Producing and Broadcasting Non-Linear Art-Based Content Through Open Source Interactive Internet-TV

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ABSTRACT
The development of an interactive Internet-based TV system designed to cover the broadcasting needs for new media artwork introduces various complexities across the organisation, production and interaction forefronts, as live interactive installation art and multi-sourced multimedia content poses particular presentation requirements. Our work presents and discusses real-life strategies and solutions employed during the development of iMediaTV, an open-source academic broadcasting system that permits various presentation modes to be employed, extending the presentation needs for artistic and non-uniform content. We demonstrate how an open-source Internet-based production/broadcasting system may be customised to include advanced content enhancing features, enabling interactive new media arts presentation over the Web.

Categories and Subject Descriptors
J.5 [**ARTS AND HUMANITIES**]: Performing arts; **H.5.1 [Information Interfaces and Presentation]:** Multimedia Information Systems

General Terms
Performance, Design, Experimentation, Human Factors, Prototyping.

Keywords
Interaction, New Media Arts, Broadcasting, Experimental Content

1. INTRODUCTION
Presenting a high-definition movie featuring surround audio and high-resolution imagery intended for cinema through a standard-definition television with internal speakers clearly offers a rather limiting experience to the viewer. Similarly, broadcasting new media arts content [8] such as live performances and interactive installations is a task that presents special presentation requirements [12]. Particularly when this task is realised through proprietary technologies utilising fixed broadcasting standards it may result in reduced audio-visual presentation quality [3] while interactive features may not be supported. Clearly, the broadcasting medium's reduced capacity for appropriate content reproduction capabilities may be identified as the main reason for reduced presentation quality, while researchers have already recognised the evolution of TV systems towards interactivity [5].

Advances in multimedia and content representation [10], streaming [11] and broadcasting [14] need to be employed in order to expose content with particular presentation requirements to either students who may use it as an Open Educational Resource (OER) [2] or to wider audiences. Presentation deficiencies are amplified when artists introduce interaction requirements that cannot be catered for by existing passive broadcasting technologies and methodologies.

Our work discusses the particular requirements and capabilities offered by the developed Internet-based interactive broadcasting system (iMediaTV) [6], customised to allow broadcasting of content in the field of new media arts, supporting adaptive presentation modes. Our approach offers a fully customisable broadcasting paradigm supporting interaction at various levels and modes: viewer-studio, viewer-stream, viewer-camera angle and direct user interaction with the artwork.

Figure 1. The user-interface of iMediaTV combining various content-access and interaction options over a uniform Web-interface.

As opposed to the fixed television broadcasting setup which is still highly influential [14], the open source basis employed in our implementation allows various modifications to be implemented from the server-side in order to cover particular presentation requirements that could not be foreseen at the time of development. For example the end-system supports the need to broadcast non-standard aspect ratios and resolutions, a typical presentation scenario under video art. In addition, the combination of interaction with narration is also supported [16]. Rapid development was a critical issue, while cross-linking of various technologies under a common user-interface was the principal target, covering both functionality and aesthetical system requirements. In terms of aesthetics, the use of web-

EuroITV'11, June 29–July 1, 2011, Lisbon, Portugal.

interface technologies including Cascading Style Sheets (CSS) allows the interface to be adapted effortlessly. The end-user interface is accessible through http://www.imediatv.eu (see Figure 1) offering the following options: “Interactive TV”, “News in Text”, “Program”, “Video Archive”, “User Settings”, “Submit your Content”, “BackOffice Access” and “Contact Us”.

This article discusses the experience gained in the design and development of the end-system, which is actively used today to cover special presentation requirements of the student-artists of the department of Audio and Visual Arts, Ionian University, Corfu, Greece. Section 2 discusses particular artist and artwork presentation modes featuring real-life scenarios, while Section 3 presents the system-setup and discusses how each mode is supported and how dynamic component re-use may cover varying content requirements in parallel. The article is concluded in section 4.

2. ARTWORK PRESENTATION MODES

When the task in hand is to classify the presentation requirements for new media artworks, it is important to identify and categorise the content according to media types. The collaboration of artists with researchers [4, 7, 9] has generated rich and mixed media types, even introducing new challenges in the development of art [15]. We focus our analysis in three generic content types: video art, live performances and interactive installations. Artworks lying between the above fields may adaptively utilise solutions from each field in order to cover their presentation requirements. Each type displays varying levels of customisation that range between screening modes of increasing complexity: static presentation mode, dynamic video editing and interactive content exploration. More complex cases usually may be broken down to the three basic individual components.

