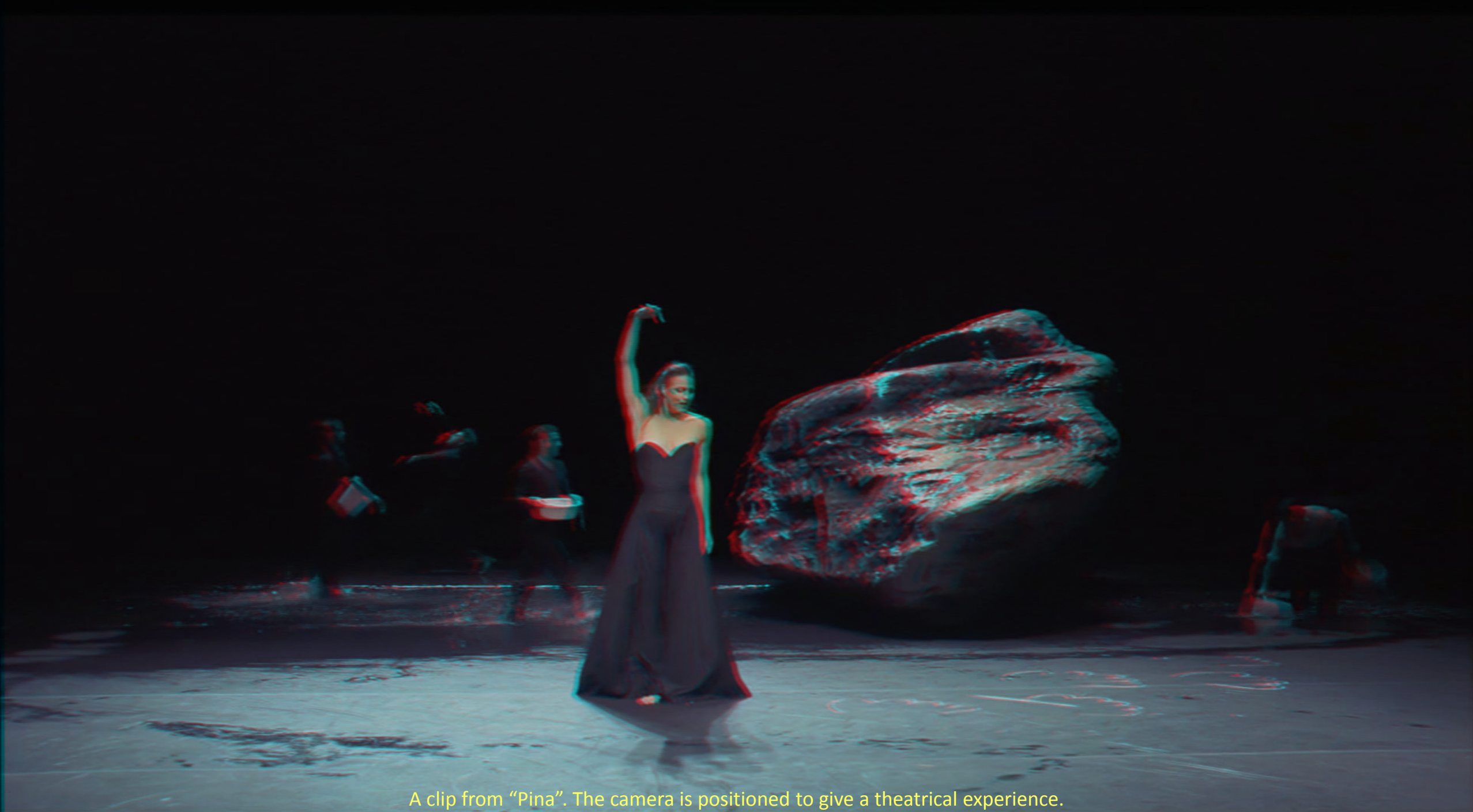
Pina (2011)

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- * visual cheats



Pina (2011)



A clip from "Pina". The camera is positioned to give a theatrical experience.





