Mobile App-Support for Advanced Digital Video-Assist Systems in Computer-Supported Film Sets

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Abstract

The paper discusses the PSU®-3 X HD video assist system developed by Vantage Film and highlights the PSU® Satellite, an iPad-based client with specific mobile video-assist apps. The philosophy behind Vantage Film's video assist technology is to model all cameras, assistance devices, and roles of the film crew in a collaborative way in order to arrive at a computer-supported film set (CSFS). The paper examines the structure of the CSFS, the functionality of the PSU®-3 X HD, and the PSU® Satellite that eases the work of directors and directors of photography and enhances the user experience of the whole crew.

1 Introduction

Post-production digital support for spectacular visual-effects-driven movies like Avatar or Star Wars Episodes I to III is well known by the broad public for decades. Today, however, even serious film makers like Wim Wenders or Roman Polanski use digital video-assist systems directly on the film set in order to support the production process of their feature films, the rendering and pre-screen simulation of special effects, and to improve the user experience of the film crew and the actors right from the beginning of the shooting. Digital video assist systems also play a significant role in the advertisement

business, where every year many thousands of TV spots and commercials for cinema and the Web are produced with digital on-set support.

A computer-supported film set (CSFS) combines video recording features with simultaneous multiple camera support (fig. 1), intelligent software functionality for on-the-set effects simulation and rendering (slow-motion, time-lapse, ramping, filtering, mix-and-overlay of takes, blue-, green-screen effects, editing, 3D support, etc.), shooting day organization, rehearsal mode, and hard- and software-support for active camera control and communication (cf. Märtin/Prell 2003).

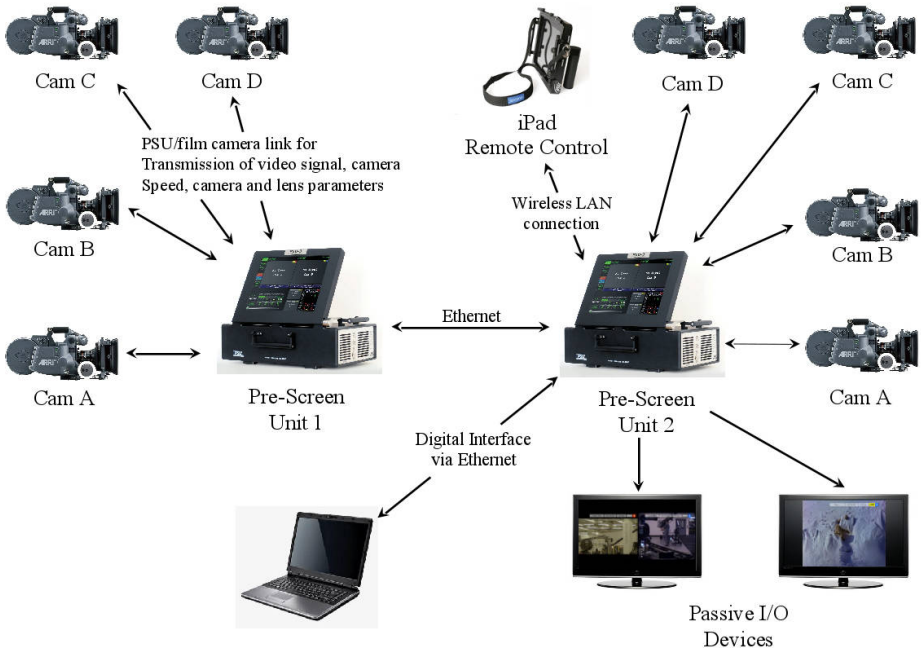

Figure 1
Computer-supported film set based on the PSU®-3X HD digital video-assist system

The CSFS based around Vantage Film's PSU®-3 digital video assist product (cf. Märtin/Prell/Kesper 2009) is now extended by PSU® Satellite, an iPad-based client with specific mobile video-assist apps that significantly raises the flexibility and the overall working quality of the people on the film set (cf. Stein 2012). Improvements to the main system's hard- and software performance as well as advanced communication features have led to the current system version, the Vantage Film PSU®-3X HD, released in 2013. The Linux-operated, touch-screen based PSU®-3X HD, currently one of the world's most advanced video assist systems (cf. Fauer 2013), the structure of

the CSFS, and the mobile client will be covered in more detail in the following chapters.

2 Related Work

The idea of storing a video version of the shot film on conventional video recorders dates back to the year 1956, when actor and comedian Jerry Lewis had the idea for previewing the shot takes on video. Today's hard disk video recorders store the video-assist signal received either from the integrated video system (IVS) embedded in the view-finder of conventional electronic film cameras (e.g. from ARRI, Panavision) or directly via the HD-SDI interface from advanced digital film cameras. The video assist-signal always shows the view as seen by the camera operator through the currently mounted lens.

