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-
Video art is in most cases produced in digital files already encoded audio, that do not require further conversion. Under this 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.
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.

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>
<thead>
<tr>
<th>Presentation /Broadcasting Mode</th>
<th>Video Art</th>
<th>Live Performance</th>
<th>Interactive Installation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Static Media (DVD)</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Static Interactive Media (iDVD)</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Live Streaming Media (User or Professionally Directed)</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Multiple Cameras (User-Directed)</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

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 multimcata 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

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