Careful lighting sculpts the objects and emphasises the water.



Even with a wide depth of field, 3D tells you where to look- it directs your attention.



The subject's face is brought slightly out of the screen to make an emotional connection with the viewer.

How is emotion conveyed in 3D?

- * scene design
- * blocking of the action
- * camera and subject of interest in motion
- * lighting and shadow used to sculpt dimension
- * proximity to viewer conveys strongest sense of connection
- * the secret weapon: understanding human instincts



Pina (2011)

How is emotion conveyed in 3D?

- * scene design
- * blocking of the action
- * camera and subject of interest in motion
- * lighting and shadow used to sculpt dimension
- * proximity to viewer conveys strongest sense of connection
- * the secret weapon: understanding human instincts



Pina (2011)

Embrace the limitations!



Creating the best 3D:

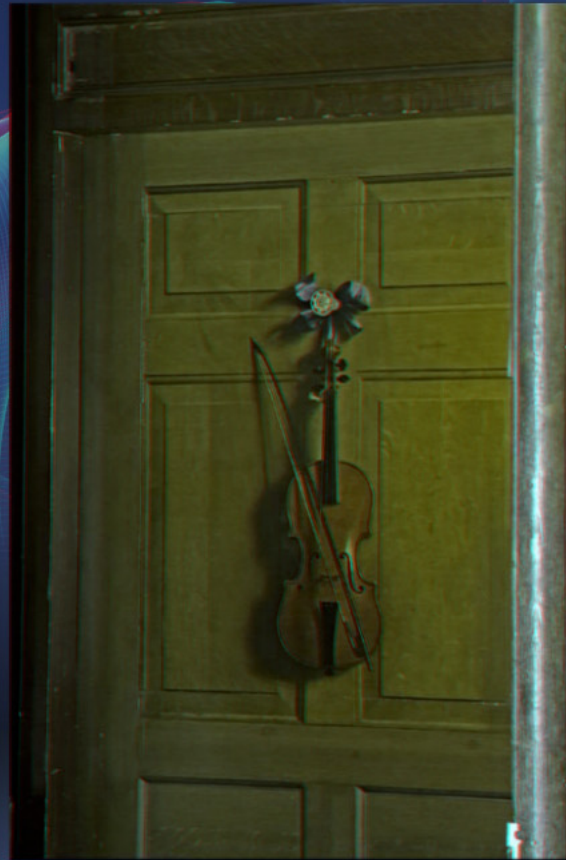


The best 3D will acknowledge the limitations of the display and the viewing circumstances. This publicity image is impossible!

Trompe l'oeil "trick the eye"