Whenever conventional analogue electronic film cameras are used the video-assist signal typically is transmitted in PAL or NTSC resolution. Only very advanced analogue cameras offer HD video resolution in their IVS systems.

As can be seen with contemporary high-resolution digital film cameras, the recorded material of only a few minutes of footage is already too large to be stored directly with the camera. Huge fault tolerant storage servers are needed to store the hundreds of terabytes of digital raw images resulting from films that are shot with 2 K or even higher resolutions. In contrast to MPEG 2 compressed videos, each single frame of a digital film has to be stored separately and in full resolution in order to allow for the high optical quality needed when the film is copied and reproduced after post-production. The recorded raw material is not directly available for replay.

When advanced digital film cameras (e.g. from ARRI, Red, DALSA, Panavision, Sony) are used in a project, a digital video signal with a lower resolution than the image shot by the digital camera is directly transmitted from the monitor output to the digital video assist system via the HD-SDI interface.

Thus, no matter whether analogue or digital film cameras are used, a modern video assist system allows for easy playback of takes in high image quality and for better administration of the thousands of recorded takes, long before the developed celluloid film or the high-definition digital raw images become available for post-production. Note, that in order to make the shooting process less expensive and allow for recording all the takes of a project

lasting for weeks or even months, video-assist devices, like the PSU®, offer the option to compress the recorded HD-signals down until a ratio of 1:10.

Although even large projects often use hardware device and software configurations individually tailored by freelance video operators as video-assist systems on the set, several years ago, an evolutionary development was initiated towards extremely powerful and more standardized high-end systems like the fully custom designed Vantage Film[1] PSU® device running under Linux or the QTAKE[2] devices running on Apple Mac hardware under OS-X. This has led to better usability and more professional support of the staff on the set.

3 Computer-Supported Film Set

A CSFS is organized as a network of computer and film equipment devices (see fig. 1) which are controlled by a high-performance film server component, e.g. the PSU®-3X HD (pre-screen unit, based on high-performance computer hardware and CSFS server software). The PSU®-3X HD uses embedded technology constructed around an energy-efficient quad core Intel Core-i7 main board. The system uses custom-designed HD video grabber cards and video-output image splitters as well as specific communication hardware and high-capacity SSD storage. It features additional electronic and mechanical hardware for robustness and environment control. The PSU® film take server, the video assist software, and the user interface are running under the Linux operating system.

Each PSU® may record and control up to four digital and/or analog film cameras simultaneously and can be connected to other PSU®s by WLAN in order to establish a consistent database for the film takes stored in a distributed fashion. Other devices are configured as *passive I/O devices* (e.g digital or analog TV-out monitors) or as *active clients* (PSU® Satellite based on iPad hardware and a CSFS client app) that interchange video data with the film server via WLAN, and can independently support the tasks needed on the film set.

To allow for an effective and efficient interplay of all the roles and an optimized work flow on the film set, the original computer-supported film set was developed using a combination of contextual design, agile development

1 http://www.vantagefilm.com <2013-09-13>

2 http://qtakehd.com <2013-09-13>

and task modeling. Film experts, DoPs, camera operators, directors and computer scientists cooperated in the initial phases of the project (cf. Märtin/ Prell 2003) and for each evolutionary product version in order to arrive at a sustainable and usable solution with little learning effort for the video-assist operators and the best possible user experience.

3.1 Usability Requirements

Apart from the enormous hardware performance needed for the real time behavior and film-related functionality, the usability requirements for the video assist system constitute a great challenge for the involved software engineers and user interface designers. A typical characteristic of the movie production staff is their dislike of mouse and keyboard interaction or applications with the look-and-feel of desktop-oriented business applications. Rather a user interface similar to the user interfaces of consumer electronics devices, like DVD players, might be accepted (cf. Petersen et al. 2002). With the advent of tablets, smart phones, iPhones and iPads, users expect video assist technology with similar input behavior.

Figure 2 PSU®-3X HD main screen recording four cameras simultaneously

All generations of PSU systems since the first product, the PSU-1 released in 2002, share a touch-screen based user interface. Complexity of the overall software functionality is hidden from the user by applying a layered user interface model that presents a standard video assist surface ready for shooting directly after startup. The user interface hides the more advanced features in deeper layers. Figure 2 shows the user interface of the recently announced PSU®-3X HD. The overall user interface and the usability design challenges of the family of PSU-systems are discussed in Märtin/Prell/ Schwarz (2005).

