Fraunhofer

TRENDS AND TECHNOLOGIES IN DIGITAL MEDIA

2nd Edition

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FUTURE TECHNOLOGIES FOR DIGITAL MEDIA

The trend in digital media is toward higher resolution, higher frame rates and toward new, flexible recording techniques in media production. 4k resolution and 3D surround sound are conquering more and more theaters. The trend is continuing in living rooms as well. Image and audio quality are approaching those in cinemas and concert halls, and expanding into streaming on mobile user devices. Encoding techniques like High Efficiency Video Coding (HEVC) and High-Efficiency Advanced Audio Coding (HE-AAC) are solutions that can offer high-resolution images and multi-channel audio for mobile user devices despite limited bandwidth and a large number of users.

There is demand for image and audio technologies that surpass stereoscopic 3D video. Promising approaches using camera arrays allow creation of many different perspectives (free-viewpoint FTV) from a single recording of a scene.

We are therefore dedicating a special section of this edition to the topic of new camera technologies. These new camera developments and algorithms offer greater flexibility and broader creative options for editing scenes. New post-production tools for audio recording facilitate high-quality sound to complement the quality of the 360-degree "moving picture" experience.

"Trends and Technologies for Digital Media" offers you insight into the most important future technologies of the media sector.

Dr. Siegfried Fößel
Spokesperson for the
Fraunhofer Digital Cinema Alliance

PROJECT SPATIAL AV – UPDATE

After the huge success of 3D films and the enthusiasm of viewers, 3D has since become almost the new normal in film creation for the big screen and Blu-rays. As a result, many new productions are being supplied in 2D as well as 3D.

High production costs that still occur due to expensive engineering and limited flexibility on the sets can simply not be borne by many productions when creating good 3D for the cinema or television screen.

To offer solutions oriented toward the future demands of the marketplace and industry practice, the member institutes of the Fraunhofer Digital Cinema Alliance have bundled their expertise in audio and video technology together in Project Spatial AV and are demonstrating the initial developments and workflows in intelligent, modular, and multi-sensory recording and production systems for immersive audio-visual media. Immersive media offer viewers the experience of being submersed in the totality of the scene as if they were part of what is happening.

The Spatial AV research project is being monitored by a group of experts from the film and television industry so that solutions are developed that will find acceptance in the sector and can be smoothly incorporated. At the Fraunhofer Digital Cinema Alliance joint IBC booth (Hall 8, Booth B80), the Fraunhofer engineering staff will be presenting the initial solutions and additional ideas about many steps in the AV production chain that have resulted from the project's first year in operation.

"Networked – Intelligent": the future of new recording and production systems

The goal of this project is to automate the procedures of 3D production – to utilize and edit data and information simply and flexibly once they are recorded. This helps

SPATIAL AV – A RESEARCH PROJECT OF THE FRAUNHOFER DIGITAL CINEMA ALLIANCE

- Goal: to develop an intelligent, modular, multi-sensory recording and production system for immersive audiovisual media
- Project launch date: 1 February 2012
- Project duration: 33 months

"We want to create new technical opportunities for creativity in cinematography through Project Spatial AV. The camera operator should be allowed to return to intensely concentrating on production of the story and be relieved of numerous technical adjustments and details that have been flooding the set since the inception of 3D."

Dr. Siegfried Fößel,
Project Manager for Project Spatial AV

Participating Institutes / Expertise:

Fraunhofer IIS
Self-calibrating cameras; implementation of new recording methods based on light field and HDR technologies; sensor arrays; post-production and distribution formats

Fraunhofer HHI
System design and equipment for production of 3D and panoramic content; algorithms for processing and correcting data for projection and playback

Fraunhofer IDMT
3D audio, object-oriented audio coding; methods and tools for audio-visual coherence; portable 3D audio reproduction equipment

Fraunhofer FOKUS
3D dome projection and methods for adapting content to panoramic or spherical projection surfaces

minimize costing pressure for expensive productions. Intelligent and networked cameras, camera and microphone arrays, as well as additional sensors for location, direction of motion or depth of field should deliver information so the systems can correct the recording parameters independently without intervention. Additional ancillary data for post-production make many different production and playback scenarios possible. Rendered visual and acoustic data that are optimal for 2D, 3D, free-viewpoint, or for 360-video can be derived from the recording data. The recording and production systems can be employed for classic cinematic reproduction and television broadcast as well as for three-dimensional screens, auto-stereoscopic displays, or for panoramic and dome theaters.

