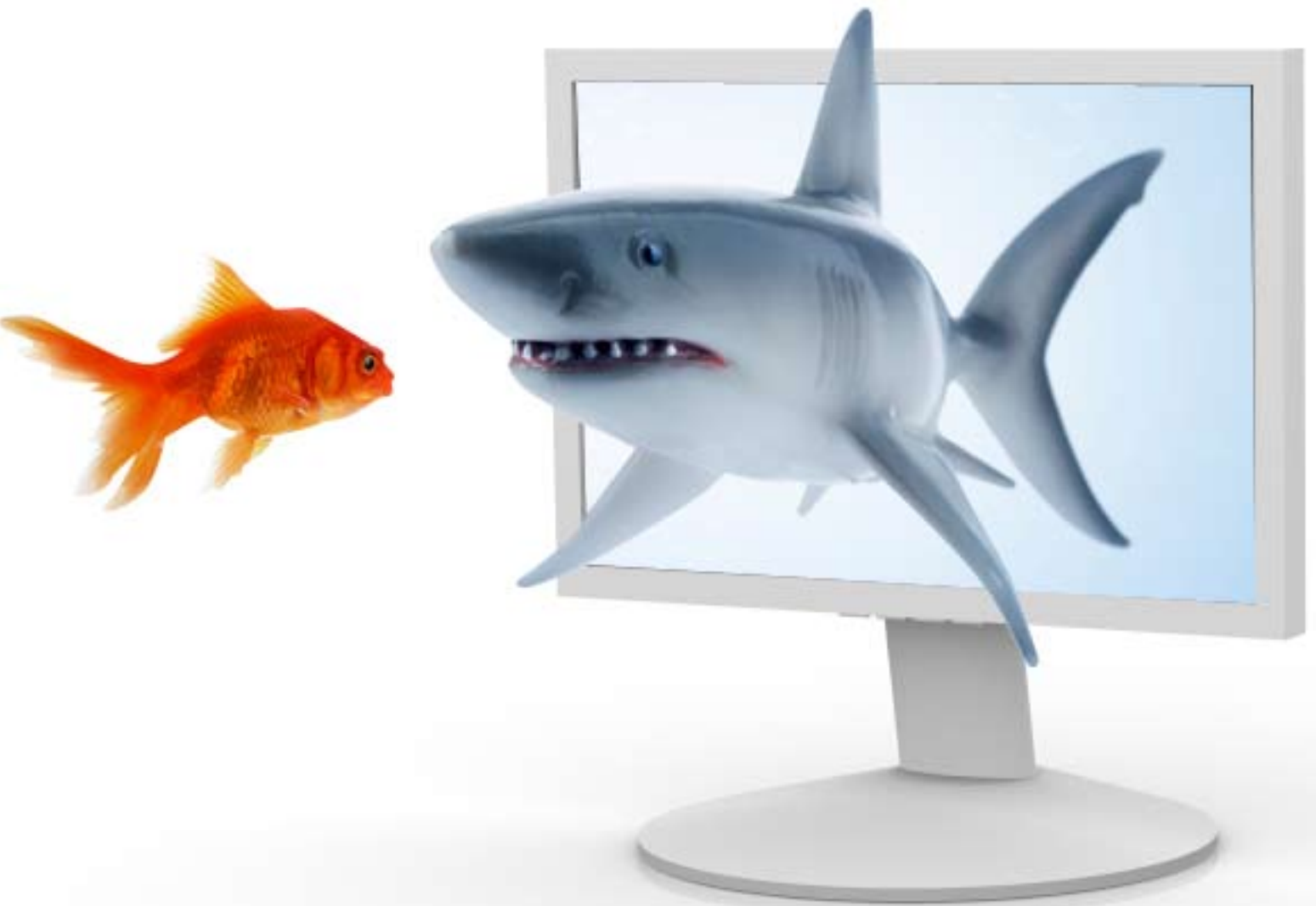


i-mag | the innovation magazine



Objective: 3D with glasses

Our 7th issue of i-mag takes you right into the world of 3D. With the digitizing of the broadcasting channel and recent progress in three-dimensional technology, we're standing at the dawn of this new world. Take a look and get immersed!

3D with glasses winning ground

These days, more and more 3D films are being shown in theatres, and we're witnessing a veritable boom in this type of production **1**. The move from analogue to digital is going to push more and more cinemas to get equipped with 3D-compatible material.