In addition to the presentation of the functional tasks with the specific look-and-feel characteristics of the PSU® video assist system, the user interface is responsible for the administration of the recorded takes and edited sequences (storing video data with or without sync-sound, searching, editing single takes, combining/editing multiple takes, deleting video data). The organization of a complex film project should not require a conventional database and query interface, but rather allow the retrieval of takes in an intuitive, visually supported way. Nevertheless, it must be possible to also store with the film takes relevant textual shooting information (e.g. lens parameters, lighting conditions, location information, etc.) that may later serve for the content-based retrieval of specific takes.

3.2 Contextual Design Approach

The design of a CSFS that is accepted by professional film crews has to adapt to their contexts of use and to their view of equipment devices as aiding tools that practically do not require any learning effort. In order to arrive at a solution that serves its purpose and meets the usability design challenges, all PSU® products were developed by a joint team of computer scientists and film professionals partly using a contextual design approach (cf. Beyer/ Holtzblatt 1999). The rich software features and the complex interaction behavior of the different CSFS devices require highly usable and self-explaining interfaces. Like for any software-controlled system, new software releases for the CSFS based on the PSU® video assist system offer additional or advanced functionality for the users. To ensure the best possible user experience, it was a design guideline over all generations of PSU® systems to enable a smooth evolutionary migration from the well-known features of an existing software version to the broader, more complex functionality of each new release.

The CSFS hardware and software is embedded into the overall environment on the film set, e.g. a network of cameras with mounted lenses, video screens, studio equipment, lighting etc. User-centered design for such an environment means that the control of the communication between computer-based CSFS components (e.g. PSU®s, PSU® Satellites) with the rest of the equipment (e.g. movie cameras, video monitors) follows the shooting workflow for standard filming situations.

For situations where CSFS hard- and software technology allows intelligent new methods of interaction of users with their equipment (e.g. access to multiple cameras controlled by different PSU®s), flexible new ways of equipment control or completely new action sequences should already be represented in the underlying task models.

4 PSU® Satellite Video-Assist Apps

The PSU® Satellite video-assist apps for the iPad (fig. 3) enable a new way of interacting with the PSU®-3X HD. Currently the Satellite comes with two independent applications, one for the management and review of already shot takes (fig. 4), and another for looking at live streams, remote control of the PSU® and wireless communication with PSU®s (fig. 5). For the future release a whole *PSU® App Collection* is under development.

An advantage of using such a mobile client on the film set is the improved flexibility for the crew. Users, e.g. directors or directors of photography, can walk around on the set and at the same time watch individual combinations of several live streams and recorded takes. The video data is compressed first and transmitted over WLAN in real time from the PSU® to the Satellite where it is decompressed again. To allow for real time transmission of up to four live images from the PSU® to the Satellite, extensive optimization of the graphics handling algorithms, the GPU firmware, and the load-balancing between the four CPUs on the PSU® side, and between the two CPUs on the iPad side were necessary. But not only the image data is transmitted. Also the sound of live streams or already recorded takes can be heard by the user of the mobile iPad client.

Besides that, it is also possible to mix up the sound data of a currently streamed take or the live signal with the instructions of the director sitting in front of the PSU® digital video-assist. This is possible due to the integrated *Director's Communication* feature. This enables users of the CSFS infrastructure extended by the Satellite to talk in a bidirectional manner like over a walkie-talkie. The technical implementation depends – among other aspects

– on a newly defined data protocol whose structural description will not be covered in this paper.

(a)

Figure 3 (a) PSU® Satellite device; screenshots: (b) dual camera live stream, (c) take selection

(b)

(c)

To switch the active camera channels on the PSU® side as well as starting recordings or browse through the takes stored on the PSU® some control elements on the PSU® side may also be activated for the iPad client. Of course the activation of these buttons has to be configured on the PSU® side to prevent unwanted and unauthorized disturbances through a third person. Another problem which also had to be considered is to guarantee button state consistency, i.e. that a button pressed on the PSU® is shown as pressed on the iPad screen and vice versa. The relevant information about the state of the control elements of the PSU® device is sent to the mobile client, which processes this information in an appropriate way.

Like mentioned above, one of the available apps is the so called *Take Manager* (fig. 4). It combines the convenience of reviewing shot takes wherever the user wants with the ability to store the takes persistently and organize and manage them directly on the Satellite. As every user has his or her

own notion of the term "well ordered" the users can feel free to create and name directories for faster location of the managed stored takes. To store downloaded takes located on the PSU on the iPad's integrated storage, users can send data request commands.