Omnidirectional, Light-field and Co. – a new world of images and workflows

The world of new camera technologies offers numerous creative options on set and in post-production. Images can be recorded with viewing angles of up to 360 degrees in 2D and 3D and be assembled into panoramic or a holographic image. Advantage: retrospectively navigating around within the scene also becomes possible – no detail is lost and you feel as though you are involved, not just a spectator.

Light-field recording is a process that has now become feasible thanks to high-performance digital technology using new camera systems. With usual fixed camera settings, a camera only ever records a fixed framing of the scene. In the subsequent post-production, there is little latitude for exchanging or post-editing subjects, changing viewing angles, or shifting the focus. With a light-field recording system consisting of several cameras, the entire scene can be recorded and the light-field captured. Every camera offers a slightly different viewpoint of the scene in a recording. As a result, other viewing angles, other depths, etc. in the scene can be selected in post-production and used for the final cinematography.

Efficient coding without a loss of quality offers advances that can be integrated into the cameras. Transmitting the recording data directly to post-production

should be more efficiently organized. Fraunhofer scientists are working on adaptive streaming processes to achieve this. They will meet the challenge when it comes to transferring content from the recording set to post-production. Fast and flexible transfer is achieved with this coding, which helps reduce production costs.

Tools for the audio engineer

Demands are also being made on audio recording technology by new, more flexible reproduction situations. To help meet these demands, Fraunhofer scientists are developing new tools for spatial audio production that will provide the support needed by senior recording engineers when converting and reproducing premium, spatially precise audio recordings. Audio-visual coherence – that is, the joint recording, editing, and matching of acoustic and visual perspectives is one focus of Project SpatialAV. The initial implementation is a microphone management system for the sound engineers that facilitates rapid and intuitive control over the audioscape, even with a large number of microphones. This is possible any time – during as well as after production – using an interactive system of 3D audio reproduction for headphones.

Further research and development work in Project SpatialAV will follow over the coming two years and will deliver additional interesting and future-oriented systems.

CAMERA TECHNOLOGIES

Everyone gets together at family celebrations – a good opportunity to pull out the video camera and film the happy gathering. While the camera used to be dug out only for special occasions, today it accompanies our every step. We have them with us constantly, integrated in the smartphones we carry in our pockets. On film sets, 3D cameras deliver high-resolution three-dimensional images that deliver us to unfamiliar worlds later in the theater.

Many of these special cameras originated from the labs of Fraunhofer Institutes. The researchers there are out ahead in developing optical methods and cameras. This expertise is reflected in the spread of the developments as well. The Fraunhofer scientists created an extremely small and lightweight camera, that can even ride an eagle in flight, braving storms, rain and the cold – yet recorded the images in high resolution. Another camera system captures not just an individual mountain panorama, but instead creates a 360-degree view allowing the viewer to select a section of an image at a soccer game for viewing – the playing field, for example, or the spectator seating. A special camera array with a total of 16 cameras is currently facilitating post-production for filmmakers. Once they record the scenes with the array, they can carry out various adjustments themselves even during post-production, which would otherwise have to be made on set. They can change the viewing angle or the depth of field, for instance. And then there are the HDR cameras that deliver good film despite poor lighting conditions. And the list goes on ...

CONCERTS AND SOCCER WITH VIEWER-SELECTABLE SECTION OF THE IMAGE

"Goooaaal!" roars from living rooms and sports bars, and the successful shot is replayed from the best section of the image. Viewers often wish they could watch the playing field during the rest of the game in a different viewing angle than the one shown. That should become possible in the future: the viewer will then become the camera operator, able to select a particular viewing angle for the virtual camera – even during a live event in real time.