Santa Maria presso san Satiro, Milan *photo Giovanni Dall'Orto*



Violin door, Chatsworth House,
Jan van der Vaardt



Escaping Criticism, Pere Borrell del Caso



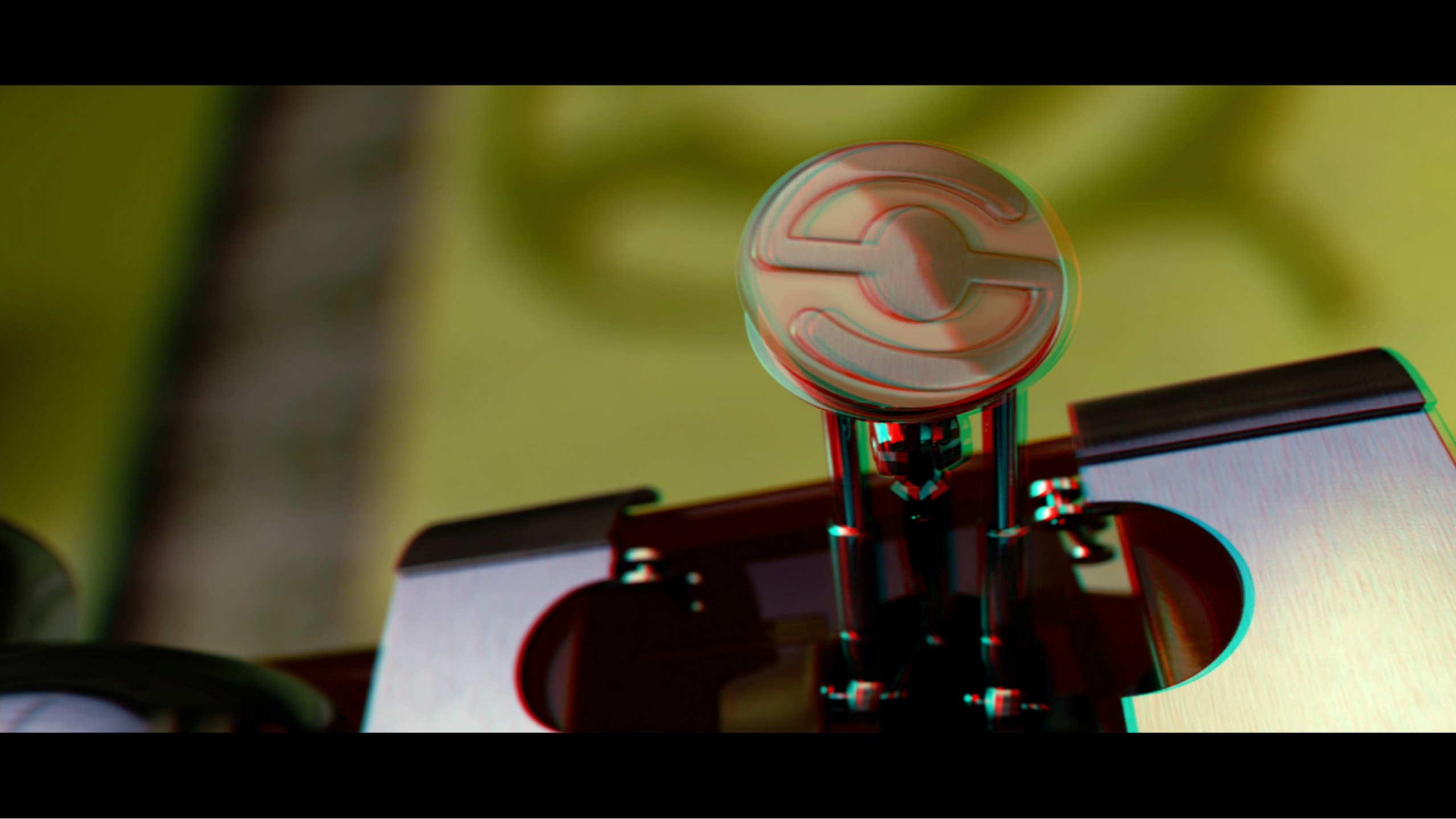
Ortho-stereo revisited: extend the viewer's room