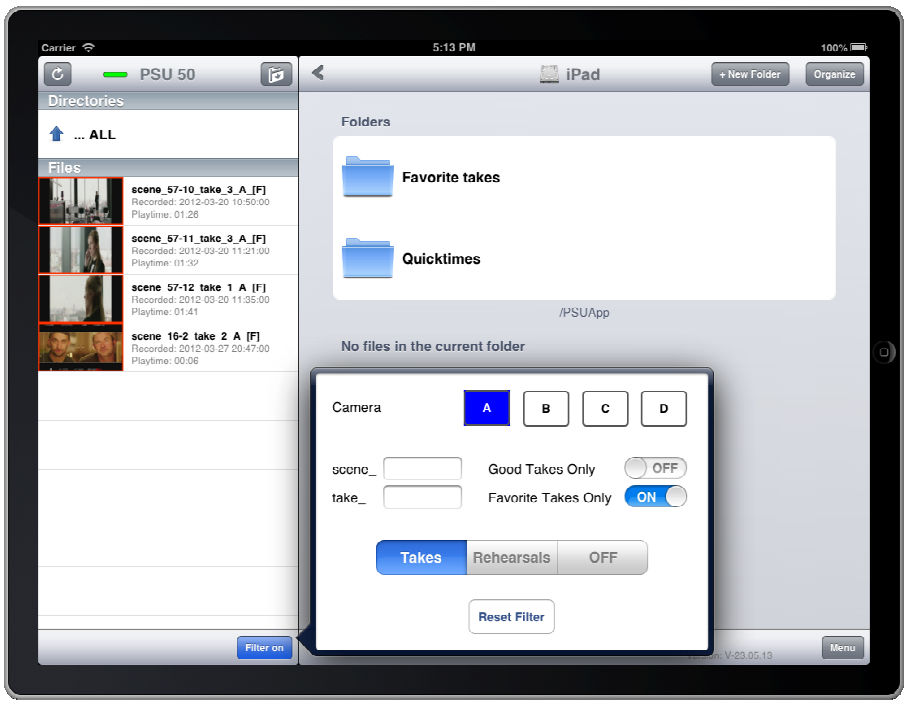

Figure 4 PSU® Satellite Take Manager app

Because it is not an unlikely case that a large quantity of takes is available on the PSU®, the Satellite Take Manager comes with a filtering option. Thus users can browse takes in a more detailed fashion, i.e. select a particular camera, show only takes with a favorite tag, a rehearsal tag or simply search for a certain (sub)string within the takes' names.

Besides for allowing bidirectional conversations and capturing live streams of up to four independent cameras or two hard disk channels, the *Satellite Video-Assist* app (fig. 5) comes with some additional features, like take browser support, take filtering, frame-by-frame skip mode, anamorphic desqueezing of displayed images, remote control of the PSU®-side and switching between available PSU® servers.

Figure 5 Satellite Video-Assist app (buttons can be hidden with a single finger tip)

Switching can become necessary when more than one PSU® is used on a computer-supported film set and data is requested by the Satellite from different PSU® video-assist systems. Therefore the Satellite clients have the ability to switch to another PSU® on-the-fly without the necessity of terminating the app through some uncomfortable finger gestures.

Of course, the apps are designed to follow the concept of (pseudo-) multitasking which is defined by Apple. Unfortunately, Apple restricts the communication window exploitable by app developers to a very limited ten minute background time window at maximum. So the upcoming conesquence that a download of a very high quality take which – under circumstances – could last longer than ten minutes, has to be considered in the future.

5 Results and Future Work

In this paper some architectural, functional, and mobility aspects of a real world computer-supported film set based on the current product version PSU®-3X HD of Vantage Film's digital video-assist system and its iPad-

based extension, the PSU® Satellite, were discussed. It was shown, how the mobile client with its specifically tailored video-assist and remote control apps significantly extends the flexibility of the overall system and at the same time can raise the quality-level of the user experience felt by all members of the production crew on the film set. Partly responsible for these satisfying results is the division of work between the PSU® main device and the iPad-based client device. The greater part of the heavy computational load accumulating when up to four (HD-) videos are grabbed simultaneously, up to two disk playback streams are executed, and video-operator control interactions happen at the same time, is mastered by the PSU® main device with its high-performance quad-core mainboard, FPGA extension boards for grabbing and image splitting and fast SSD storage disks.

The iPad-based Satellite extension contributes to the overall performance by offering all the gestural and graphical interaction capabilities of the iPad to remotely access the PSU®'s video-assist and film take server functionality over a WLAN interface. For this purpose fast and flexible communication mechanisms had to be included into both the PSU®'s server and user interface software as well as in the Satellite apps' data exchange functionality.

Although all members of Vantage Film's PSU® family since the first product, the PSU®-1, launched in 2002, were operated by a touch-screen-based user interface, the new experience gained from the intensive work with the iPad software and user interface development environment, has also inspired some new gestural (multi-touch) interaction techniques for the PSU®'s current and future touch-screen user interface.

The future evolutionary development of the CSFS will also pave the way for even higher video recording image resolutions, direct interfaces to the raw data film take storage, and advanced support tools for the post-production process.

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