The new "OmniCam360", developed by the researchers at the Fraunhofer Institute for Telecommunications, Heinrich Hertz Institute HHI in Berlin, makes this possible. If it is positioned at the edge of the field above the center field line, it displays the entire panorama, i.e. a 360-degree view. And what is special is that the camera only weighs 15 kg (33 lbs). As such, it can be carried by one person and fixed to a camera mount. Its predecessors weighed in at a good 80 kg (over 175 lbs) by comparison. In addition, it is no larger than a normal TV camera.

To maintain the 360-degree view, the OmniCam360 consists of ten cameras that gaze in various directions. A mirror system guides the event, i.e. the soccer match for example, to the camera in such a way that it can be can be re-assembled into the entire panorama. A further advantage: it does not need to be tediously calibrated. Unpack the camera, connect it – and start shooting. This is made possible by a special technique with which the ten cameras are fixed to the chassis.

The panorama camera can also provide superb service for concerts: the scientists are currently planning to transmit a concert by the Berlin Philharmonic Orchestra live to Japan.

CAMERA FLIES LIKE AN EAGLE

Breathtaking mountain peaks of the Alps – from the eyes of an eagle. These images come from the film "The Way of the Eagle", produced by Terra Mater Factual Studios of Red Bull Media House and premiering in cinemas in 2014. Viewers will experience an eagle's flight as an eagle, as the eagle was carrying a camera on its back during its daring airborne maneuvers. The camera, a flyweight at 70 g (a mere 2 ½ oz), was probably hardly noticed by the bird of prey, or at least did not impair its flight. Additionally, the camera is quite small. At only 25 x 120 mm (1" x 5"), it belongs in the miniature class of cameras. Nevertheless, its features are not miniature. It withstood extreme weather conditions during its flight, even snow at 2500 m (8,300 ft) – and delivered cinematographic-quality images sunrise to dusk.

The camera system, named INCA, originated in the labs of the Fraunhofer Institute for Integrated Circuits IIS in Erlangen, Germany. More precisely, what is involved in INCA is not just a camera, but instead a complete image processing system. It includes an Android operating system, for example, and can be expanded very simply with continually new apps for new functions. Its high computational processing power enables it to compute complex algorithms right in the camera. One example: the camera can perform facial recognition and later analyze it for a different application.

There are many applications for INCA. It could deliver additional image information during sporting events, for instance. The viewer can then "lay" into the curves with a motorcyclist, "jump" over rises with a mountain biker, or "overtake" the competition as an athlete. Sensors integrated into the camera measuring temperature, acceleration, and atmospheric pressure in real time deliver supplementary information to sporting enthusiasts.

MOVING PICTURES AT ALL LIGHTING LEVELS

Spotlights immerse the singer in bright light. Either the singer's face loses sharpness and contrast due to excessive brightness, or the rest of the band and the background disappear into darkness.

The engineers at Fraunhofer IIS applied themselves to this difficulty in recording technique and are introducing the prototype HDR camera for professional moving pictures. HDR stands for high dynamic range. Meaning, the contrast range between the brightest and the darkest pixel that the camera can capture is extended. The camera does this by simultaneously recording several different images with different photosensitivities at one time. During a post-processing step, the images are then automatically melded into a single HDR image with very high dynamic range. By not recording a sequence of moving images each with a different exposure time, ghosting arising in motion pictures is avoided. To accomplish this, the scientists utilized a special optical filter positioned in front of the image sensor that creates differing sensitivities. By irregular configuration of the filter, they attain similarly high local spatial resolution, but considerably greater dynamic range than with conventional cameras.

An additional solution offered for HDR that can be used with the existing sensors is configuring what is known as a camera array. This array is made up of several individual cameras with different neutral density filters in front of the lenses. By using a high-performance algorithm, the engineers can knit the various individual images together into a single HDR image. In recording situations where an individual conventional camera would be unable to cope with the complete dynamic range of the scene, this approach is a clever solution for providing optimal conditions to achieve good imaging.