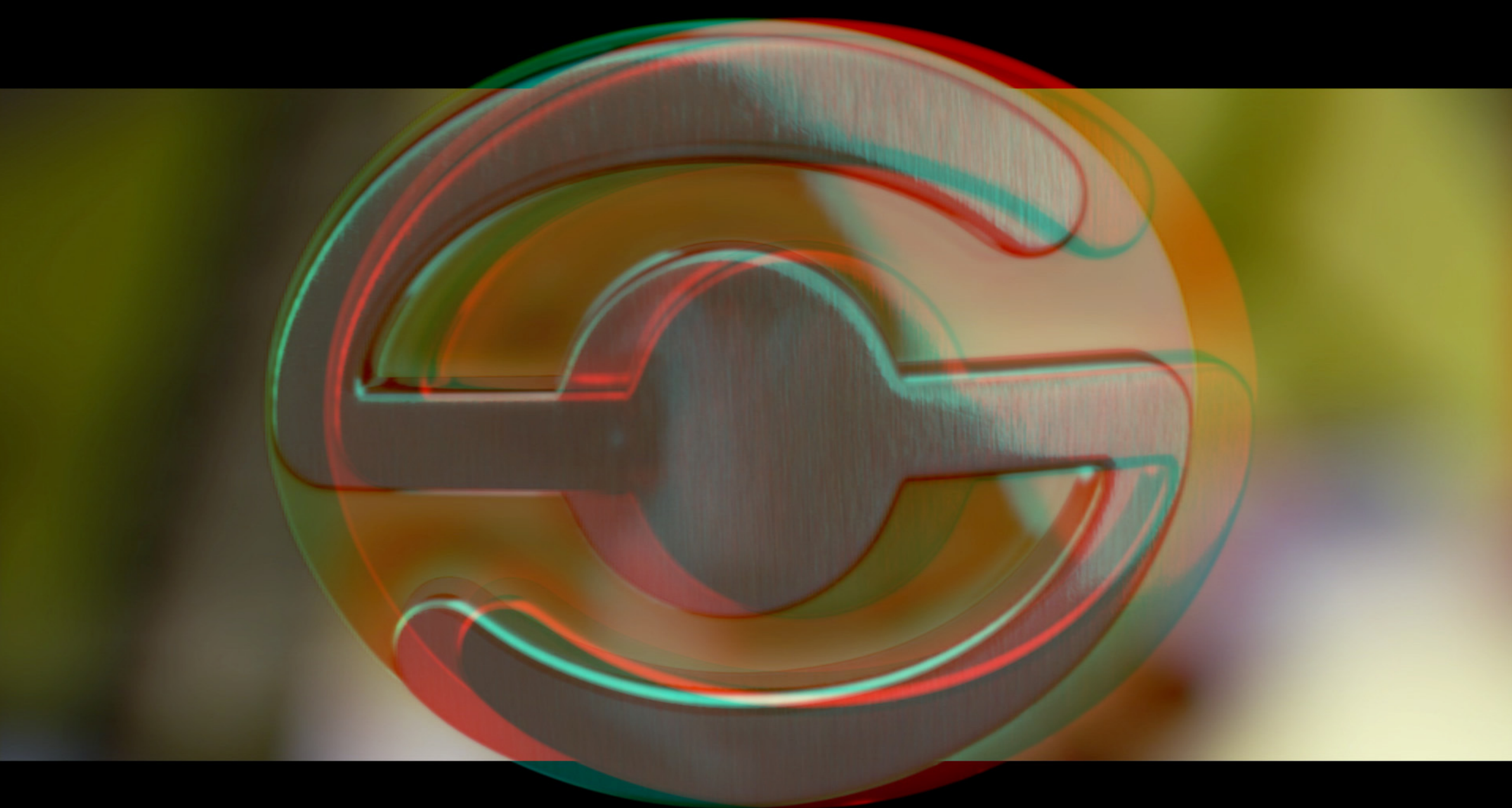
The artworks shown above use this approach to great effect.





The Disney film G-Force uses this approach too...