At the same time, the arrival of 3D television will allow viewers to get familiarized with this universe. "3D-ready" television sets are already available on the American and Japanese markets, and the first 3D programme broadcasts **2** have started to make their appearance, adding another dimension to live sports events for instance, but also to films and documentaries.

On the mobile side, a 3D-inclined device without glasses was for example launched in Korea last year. It uses two small cameras to film in 3D. Its screen contains a parallax barrier, a filter that lets you watch specific programmes (provided through a VoD platform) in 3D without glasses. 2D contents can also be converted to 3D as it's broadcasted **3**.



The advent of 3D cinema with glasses, 3D TV with glasses, cinema channels, VoD platforms and Blue-Ray that accommodates 3D format, makes it possible to reproduce an economic model similar to the existing one, and that includes movie theatres, DVD and television. Far from being just an epiphenomenon, 3D is therefore bound to cause an upheaval as big as the arrival of colour in the era of black-and-white.

1 James Cameron, Steven Spielberg, Georges Lucas... Pixar studios are showing interest. Dreamworks announced that it will be issuing its entire production in 3D starting 2009, whereas Disney nowadays is thinking 3D for all its animation films (scriptwriting and storyboard). Robert Zemeckis's "Beowulf" came out on 1,100 3D screens in the USA. The 3D version of "Journey to the Center of the Earth" this summer earned 4 times more at the box office than its 2D counterpart.

2 Several trials have been launched, especially in sport, with the rebroadcasting of NBA matches in 3D, a six-nation rugby test match in England, and international tennis from Roland Garros in France. In Japan, BS11, one of the NHK group's channels, broadcasts one hour of 3D contents per day.

3 The principle behind 2D-3D conversion solutions is to add depth information to existing 2D images. The quality is not necessarily great, since errors tend to slip in and the image is not truly three-dimensional. The result could be compared to that of hand-coloured films in the days when television went from black-and-white to colour.

principle and technologies

The basic principle behind 3D vision is to reproduce human binocular vision. Our eyes in fact see each scene that we're looking at, from two slightly different angles. The visual cortex in our brains then merge these two sets of information to produce a three-dimensional image with an illusion of depth. 3D TV will simulate this three-dimensional impression by producing two slightly different images of the same scene, one for each eye **1**.

The main technologies used for 3D imaging are the following:



Anaglyph glasses

Type: classic stereoscopy

These are the well known 2-colour glasses (each lens with an opposing colour filter, usually red and blue or cyan). The principle? The two previously filmed images are shown with different colours (red for one view, cyan for the other). Using the same colour filters on the glasses as for the images, the two viewing angles are separated, so that each eye receives a different picture.

The quality is not always very good and the colours tend to be altered, which makes it somewhat tiring to watch films in this way, with the brain having to compensate for the induced colorimetric deformations. The technology has therefore made way for more efficient methods.



Polarised glasses

Type: classic stereoscopy

Two pictures, polarised from different angles, are superimposed on the screen. The glasses, with polarised filters, let through only similarly polarised light to each eye, letting the two eyes see two different images to create a 3D impression.

This technology has been integrated on flat 2D HD television screens. One possible implementation is to display even lines in one direction and uneven lines in the other direction.

This approach is for instance used by Hyundai in Japan. Orange applied the solution for their demonstration broadcasting Roland-Garros tennis matches in May 2008.

The technology has also been implemented in 3D cinemas and on new 3D PC screens.

1 Basically, a scene is filmed with two cameras, set exactly in the same way but 6.5 cm apart, which is the average distance between people's eyes.



Active stereo vision

Type: classic stereoscopy

This technology, also called alternate-frame sequencing, consists of displaying left- and right-eye images successively on a screen at a very high frequency (48 frames per second). Shutters on each lens alternately hide the images from each eye at a very fast speed, synchronised with the successive display of the images: right-eye shutter when the left-eye image is displayed, and vice versa.

This system is better adapted to overhead projectors and plasma screens. It is less suited to LCD screens of which the frame frequency is slower, which tends to create ghost images in 3D. The technology is also used in 3D film theatres.