2.1 Video Art

Video art is in most cases produced in digital files already formatted in DV 4:3 or 16:9 video modes with appropriately encoded audio, that do not require further conversion. Under this scenario, content is usually ready to be broadcasted through Internet TV and the multicast server should only be adjusted to utilise the appropriate audio-visual transmission protocol, frame rate and resolution mode.

For video art instances utilising non-standard compression, screen modes and audio formats, it is necessary to plan the appropriate course of action. The digital conversion process followed resembles the conversion of old cinemascope films for television where in order to display the whole video width, the longest horizontal dimension was stretched to the edges of the frame, while the vertical dimension was compressed in order to retain the original video’s aspect ratio. This introduced large unused areas in the screen, which were then blanked out in black background colour. Similarly, in the case of sound, systems used for playback that do not have the necessary audio definition or directional capabilities result in degradation of audio quality or in the case of less audio channels, reduction in directional effects.

In order to overcome these deficiencies under our content deployment strategy, we introduced an XML accompanying file stored at the server that records the minimum audio-visual system requirements that need to be used in order to allow full stream reproduction at the intended quality. When the users access each audio-visual recording, they are presented with the option to either adjust their video and audio player appropriately, or simply receive and display the content in standard quality mode. From the visual broadcasting point of view, video dimensions are fully adjustable at the client’s side under Internet broadcasting scenarios; each stream is adjusted automatically by streaming the appropriate header information to the player of the client. This is implemented in the on-demand scenario, while the live streaming version follows a strict media format. Similarly, when the client does not support an audio-rich presentation, audio channels are reduced to stereo.

2.2 Live Performances

Live performances introduce complex production and broadcasting problems. Although the performance scenario or general idea and key actions may be planned in advance, the performer and audience responses are usually impulsive, do not last long and it is not always easy to capture all the action with cameras, due to the spontaneous nature of events.

The suggested coverage methodology for these scenarios begins with careful planning for the multi-camera crew in order to be warned ahead and capture the interactive aspects of the performance. In other words, cameras and technicians are “choreographed” within the live event. Multiple cameras are used to record various angles and each individual video stream may be used for three purposes: live broadcasting of the event with a stage director, direct online interactive streaming where the user selects the viewing angle and finally interactive offline in the form of an edited version offering interactive features that may include multiple camera views.

Figure 2. A performance produced and broadcasted both live and in interactive modes as a test case study.

A real life example is shown in Figure 2, where an interactive performance is recorded using multiple-cameras and broadcasted live enabling users to dynamically select a camera view [1]. Camera choice was implemented by accessing the appropriate video stream that was broadcasted in parallel via the Internet. This permits the parallel utilisation of an internet-based broadcasting system for live performances enabling remote user access. Ultimately, an interactive DVD was produced allowing dynamic camera selection at any point of the video, through the “camera angle selection” option offered by the device’s controller. Similar functionality may be implemented with pre-recorded multi-

sourced content where the proposed system is used to provide a supporting presentation platform.

2.3 Interactive Installations

Interactive installations pose additional complexities than the previously examined cases, as the audience usually communicates with the system dynamically without following a necessarily ordered pattern. For example in the case of the interactive video installation entitled "Invisible places – immense white" [13] biometric activity is utilised to detect what state the user is in: relaxed or stressed. The collected data are then used for the adjustment of the audio-visual environment, and direct interaction with the artwork, via direct drawing of the user's state in the work in the form of a line (see Figure 3, left screen).

This installation consists of five synchronised screens that project a continuous and dynamically adjusting/rendering video sequence in an attempt to affect the user's stress levels, under a cinematic audio-visual scenario. A corridor where each wall is a reverse-projection display, leads to a cyclic projection comprising of three arc-shaped screens. An appropriately edited 3600x576 resolution video is displayed across the five screens, while on the left corridor wall the user's stress level is drawn dynamically.