FREE-SELECTABLE IMAGE COMPOSITION THANKS TO LIGHT-FIELD RECORDING SYSTEMS

More eyes see more – this applies to recording techniques on a production set as well. Camera operators today work with individual cameras or stereoscopic camera systems for 3D that fix important camera parameters such as position, viewing direction, depth of field, and angle of incidence for a given fixed viewing angle. The creative possibilities offered by these fixed settings are rather limited. The use of camera arrays changes that. This configuration, consisting of an array of many cameras, can capture part of the total light field – i.e. all of the light rays – of a scene. They do this by recording slightly different visual representations of the scene. Various effects or viewing angles can then be obtained from a single light-field image during post-processing.

The light-field media production system that researchers at the Fraunhofer Institute for Integrated Circuits (IIS) in Erlangen, Germany developed consists presently of 16 high-resolution HD cameras. During post-production, filmmakers are able to selectively edit the images and change the scenes, like the viewing angle for instance – as in the matrix effect, which permits actors to appear frozen in a scene while the camera moves about them. The viewing angle can be shifted as well as widened without changing the camera position. In this way, parts of a scene that would be obscured in a straight-ahead view can be brought into it.

Multiple viewing angles also allow virtual changes to the camera position. Without having to change the position of the camera array, the subject can be moved backwards or forwards from the viewer, allowing the camera operator to achieve a vertigo or a dolly-zoom effect. In other words, the operator can make a virtual camera movement and simultaneously adapt the focal length. In addition, the virtual stereo baseline for 3D films can be changed by computing two new views, yielding an improved 3D effect.

NEW HEVC CODING STANDARD

The Soccer World Cup will be upon us again in the Summer 2014. The path to Brazil will no doubt be long. Nevertheless, many fans will probably have the feeling of being there live. 8k resolution is planned for the games – that corresponds to 33 megapixels.

High-resolution televisions are already filling the shelves of home entertainment stores. While they have not achieved a resolution of 8k yet, they have a 4k display, also referred to as 2160p format. These have four times as many pixels as commonplace televisions today. However, this continually increasing number of pixels needs to be fed on suitable content in order to make best use of the capabilities of television. That is associated with enormous costs and is worthwhile only for large events, such as the World Cup coming up.

The previous standard for encoding data and transmitting it from television station to television set is known as H.264/ MPEG-4 AVC. This standard would theoretically have been able to handle the flood of data, but considerable costs arise when transmitting higher resolution video. An additional channel is needed for television transmissions and internet servers require larger bandwidth for internet streaming. Leading electronics manufacturers have therefore jointly developed a new transmission standard called High Efficiency Video Coding, or HEVC. An important contribution to the standard stems from the laboratories of the Fraunhofer Institute for Telecommunications, Heinrich Hertz Institute (HHI) in Berlin.

The advantage of HEVC is that twice as many pixels can be transmitted for the same bandwidth, and thus greater detail as well. The quality that the viewer experiences remains the same. How is this accomplished? "Many components of H.264 were carried over and optimized," explains Benjamin Bross, who is the main editor of the HEVC specification and is leading the HEVC project. "One example

is the block size. Where H.264 divides the image for transmission into blocks of 16 by 16 pixels, HEVC breaks it up into variable block sizes of up to 64 by 64 pixels. Larger blocks can be encoded more efficiently."

For instance, if an object seen in an image is moving sideways, this motion takes place smoothly. The standard therefore established a movement descriptor that is typically transmitted once per block. For larger blocks, correspondingly less movement data is necessary.

Development was completed in January 2013 and the standard was published in April 2013. In future, new equipment such as televisions, smartphones, and PCs will contain decoders able to convert data encoded as HEVC into high-resolution television images. The HEVC standard for 3D films as well should follow in about a year. In addition, video telephony should benefit from the new standard. It too was largely based on H.264 up to now. HEVC can significantly increase the image quality for the same data transmission rate.