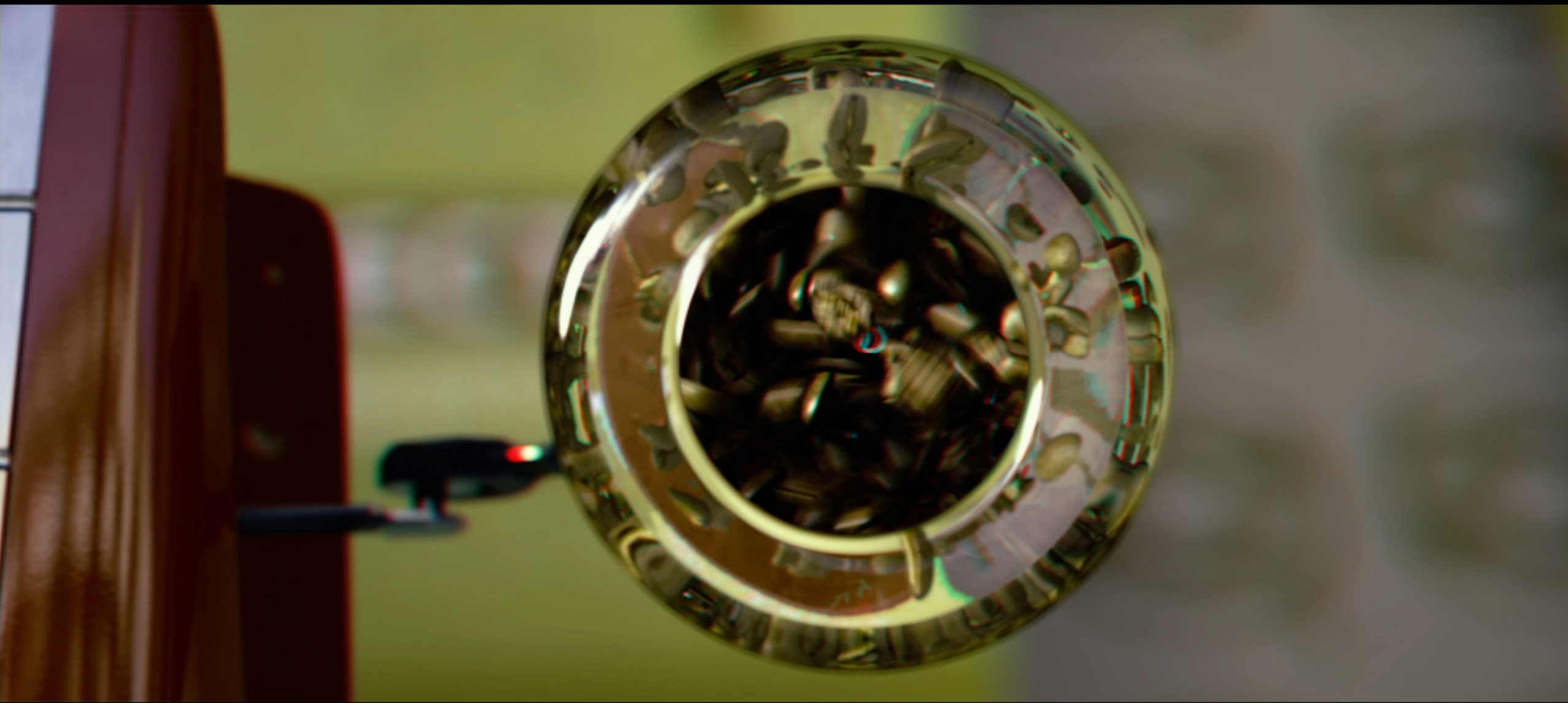
Occasionally object break through the horizontal masking of