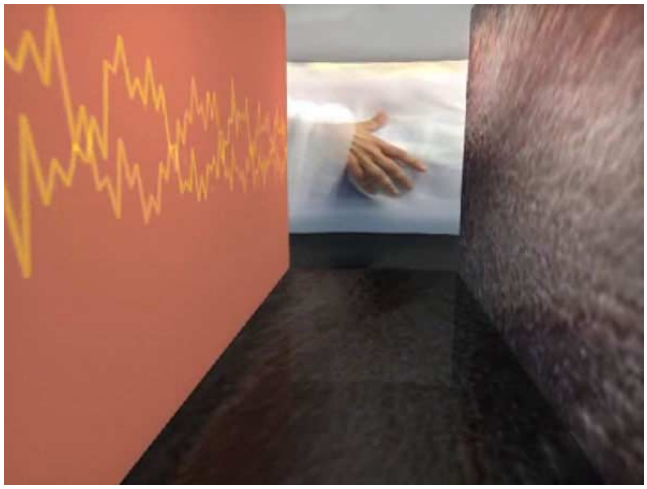

Figure 3. The entrance of the interactive video installation.

Brainwave activity used to dynamically draw the line was measured by customised wearable head-mounted sensors (iCubeX http://infusionsystems.com/) enabling free visitor movement within and around the installation. User-system interaction under the currently examined project extended beyond the development of a simple action-response system to a fuzzy decision process that temporally tracks, senses and plots directly in the artwork the state of multiple users that experience the environment.

Complexities are introduced when one attempts to select the correct presentation strategy for this particular type of content. Traditional filming of the environment displays only certain instances of the works. Its time length extends over five minutes, complicating matters further, as the director of such a presentation has to focus on specific aspects displayed at different times. The problem is addressed using multiple camera views covering at particular areas of interest, including a synchronised play through version displaying all screen simultaneously in the form of a video array. Interactive camera selection allows the user to navigate in space either live at the time of the event presentation, or in recorded mode, viewing user responses.

3. SYSTEM DESIGN

Under typical capturing/editing/broadcasting scenarios a centralised director –based configuration is commonly employed, enabling direct editing for live events or offline processing and editing of multi-camera sourced content. The single-view end-result of this process may be broadcasted either live or on-demand. The proposed system supports this organisation while it offers various interactive capabilities to the viewer, permitting advanced interaction modes to be realised: live events may be viewed either by selecting the directed version or via direct camera access while interactive user to studio feedback is supported and offline multicamera-based events may also be viewed in an interactive selection manner without interaction.

Table 1 summarises the presentation modes that may be called upon for different art content instances. Content complexity may vary anywhere between simple streams featuring pre-recorded video art (static), to professionally-directed or user-directed live performances and interactive installation art that may call upon multiple presentation modes, depending on artwork interaction requirements. Under each new media art category, one may decide to employ all or some of the presentation modes listed, while their combination may cover instances with rich interactive requirements.

Table 1. Presentation and broadcasting modes that may be employed for varying content types

Presentation /Broadcasting Mode	Video Art	Live Performance	Interactive Installation
Static Media (DVD)	Yes	Yes	Yes
Static Interactive Media (iDVD)	No	Yes	Yes
Live Streaming Media (User or Professionally Directed)	No	Yes	Yes
Multiple Cameras (User-Directed)	No	Yes	Yes

Figure 4. Live mixing and broadcasting setup at the studio.

A typical studio setup is shown in Figure 4, complete with the editing console, audio mixer, DVD player and cameras, while servers are accessed remotely over the Internet.

In the technological forefront, existing studio equipment had to be utilised in multiple modes under the system implemented. For example, output from each camera was transferred simultaneously to the mixing console for online editing, broadcasting and file capture and to the server supporting direct interactive camera access remote users. The file captured was subsequently used for the production of the standard DVD and interactive multicamera iDVD versions.

Broadcasting is realised covered using the multicast protocol and low-end personal computers for individual servers. The open source software used for the server application utilises the MPEG-4 and H264 codecs [11] that support dynamic video adjustment on the fly. The system was tested using a 24Mbps DSL connection line and the average network latency for full 4 stream broadcasts in parallel averaged close to the 10-second mark.

The requirements of such a system for experimental use involve the use of standard studio equipment: SD or HD cameras, an audio mixer, a video/live effects mixer with microphones and a computer supporting the desired encoding frame rate and multicast encoding and transmission process. For large-scale projects, dedicated encoder and server computing units should be used in order for a minimum of 24 fps frame rate to be sustained.