Techniques without glasses

Type: autostereoscopy

A filter – called a parallax barrier or lenticular network – is placed in front of the screen that separates images automatically, which means viewers don't need to wear glasses! Viewers need to hold their head in a certain position so that each eye sees a different image. However, they must be at the right distance and angle from the screen in order to receive the right image on the right eye, otherwise an inverse stereoscopic effect is created that could be very disturbing. To overcome this drawback, "multiscopic" systems are starting to appear that show not only two, but several different views of the same scene (five, eight, nine or even 25). This means you can see images in three dimensions even if you move around. Such systems however greatly reduce the definition of each image (number of pixels) which complicates the filming of natural scenes. Besides, each screen has its own format and number of images that it displays, and there is currently no standard for transmitting this data. The use is therefore restricted to end-to-end proprietary systems.

To date, there is also no equivalent technology for transposing this system to cinema.

optimising the 3D experience

Compared to 2D images, 3D has to be produced in a perfect way to avoid visual discomfort. Three-dimensional vision not only depends on the outlines of objects or on colours, but on small horizontal differences between corresponding points on two images. It is a physiological phenomenon that cannot be interpreted: the brain does the processing automatically **1**. Each person in fact sees 3D images in his or her own way **2**.

1 With photos for instance, interpretation is essential. From an early age we learn to interpret pictures. Cognitive learning is therefore indispensable for understanding photos. With 3D however, the process is automatically steered by our brains. This is why badly made images can cause headaches and visual discomfort.

2 About 5% of all people do not see 3D images at all. Others find it hard to watch if the three-dimensional quality is too pronounced.

This is a new factor in the history of audiovisual production: with 3D programmes, the final viewing conditions have to be taken into account right from the shooting stage in order to produce images that conform to reality. It seems essential therefore that rules for three-dimensional conformity must be defined if 3D is to be experienced in the most natural way by the largest number of people. A totally new way must be found of producing images differently to 2D ³. Incoherencies between distance and size, typical of 3D images, could for instance occur ⁴.

Subjective tests have been carried out with viewers to determine the threshold values beyond which they experience discomfort, in terms of differences between two images, between light and colours, compression, etc. Recommendations have already been issued by a Japanese consortium founded on the initiative of Sharp, Sony and Sanyo. Similar studies have been undertaken in Europe, in particular under the European project 3D4YOU, as well as the USA, where a consortium and several workgroups on stereoscopic content transmission have been set up.



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These tests in particular show that, when it is well done, people much prefer 3D to 2D video, regardless of the viewing criteria: immersion in the displayed scenes, natural impression of objects, quality of images, etc.

³ One or two seconds are needed to adapt and start appreciating a 3D image. Alternating too rapidly between shots therefore disturbs the viewer. Certain rules must also be obeyed when setting up a scene: in 3D vision, there may for instance be a discrepancy between the eyes' distance of convergence and the focusing distance. Therefore, depending on the viewing distance, for example 2 meters, objects cannot be reproduced that are more than 4 meters from the screen. In a theatre, where the screen is further away, such problems do not exist, but they may well occur on TV or PC.

⁴ If the shooting parameters are not chosen correctly, several effects typical of 3D could occur:

- "Modelling effect" which gives the impression that you're watching the scene in a shoebox. The image is three-dimensional, but the people look smaller than in reality and in the screen shot.
- In other cases, objects could appear larger or smaller than in reality, depending on the size of the screen or shooting parameters.
- To make objects "come out of" the screen, they must be seen as a whole, without cutting off any part. If objects are cut off, incoherencies may occur, like seeing them behind the screen as well.
- If the two eye images present dissimilarities (colour, definition, vertical difference between images, etc.) produced by the filming process or during restitution, this could be disturbing to the eye.

technical challenges

A perfect technical solution for 3D does not yet exist. Approaches with glasses, apart from reserves from people who don't normally wear them **1**, have the advantage of being mature, and of being deployable in the short term, since they can be made compatible with the current broadcasting channel **2**.



For Orange's Roland-Garros trial **3**, the choice fell on pairs of stereoscopic cameras **4**, retransmitting some of the tournament matches live in a demonstration area. This technical achievement contributed to validate the compatibility of the 3D solution with the current broadcasting channel, with two images transmitted in one single HD image **5**.

1 It is still uncertain how the public will accept the wearing of glasses to watch 3D programmes, especially those who don't normally wear spectacles. For those who do wear ophthalmic glasses, and who would have to put on a second pair for 3D, one could eventually foresee lenses that would be both corrective and contain the necessary elements for three-dimensional viewing.