HEVC in brief:

- Television resolution is constantly improving – new 4k displays have four times as many pixels as the TVs today
- More pixels need more data – so this must go hand-in-hand with transmitting the data more efficiently
- Reputable electronics manufacturers have now joined forces with Fraunhofer researchers to develop a new broadcasting standard for video compression: HEVC
- The HEVC Standard is twice as efficient as H.264, therefore a high quality film needs only half of the bandwidth.
- The Standard was published in spring 2013.

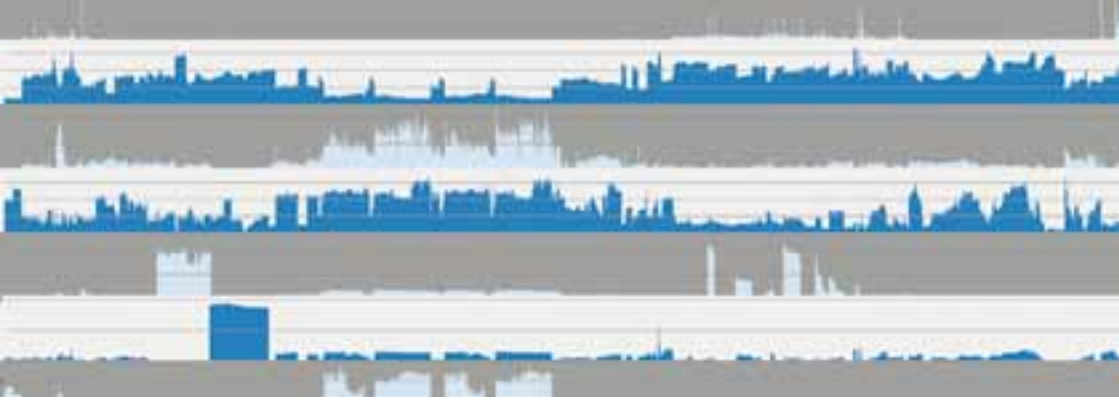
SIFTING THROUGH AUDIO AND VIDEO DATA EFFECTIVELY

Music programming, science reporting, the news – day after day, radio and television stations broadcast enormous amounts of data that subsequently rest in archives. Film producers must also keep an overview of an ocean of data during production. This is only feasible with automated methods of data analysis. By using the A/V Analyzing Toolbox, for example, developed by researchers at the Fraunhofer Institute for Digital Media Technology (IDMT). "This toolbox is a comprehensive collection of components for analyzing audio and video," says Dr. Uwe Kühhirt from the Fraunhofer IDMT. "It offers clients many modules that they can integrate into their solutions, depending on their requirements."

Raw footage, finished films, and videos are stored in broadcast archives. Error-filled recordings have no business here, however – they would only take up storage space unnecessarily. "Defects like bars at the image edges or silences in the soundtrack are often recognized far too late. This is because a staff member had to go through the image and sound material manually up to now. That not only takes time, it also increases the production costs. The modules for error recognition from the Fraunhofer Institute for Digital Media Technology IDMT in Ilmenau, Germany, help analyze all of the audio and video material automatically and continuously during the entire production process. This ensures that only material free of defects goes into subsequent production, is released, or stored in archives," explains Kühhirt

Videos and films in small helpings

Whether analyzing films or producing them, the first step consists of parsing the cinematography in the time domain. This function can be taken over by the Temporal Video Segmentation Module. If the film cutter receives a video containing raw footage, for example, the software breaks it into individual shots, i.e. into sections that were filmed contiguously.



The cutter then assembles the shots into scenes by appropriate cutting so that the desired effect is achieved. What is special about the module is the selection of the key frames – i.e. those images that are displayed as a representative summary of the shot and help to keep an overview in larger inventories of video. Most analysis programs choose these images randomly. They display the first, the middle, or the last image of a video sequence for example – which is not always very expressive or representative. "Our software chooses images that are as representative as possible of the shot," says Kühhirt. These are images, for instance, having high activity levels. In a static image, this level would be zero, while in a chase scene it would be very high. If the image has a high activity level, it is usually more expressive and representative than one with a low level.