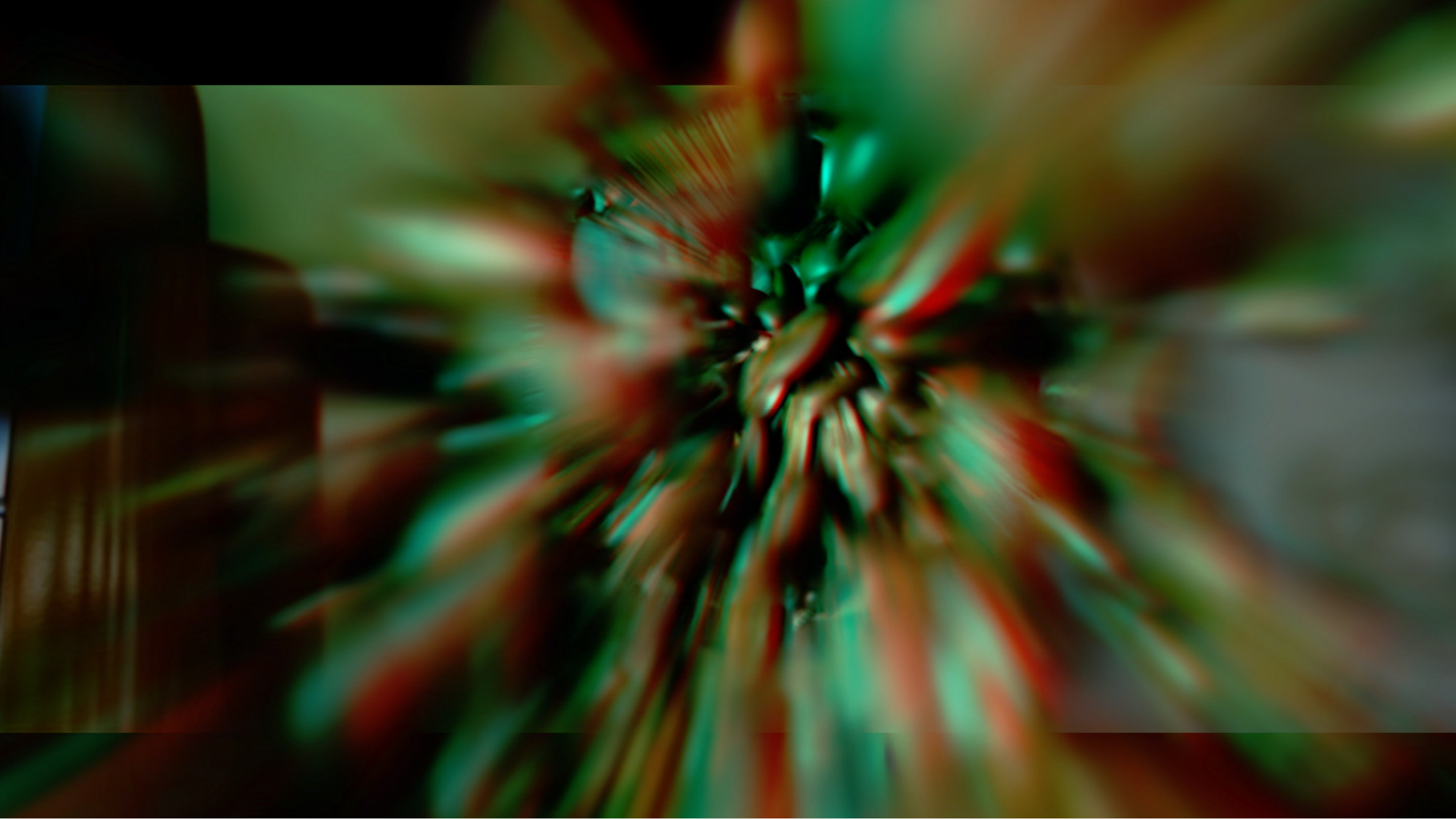
the screen to surprise the audience!



CONNECTING

Y TO THE
LIANCES
NEAR YOU







“Holographic” head-tracked 3D

Dynamically adjust the perspective to compensate for the viewing position.