4. CONCLUSION

In this work we discussed particular production issues that arise when capturing and producing content in the area of new media arts. Generic artwork types include video art, live performances and interactive installations all of which pose challenging requirements in terms of capturing, presenting and broadcasting to the audiences. Interaction is another aspect that was covered, as particularly in live events user-feedback is limited when proprietary broadcasting modes are utilised. In this context, we implemented an adaptive broadcasting system for the combination of various content-access, that supports advanced Internet-based interaction options. This may be configured in multiple modes covering the presentation requirements of generic and intermediary artistic content types, an approach that supports both proprietary and customised production scenarios and does not limit the author creativity to specific broadcasting standards.

The paradigm introduced in this work may be employed under multiple scenarios: research, educational, experimental and commercial. Under the research perspective, the variety of interactive capabilities offered may aid the evolution of television as an interactive Internet-based medium as the implemented system combines features from both fields under a single platform. From the educational perspective, the infrastructure may be utilised as an Open Educational Resource (OER), permitting the presentation of live interactive content that under standard non-interactive broadcasting would require professional directing and editing.

Future system enhancements will be oriented towards the development of a uniform and adaptive interface that caters for particular stream types by direct and automated adjustment of the data presentation options available. This task includes the development of a content-based search engine in order to facilitate retrieval of archived and live content, supporting customised content-based and social context queries originating from social software. Artistic content characteristics and presentation requirements should be analysed further, enabling specific system features to be mapped directly to specialised applications. These may result in the utilisation of different system features under a live performance and an installation art scenario, enhancing further the user-experience.

5. REFERENCES

1. Argyriou, D., 2010, Rec. Interactive Movie on DVD, Final Year Project, Department of Audio and Visual Arts, Ionian University, Corfu, Greece.
2. Atkins, D.E., J.S. Brown, and A.L. Hammond, 2007, A review of the open educational resources (OER) movement: Achievements, challenges, and new opportunities. Report to the William and Flora Hewlett Foundation.
3. Beerends, J.G. and F.E.D. Caluwe, 1999. The Influence of Video Quality on Perceived Audio Quality and Vice Versa. J. Audio Eng. Soc, 47(5): p. 355-362.
4. Biswas, A., 2008. Managing art-technology research collaborations. Int. J. Arts and Technology, 1(1): p. 66-89.
5. Cesar, P. and K. Chorianopoulos, 2009. The Evolution of TV Systems, Content, and Users Toward Interactivity. Found. Trends Hum.-Comput. Interact., 2(4): p. 373-95.
6. Deliyannis, I., A. Anastasios, and P. Pandis, 2009, Design and Development of an Experimental Low-Cost Internet-Based Interactive TV Station, in 4th Mediterranean Conference on Information Systems (MCIS): Athens.
7. Lovejoy, M. 2004, Digital Currents: Art in the Electronic Age: Routledge. 342.
8. Manovich, L. 2002, The Language of New Media: MIT Press. 394.
9. Popper, F. 2005, From Technological to Virtual Art: MIT Press Ltd. 504.
10. Ransburg, M., C. Timmerer, and H. W. Hellwagner 2008, Dynamic and Distributed Multimedia Content Adaptation based on the MPEG-21 Multimedia Framework. Studies in Computational Intelligence. Vol. 101/2008. Berlin: Springer.
11. Richardson, I.E.G. 2006, H.264 and MPEG-4 video compression: Video coding for next-generation multimedia Chichester: Wiley.
12. Seifert, U. and J.H. Kim, 2007, Entelechy and embodiment in (artistic) human-computer interaction, in Proceedings of the 12th international conference on Human-computer interaction: interaction design and usability Springer-Verlag: Beijing, China. p. 929-938.
13. Strapatsakis, M., 2008, Interactive art-installation: Invisible places - immense white: Strasbourg November 2008. p. Interactive Video Installation with use of sensors.
14. Tay, J. and G. Turner, 2009. Not the Apocalypse: Television Futures in the Digital Age. International Journal of Digital Television: p. 31-50.
15. Trifonova, A., L. Jaccheri, and K. Bergaust, 2008. Software engineering issues in interactive installation art. Int. J. Arts and Technology, 1(1): p. 43-65.
16. Ursu, M.F., et al., 2008. Interactive TV narratives: Opportunities, progress, and challenges. ACM Trans. Multimedia Comput. Commun. Appl., 4(4): p. 1-39.