Mountains, beach, or city?

The semantic video analysis modules figure out what kind of content is contained in videos and films. It categorizes videos according to their visual design – for example day, night, or twilight, and indoor, outdoor, or landscape. They then analyze whether the scene takes place at the beach, in the mountains, in a forest or in the city. "The recognition system must be trained for each query so it can adapt to the requirements of the customer," according to Kühhirt. In other words, the researchers must feed the software with appropriate examples of each query and teach it.

Determination of the musical parts

How much music is present in a television or radio program is of interest not just to the listeners but to the copyright utilization companies as well. Until now, the stations have been paying certain lump sums. These will be replaced over time with detailed accounting models, however. That means that the proportion of music in the entire program must be precisely evaluated in the future. This is the only way to determine the fees in each case. "We have developed a solution that can differentiate between the categories of speech, music, and music containing "speech and silence" in audio signals. This way, we can automatically evaluate programs," says Kühhirt.

MOBILE SURROUND SOUND AND MORE

Consumers are familiar with surround sound at the cinema or from their home theater system, but until recently, that is where the experience ended. After years of research and testing, theater quality surround sound is now a reality for mobile users thanks to Fraunhofer Cingo. With Cingo, built-in stereo speakers or headphones deliver high-quality surround sound on mobile devices giving consumers an unprecedented mobile audio experience.

How does Cingo work?

Cingo technology was developed by the world renowned audio and multimedia experts at the Fraunhofer Institute for Integrated Circuits (IIS) in Erlangen, Germany. Cingo processes sound in a way that dramatically improves users' surround sound entertainment experience on mobile devices.

"When traveling from speakers to our ears, sound undergoes several changes such as the audio waves reflecting off walls, for example," explains Harald Popp, head of the Business department of the Audio and Multimedia division at Fraunhofer IIS. "The audio signal captured by our ears therefore also contains information about our aural environment, in addition to the musical and lingual information. Furthermore, sound waves are modified by our head and pinnae, depending on the different directions the waves come from," Popp added.

With Cingo, these changes to the sound waves can be replicated using digital filters. If these filters are applied to audio signals that are reproduced over small speakers or standard stereo headphones, a soundscape develops that resembles a home theater system. Built-in optimization of sound volume and intelligent tone control creates the best possible sound from stereo and surround-sound content, even with small loudspeakers and headphones and in the presence of high ambient noise as well.

Google's Nexus 7, launched in July of 2013, is the first mobile device to natively integrate Cingo, allowing mobile users to immerse themselves in music and movies with surround sound on the go. Cingo will also be found on other devices within music or video player apps from various service providers. This is because the hardware, i.e. the loudspeakers or headphones, do not have to be altered.

The efficient delivery of surround sound to mobile devices is made possible by the High-Efficiency AAC (HE-AAC) audio codec. HE-AAC was co-developed by Fraunhofer IIS and is found in more than six billion devices. It is today's most efficient audio codec for high-quality stereo and surround sound and is natively supported in important operating systems like Android, iOS and Windows. In Android 4.1 and later, HE-AAC is the only native surround sound codec. This enables playback of high-quality 5.1 surround content from Android phones and tablets connected via HDMI to a home theater system.

Audio technology is moving primarily toward greater flexibility for the end user by utilizing technologies like Dialogue Enhancement. Through Dialogue Enhancement the viewer can adjust the volume level of speech separately from that of the rest of the audio signal.

Future trends

In addition to greater flexibility, audio today and in the future will be based on applications and services that rely on an highly efficient transmission of audio and video content to deliver the best possible media experience at any given data capacity. For example, in order for digital radio to offer as many stations as possible with good sound quality and low transmission costs, lower data rates are necessary. The Extended HE-AAC (xHE-AAC) codec, co-developed by Fraunhofer IIS, is the first audio codec with the ability to encode speech as well as music at extremely low data rates, thereby facilitating transmission of additional programming in the broadcast.