2 The signal is encoded in HD MPEG4 and requires a bandwidth of 12 to 25 Mbps. It is subsequently decoded by a classic Orange HD set-top-box. The transmission is compatible with the 2DHD broadcasting channel and with existing networks.

3 On 26, 27, 28 and 30 May 2008, during the Roland-Garros tournament, Orange carried out one of the very first tests worldwide broadcasting international tennis matches live and in 3D. During four days, seven matches were retransmitted live, and for the rest of the tournament in VoD on special 3D television sets with polarised glasses set up at Roland Garros and in two Orange outlets for the mass market.

4 The shooting was done by the Japanese company NHK MT (an affiliate of the Japanese TV channel NHK) on the Suzanne Lenglen court with three pairs of cameras.

5 Each eye receives one out of every two lines, reducing the vertical resolution by half. The two images are then transmitted side by side, thereby reducing the number of horizontal points by half as well. Therefore in all, there are four times less points per image than in an HD image. For the restitution, a television with a polarised filter made by the Korean company Hyundai IT was used.

3D without glasses – a viable option?

With the arrival of autostereoscopic systems, multivision approaches without glasses will be developed. Since this requires the filming of more than two images at a time, it will complicate the production and transmission process. European research projects are looking at new so-called “2D+z” image formats that capture one or more 2D images as well as the associated depth maps when shooting. An algorithm is then used to rebuild 2, 8, 9 or even 25 viewing angles. This facilitates transmission on any type of screen – mobile, PC, TV, cinema, etc. – from a single acquisition, by adjusting the number of viewing angles and three-dimensional depth. These “2D+z” formats also allow the user to adjust the depth in order to get the most out of the experience.

This type of format is currently being investigated by standardisation bodies. It seems to be restricted to television or the broadcasting of images in public places, since it is not adapted to the kind of stereoscopic content transmission currently used in 3D movie theatres and approaches with glasses.

Orange heads for 3D

Judging from these new 3D technologies’ success with the first test users, chances are that the demand for 3D contents will keep growing in the months and years to come, as new ad hoc devices come out on the market and users get better equipped. With potential applications for all image-based services (VoD, video, photo, mobile phones, games, films, TV...), 3D has a bright future in store.



For television, a first significant step was taken in May 2008 with the live shooting of Roland-Garros tennis matches in 3D.

Orange enters the race

As an access and content provider, Orange has to initiate the creation of attractive programmes in 3D. The group via its affiliate Studio 37 has therefore coproduced its first 3D animation film, *La Nuit des enfants rois* ¹, which will be released early in 2010. Other film projects are underway too.



For television, a first significant step was taken in May 2008 with the live shooting of Roland-Garros tennis matches in 3D. This trial should deliver concrete results in 2010 with the retransmission of first-league football matches, this time for all Orange customers who have 3D TV.

¹ Coproduced with Fidélité Films and Onyx Films, the movie is an adaptation of a novel by Bernard Lenteric. It was decided to make an animation film, which would entail less technical constraints than a full feature with real actors. The plot? Seven children decide to take revenge after a brutal attack in Central Park.

glossary

parallax barrier

A 3D filter placed in front of a screen that is used for autostereoscopic systems. It consists of a series of opaque and transparent lines or slits that hide certain pixels and let others show through. Placed in front of the screen, it lets one eye see certain pixels and not others, depending on the viewer's position. Sharp is the first manufacturer to market an LCD screen on which the parallax barrier can be activated simply by pressing a button.

“2D+z” image format

2D image incorporating a depth map in grey scale. The result comes close to that of images filmed with the “night” function on certain video cameras. The map gives information on the distance of each object in the filmed scene. Nearer objects will be in whiter tones, whereas objects that are further away, will appear darker.

lenticular network

A series of micro-lenses used in autostereoscopic systems. Placed in front of an LCD screen in the same way as a parallax barrier, it allows the viewing of images from different angles.

alternate-frame sequencing

Also called “active” stereoscopy, this technology requires the use of special glasses with shutters on each lens. The right eye is hidden while the left-eye image is displayed, and the next instant the left eye is hidden when the right-eye image is displayed.

autostereoscopy

A method for displaying 3D images that can be viewed without wearing special glasses, unlike stereoscopic systems.