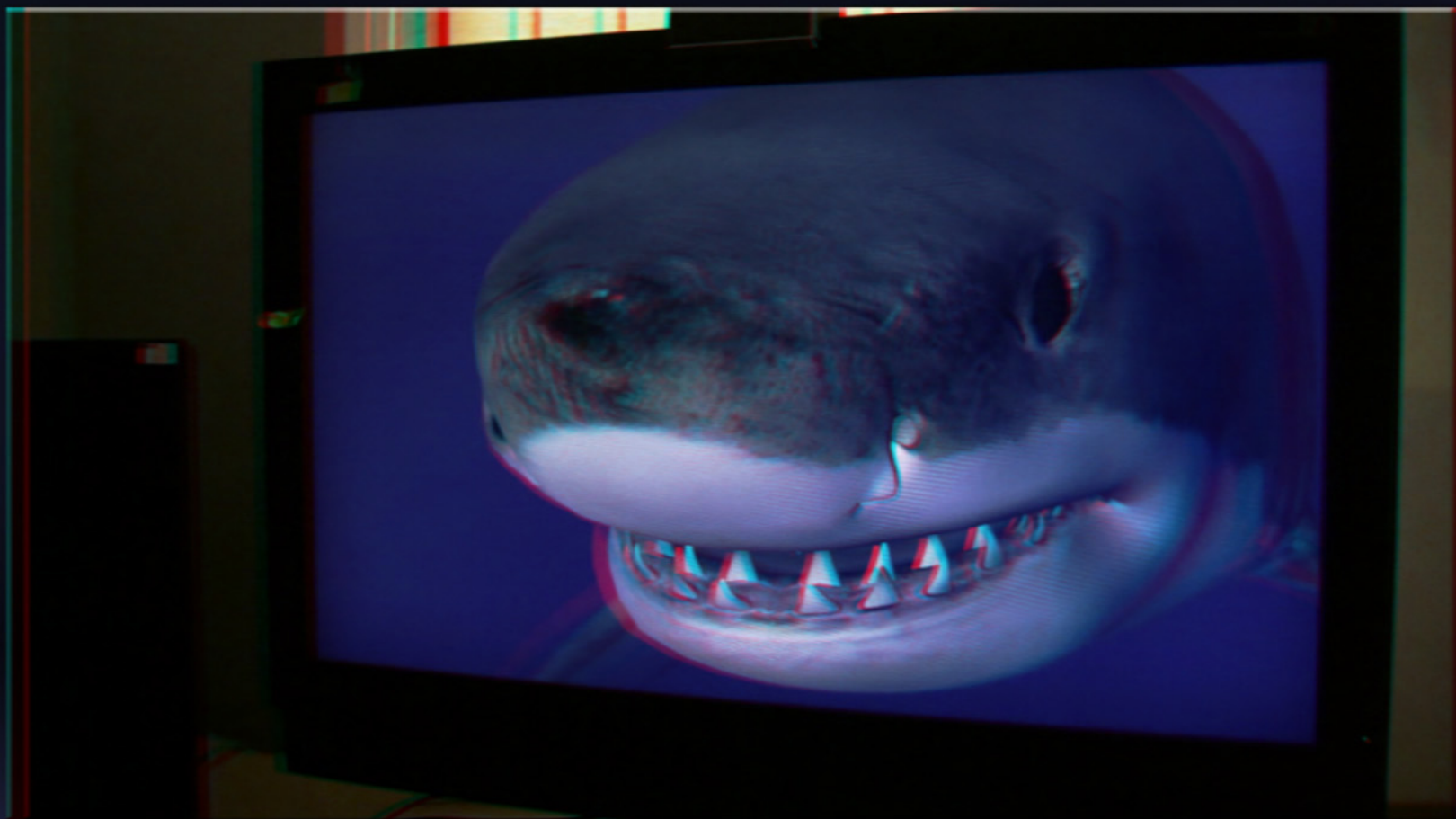
“Holographic” head-tracked 3D

The viewer can inspect the object from any angle as if it is really there.





“Holographic” head-tracked 3D



“Holographic” head-tracked 3D



3D



Spatial gaming using the
PlayStation® Move

Virtual world seamlessly
merges into the real world



Spatial gaming

These techniques are ideal for spatial gaming devices such as the Move





Conclusion

3D

There are over 80 3D games now available for the PlayStation 3 but this is just the beginning of what will be possible!



Conclusion

3D

3D has been around for over 150 years but this is not the case for *interactive* 3D. There are enormous creative opportunities. The text book has yet to be written!



3D

world

Created by Sony

THANK YOU

www3dteam@scee.net