DCP – THE DIGITAL CINEMA FORMAT FOR EVERYONE

Leonardo di Caprio, Bruce Willis and Cameron Diaz – none of them are captured any longer on traditional film reels during filming sessions, but instead have been recorded digitally for some time now. Before films are able to fascinate the viewer in a movie theater, they have to be converted to the appropriate format. The reason: about ten years ago, studios in Hollywood worked out a worldwide standard for digital cinematography called the Digital Cinema Package, or DCP. This standard was meant to guarantee that movies continued to possess higher entertainment value than home television, even a few years hence – and that cinema enthusiasts would continue to make the pilgrimage to movie theaters. The standard sets down exactly how the data for the big screen should be packed – for example, how they must be encrypted so that they cannot be viewed outside of the movie theater. The encryption and the conversion to the DCP format is a very complex procedure that only experts had command of until now.

However, a path has been opened up for all those interested in digital movies. They can now convert film content to DCPs in a simple manner themselves using easyDCP software, developed by the researchers at the Fraunhofer Institute for Integrated Circuits IIS in Erlangen, Germany. "Using our software, even non-experts are able to produce this standard in a few simple steps – and thereby suitably convert their own films or advertising recordings," says Heiko Sparenberg, group manager at IIS. Scientists first introduced easyDCP four years ago and already many customers worldwide are using the software. According to estimates, the software is in the top three and may possibly even be the leader in this niche market.

www.easydcp.com

The number of users may significantly climb again in future. As Blackmagic Design Pty. Ltd. recently announced, they are integrating easyDCP into their

DaVinci Resolve 10 software. Blackmagic is a leader in the area of digital post-processing of film scenes, especially with regard to color correction. Integration of easyDCP facilitates the users' work. Until now, users who have received data from production – i.e. from the set – have immediately processed it in DaVinci Resolve. They have cut it, color corrected it and assembled the respective scenes into film. Once these processing steps were completed, they had to copy the data to a harddrive in order to subsequently convert it with easyDCP into digital cinema format. With the enormous quantities of data, this represented a tedious as well as costly affair. "By integrating easyDCP into DaVinci Resolve 10, it made the intermediate save to harddrive superfluous. All the processing steps can take place within one program, from the raw data, to the cutting and color processing, right to DCP conversion. And all with the highest possible quality," explains Sparenberg. The easyDCP plugin should also be available as soon as Resolve 10 comes on the market.

easyDCP is not the only software that supports users in converting to the DCP standard. "However, easyDCP has shown itself to be very reliable over recent years. Films created with our software are running on projection systems worldwide. In addition, the software is easy to operate, which is what it has built its great success on," says Sparenberg.

3D INNOVATION CENTER

3D – is not just for blockbusters from Hollywood, 3D also helps Germany advance its traditionally strong economic sectors like automotive and medicine. However, what does the future hold for 3D? What was missing up to now was a place where various influential experts could meet, test and present new technologies, and discuss business models and market strategies with one another. Brainstorming is not a solo activity.

The 3D innovation Center offers a communication platform for providers and users as well as a marketing tool for advertising and sales – in the form of joint presentations at trade shows and conferences, through joint distribution, and overall public relations.

Through active collaboration in working groups, the Center also becomes the development and testing platform for 3D technologies, applications, and infrastructure. Experts can share their knowledge and different areas of expertise in workshops and seminars in cooperation with universities and business.

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FRAUNHOFER DIGITAL CINEMA ALLIANCE

Fraunhofer Institutes in the Digital Cinema Alliance jointly offer innovative solutions and products for the transition to the digital movie and media world of tomorrow. The Institutes in the Alliance are available as renowned contacts and partners for all of the digital topics connected to digital media, digital movies, and standardization, as well as new cinematography, audio, and projection technologies, post-production, distribution, and archiving. The goal of the Fraunhofer Digital Cinema Alliance is to quickly and easily help find the right contacts, partners, and suitable technology.

The Fraunhofer Institute members are
- Digital Media Technologie IDMT
- Integrated Circuits IIS
- Telecommunications, Heinrich-Hertz-Institut HHI
- Open Communication Systems FOKUS

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